Tennessee Department of Transportation

Work Zone Design Manual

TDOT Department of Transportation

March 2022

Preface

The Tennessee Department of Transportation (TDOT) *Work Zone Design Manual* (*WZDM*) has been developed to provide uniform work zone design practices for TDOT Design Teams, local agencies, and consultant personnel preparing traffic control plans. The *WZDM* presents a majority of the information that is typically required to develop a work zone design and prepare traffic control plans. However, the Design Team must exercise engineering judgment when making decisions to execute a work zone design approach that meets the desired outcomes of a project within the context of that project.

The *WZDM* provides a resource for designers to plan, design, construct, maintain, and operate work zone traffic control. By understanding the key principles, guidance, and applications provided in each chapter of the *WZDM*, a Design Team should be able to produce designs that consider the needs, safety, and mobility of the full range of roadway users.

The *WZDM* was developed by the TDOT Roadway Design Division with assistance from the transportation engineering consulting firm of Kittelson & Associates, Inc. The *WZDM* Review Committee consisted of:

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WORK ZONE DESIGN MANUAL

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INTRODUCTION AND OVERVIEW

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Chapter 1

Introduction and Overview

1.1 INTRODUCTION

The purpose of the Tennessee Department of Transportation (TDOT) *Work Zone Design Manual* (WZDM) is to:

- document the TDOT work zone design practices, procedures, standards, devices, and technologies
- guide practitioners designing work zones on projects managed and/or funded by TDOT
- characterize other best-practice strategies for work zone design
- provide designers with a resource for preparing traffic control plans, specifications, and cost estimates

The *WZDM* is a resource for all Design Teams developing work zone designs for TDOT-funded and/or managed projects and work permitted within TDOT right-of-way.

The *WZDM* is a resource for TDOT designers, engineers, and technical staff. In addition, this manual may also be useful for local agencies and consultants outside of TDOT that are involved in and developing work zone designs for TDOT-funded and/or managed projects and work permitted within TDOT's right-of-way. The manual focuses on design guidance for long-term stationary operations (i.e., more than three days in one location) but includes an overview of other types of operations. The *WZDM* does not include work zone analysis guidance and procedures but instead provides references to other TDOT resources related to work zone analysis.

Long-term is an operation that stays in one location for more than three days and a project specific Traffic Control Plan is typically required.

The *WZDM* has been developed to provide uniform work zone design practices for TDOT Design Teams, local agencies, and consultant personnel preparing traffic control plans. The *WZDM* presents a majority of the information that is typically required to develop a work zone design and prepare traffic control plans. However, the Design Team must exercise engineering judgment when making decisions to execute a work zone design approach that meets a project's desired outcomes within the context of that project. Engineering judgment includes evaluating available pertinent information—as well as the application of appropriate principles, standards, guidance, and practices contained in the *WZDM* and other sources—to decide the applicability, design, operation, or installation of a traffic control device and traffic control strategy. Engineering judgment shall be exercised by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer.

The Transportation Management Plan (discussed in **Chapter 2**) and the Work Zone Design Deviation Process (discussed in **Chapter 6**), provide documentation of engineering judgment that may be used on a project.

Chapter 1 sets the basis for the entire *WZDM* by providing an overview of the key goals and objectives for developing work zone designs for TDOT-funded and/or managed projects. It provides an overview of how to use the manual and an overview of the TDOT project development process, with references to key TDOT policies that relate to work zone design.

1.2 HOW TO USE THE MANUAL

The *WZDM* provides a resource for designers to plan, design, construct, maintain, and operate work zone traffic control. By understanding the key principles, guidance, and applications provided in each chapter of the *WZDM*, a Design Team should be able to produce designs that meet a project's desired outcomes and consider the needs, safety, and mobility of the full range of roadway users. **Table 1-1** provides an overview of each chapter in the *WZDM*.

Table 1-1
Chapter Overview

Chapter Title	Chapter Description and Key Guidance
Chapter 1 Introduction and Overview	Provides an overview of the manual purpose, intended audience, scope of information, and key TDOT policies and practices; describes how work zone design connects to the project development process.
Chapter 2 General Standards and Practices	Introduces the key principles of traffic control plan design; emphasizes safety and the importance of understanding the project context, type, and user needs; includes guidance for preparing transportation management plans and speed reduction requests.
Chapter 3 Stakeholder Outreach and Public Engagement	Provides guidance on stakeholder outreach and public engagement approaches for projects involving work zone design; includes information on how to engage stakeholders and coordinate with the TDOT Public Involvement and Communication Office.
Chapter 4 Pedestrians and Bicycles	Outlines design considerations for pedestrians and bicycles in the work zone; includes specific design elements and approaches for effectively integrating pedestrians and bicycles into the work zone design.
Chapter 5 Temporary Traffic Control Devices	Provides details and guidance for installing temporary traffic control devices in the work zone; highlights considerations for devices, including smart work zone devices.
Chapter 6 Work Zone Traffic Control Strategies	Outlines work zone traffic control strategies for work zone applications within the range of TDOT-funded and/or managed projects, including design details, figures, example photos, and additional information about applying temporary traffic control devices; includes constructability considerations and a decision-making framework for selecting an appropriate strategy.
Chapter 7 Traffic Control Plans	Outlines the traffic control plans that are developed for various work zone designs, including information about plan sheet function and sequence, developing plan sheets, typical sections, and drafting standards related to work zone design.
Chapter 8 Reference Materials for Specifications and Estimating	Provides guidance on how to develop and use specifications and standard drawings; references TDOT Standard Specifications, Special Provisions, Standard Drawings, and special details; includes guidance on what quantities to use for developing traffic control cost estimates, including information about traffic control plan pay items and quantity calculations.

The following appendices supplement the chapter content and provide additional details about terminology, procedures, devices, and traffic control plan examples.

- **Appendix A: Manual Terminology**
    - Glossary of Terms
    - List of Acronyms
- **Appendix B: Forms**
    - Work Zone Significance Determination Form (Chapter 1)
    - Delay and Qualitative Criteria Determination Form (Chapter 1)
    - Transportation Management Plan Form (Chapter 2)
    - Project Outreach Information Checklist (Chapter 3)
    - Example Completed Work Zone Design Deviation Form (Chapter 6)
- **Appendix C: Example Transportation Management Plans and Traffic Control Plans**
    - Freeway Widening Project
    - Bridge Repair Projects
    - Intersection Projects

See author notes in the margin for emphasizing key messages and referencing to other chapter content.

The manual includes author notes in the page margins to emphasize chapter content, provide additional considerations, and reference information between chapters. Website links to online resources have been provided throughout the manual to allow Design Teams to easily access other TDOT resources and tools.

1.3 Key Terminology and Definitions

This section presents the specific qualifying words used throughout the *WZDM* and provides definitions for key terminology. **Appendix A** provides additional information about manual terminology, including a glossary of terms and a list of acronyms.

1.3.1 Qualifying Words

Many qualifying words are used throughout work zone design projects and within the *WZDM*. 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. A deviation from the criteria may be granted through the Work Zone Design Deviation Process (discussed in **Chapter 6**) and requires approval from the State Work Zone Engineer and State Traffic Engineer.
2. **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. The decision made by the Design Team should be documented.
3. **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.
4. **Standard:** A statement of required, mandatory, or specifically prohibitive practice. The verb "shall" is typically used. The verbs "should" and "may" are not used in Standard statements. Standard statements are sometimes modified by options. A deviation from the standard may be granted through the Work Zone Design Deviation Process (discussed in **Chapter 6**) and requires approval from the State Work Zone Engineer and State Traffic Engineer.
5. **Guidance:** A statement of recommended but not mandatory practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate. The verb "should" is typically used. The verbs "shall" and "may" are not used in Guidance statements. Guidance statements are sometimes modified by options.
6. **Option:** A statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometimes contain allowable modifications to a Standard or Guidance statement. The verb "may" is typically used. The verbs "shall" and "should" are not used in option statements.

7. **Support:** An informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The verbs "shall," "should," and "may" are not used in Support statements.
8. **Criteria:** A term typically used to apply to design values, usually with no suggestion on the criticality of the design value.
9. **Target:** Selected criteria that the Design Team is striving to achieve. However, not meeting these criteria will typically not require a justification.
10. **Policy:** Indicates TDOT practice, which TDOT generally expects the Design Team to follow, unless otherwise justified.
11. **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.
12. **Minimum, maximum, lower, upper, (limits):** Representative of generally accepted limits within the design community but not necessarily suggesting that these limits are inflexible.
13. **Practical, feasible, cost-effective, reasonable:** Advise 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.
14. **Typical:** Indicates a design practice that is most often used in application. However, this practice does not necessarily represent the "best" treatment at a given site.
15. **Acceptable:** Design criteria that do not meet desirable values but are considered to be reasonable and safe for design purposes.

1.3.2 Key Terminology

The following key terminology is used consistently throughout the *WZDM* and is defined below to provide a clear understanding of each term's use in the context of the chapter content.

1. **Traffic Control Device (TCD):** A sign, signal, marking, or other device used to regulate, warn, or guide traffic that is placed on, over, or adjacent to a street, highway, pedestrian facility, shared-use path, or private road open to public travel by authority of a public agency having jurisdiction.
2. **Traffic Control Plan (TCP):** A plan describing the intended type and application of traffic control devices to be used for facilitating vehicle and pedestrian movements through a temporary traffic control zone. This may also be called a temporary traffic control plan (TTCP) or a work zone design plan. This manual will use "traffic control plan (TCP)." The TCP refers to the plans developed for long-term operations and the use of temporary devices and temporary work zone activities to control traffic during various construction phases.

The TCP refers to the plans developed for long-term operations and the use of temporary devices and temporary work zone activities to control traffic during various construction phases.

3. **Transportation Management Plan (TMP):** A Transportation Management Plan (TMP) is a complete evaluation of work zone issues for a project. It describes all projected impacts of the work zone, lays out a set of coordinated transportation management strategies, and describes how these strategies will mitigate the projected impacts. Transportation management strategies for a work zone include temporary traffic control measures and devices, transportation operations strategies, and public information strategies.

1.4 TDOT POLICIES AND PRACTICES

Developing and implementing traffic control plans require coordination with other departments within TDOT and collaborating with a multidisciplinary team. Engaging the appropriate departments within TDOT early in the development process will verify that the design decision making aligns with TDOT's policies and practices and meets both the project's and the roadway users' needs. There are additional TDOT policies, practices, and resources that can support decision making and developing traffic control plans.

TDOT's policy is to plan, design, construct, maintain, and operate safe and efficient work zones. Controlling all users traveling throughout a work zone is essential to highway construction, utility work, maintenance, right-of-way use, and environmental permitting. This section provides an overview of the TDOT policies and practices most relevant to work zone design.

1.4.1 TDOT Project Development Process

The designer needs to understand the overall TDOT project development process and how developing traffic control plan designs fits within the overall process.

To develop effective traffic control plans and adequately coordinate with the multidisciplinary team required to execute construction projects, the designer needs to understand the overall TDOT project development process and how traffic control plan design fits within the overall process. Chapter 1 of the TDOT *Roadway Design Guidelines* (*1*) and Chapter 3 of the TDOT *Traffic Design Manual* (2) outline details of the TDOT project development process, describe roles of the multidisciplinary team, and include specific instructions for developing and submitting design plans.

The project stages and process may vary depending on the unique project requirements. Some projects may not include each of the four stages described in Figure 1-1.

The TDOT projects typically include four primary stages:

- Preliminary Design
- Right-of-Way Design
- Construction (Design)
- Construction

Within each stage, there are key milestones for design team meetings, development, design plan submittal, and project cost/quantity estimation. **Figure 1-1** provides a graphical overview of the project process and illustrates how the work zone design activities align with each stage of the process. Some projects may not include each of the four stages described in **Figure 1-1**; however, each stage will be considered to assess the unique project needs, processes, and requirements.

Figure 1-1 TDOT Project Development Process Flowchart

PROJECT STAGES	ROADWAY DESIGN PROCESS	WORK ZONE DESIGN ACTIVITIES	TDOT STAFF COORDINATION
PRELIMINARY DESIGN	Initial Studies - Gather planning, survey and traffic data		
	Prepare Preliminary Plans and Estimates	Begin initial estimates for traffic control quantities and identify preliminary item numbers.	
	Preliminary Field Review	Begin initial traffic control planning and identify conceptual phasing considering constructability. Determine project significance.	Regional Safety Coordinators, Regional Traffic Engineer
	Design Meeting/Public Meeting (For Larger Projects)	Attend and discuss general traffic control elements such as road closures, detours, phasing, and potential adjacent property impacts.	
	Finalize Preliminary Plans and Estimates		
	Site Review	Attend and discuss traffic control based on Site Review requirements (See Chapter 1 of the TDOT Roadway Design Guidelines)	Regional Safety Coordinators, Regional Traffic Engineer
RIGHT-OF-WAY DESIGN	Prepare Right-of-Way (ROW) Plans, TCP and Estimated Roadway Quantities	Determine project significance. Determine type of Traffic Control Plan (TCP) needed (written or plans). Develop Draft TCP, Draft Transportation Management Plan (TMP), Estimated traffic control quantities. Speed reduction requests may be considered. Review the need for adjacent project coordination.	
	ROW Field Review	Attend and discuss Draft TCP and Draft TMP. Coordinate Draft TMP Traffic operations and public information strategies.	Regional Safety Coordinators, Regional Traffic Engineer
	Identify Permit Needs		
	Finalize ROW Plans	Update TCP based on field review comments. TMP is finalized, reviewed and signed. Confirm speed reduction requests.	Regional Traffic Engineer, Regional Safety Coordinators, State Work Zone Design Engineer
	Distribute ROW Plans, Draft TCP and TMP	Provide TCP information to Utilities for Utility Plan development.	
CONSTRUCTION (DESIGN)	Potential Constructability Review (If requested)	Discuss TCP and construction phasing. This only occurs if requested by the Construction Division.	Construction Division
	Prepare Construction Plans	TCP becomes part of the Construction Field Review. Confirm need for adjacent projet coordination.	
	Construction Field Review	Attend and discuss the TCP at the meeting. Updates to TCP are completed if needed.	Regional Safety Coordinators, Regional Traffic Engineer
	Finalize Construction Plans and Estimate, Re-Evaluate TMP	Finalize TCP, re-evaluate TMP, develop detailed quantity estimates.	
	Final Construction Review	Final TCP and Construction TMP is signed.	Regional Safety Coordinators, Regional Traffic Engineer
	Final Turn-in	Final TCP, Construction TMP and estimates are included.	
	Roadway Construction Letting	Prepare TCP Letting Revisions, if needed. Coordinate with adjacent projects, if needed.	
CONSTRUCTION (FIELD)	Project Construction	Implement TCP and coordinate with contractor. For Construction Revisions, follow the Contractor Change Request Process identified in Section 2.8.	Construction Division, Roadway Designer, Contractor

DESIGN MANAGER

As shown in **Figure 1-1**, high-level discussions about construction staging and potential strategies for minimizing impacts to adjacent properties and stakeholders begin in the Preliminary Design stage. Draft traffic control plans begin development in the Right-of-Way stage, and the plans continue to be refined and finalized during the Construction (Design) stage. The TMP (Transportation Management Plan) is a key component of identifying and planning for impacts to traffic and is initiated during the Right-of-Way stage. Additional information about the TMP is provided in **Chapter 2**.

The Design Manager is responsible for developing the traffic control plans. Regional Safety Coordinators, Regional Traffic Engineers, and the State Work Zone Engineer are engaged at various stages to discuss and review specific aspects of the traffic control plans.

Chapter 3 provides additional information about work zone outreach activities that may occur at each stage.

The Design Manager is responsible for developing the traffic control plans. Regional Safety Coordinators, Regional Traffic Engineers, and the State Work Zone Engineer are engaged at various stages to discuss and review specific aspects of the traffic control plans.

1.4.2 Design and Construction Approaches

There are three different design and construction approaches within TDOT:

- **Design-Bid-Build:** The Design-Bid-Build approach includes separate contracts (and contractors) for the design and construction stages of the projects. The TDOT Design Team may develop the design, or an outside designer may be contracted. Once the design is complete, TDOT solicits bids for a construction firm to execute the project. This is the most common type of project delivery method at TDOT.
- **Design-Build:** The Design-Build approach is a construction process in which a single contractor performs both the design and construction services for a project. For these projects, the design and construction phases typically overlap, which often reduces the overall project timeline and helps reduce project costs. However, this type of project requires additional oversight from TDOT staff to verify that TDOT policies, practices, and design criteria are followed and executed accurately. Additional directions on critical design criteria may be required, and consistent collaboration between the Design Team and TDOT staff is necessary.
- **Construction Manager/General Contractor (CM/GC):** The Construction Manager/General Contractor (CM/GC) approach is an integrated approach to planning, designing, and constructing a project. TDOT staff, designers, and contractors work collaboratively to develop the project scope, optimize the design, improve quality, and manage cost. A CM/GC project delivery allows TDOT to engage a Construction Manager during the design process for constructability input. The Construction Manager is generally selected based on qualifications, past experience, or a best-value basis. During the project development process, the Construction Manager advises on scheduling, pricing, phasing, and other input that facilitates a more constructible project. At the Right-of-Way stage (approximately an average of 60% to 90% design completion), TDOT and the Construction Manager negotiate a price, scope, and schedule, and the Construction Manager becomes the General Contractor.

The Design Manager should be familiar with the various design and construction approaches and understand the respective processes; however, the same principles outlined in this manual apply when developing traffic control plan strategies.

1.4.3 Determining Project Significance

The Work Zone Safety and Mobility (WZSM) Rule outlined in federal regulation, 23 Code of Federal Regulations (CFR) 630 Subpart J, requires a policy for the systematic consideration and management of work zone impacts on all federal-aid highway projects across all stages of project planning, development, construction, and operations *(3)*. The TDOT Work Zone Safety and Mobility Program applies this federal rule, which requires that all projects be classified into one of three categories: significant, non-significant, or exempt. These classifications allow TDOT to manage work zone impacts of individual projects and help determine what mitigation strategies should be considered in the Transportation Management Plan (TMP).

Chapter 2 provides additional information about developing TMPs and determining the project significance.

The *TDOT Work Zone Safety and Mobility Manual* outlines the implementation plan for this program, including guidance on work zone assessment and impact management, training, review process, and coordination with local agencies *(3)*. This manual is a resource for Design Teams to determine the significance of a project; develop TMPs; and identify internal responsibilities for developing, reviewing, and executing the TMP.

TDOT Work Zone Safety and Mobility Manual

1.4.3.1 Significant Projects

A Significant Project is one that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts that are greater than what is considered tolerable (see the Delay and Qualitative Criteria Determination Form shown below). Significant Projects are defined as follows:

Chapter 2 provides additional information the TDOT delay criteria.

The Delay and Qualitative Criteria Form determines if the work zone impacts are greater than what is considered tolerable.

- All freeway projects within the boundaries of a designated Transportation Management Area (TMA) that occupy a location for more than three days with either intermittent or continuous lane closure.
    - TMAs are defined in the *TDOT Work Zone Safety and Mobility Manual.*
- All freeway system projects where all lanes in one direction will be closed
- A project on a non-freeway with an average annual daily traffic (AADT) of at least 50,000 vehicles per day, where all lanes in one direction will be closed
- A project that meets TDOTs Delay/Qualitative Criteria (use the **Delay and Qualitative Criteria Determination Form** in the *Work Zone Safety and Mobility Manual*). This form includes an assessment of:
    - Delay Criteria, considering AADT
    - potential need for a Design Deviation
    - impacts to businesses and public interest
    - potential detours
    - impacts from concurrent projects

- A freeway project that cannot maintain horizontal lane widths of at least 11 feet and shoulder widths of at least 2 feet at all times
- A freeway project where lane closures are required during any phase of construction

Significant Projects require a detailed TMP, and additional information on developing TMPs is discussed in **Chapter 2** of the *WZDM*.

1.4.3.2 Non-Significant Projects

A Non-Significant Project does not meet the Significant Project criteria. This type of project does require a TMP but may not require all of the details of the traffic operations strategies and public engagement strategies that are required for a Significant Project. Additional details about the TMP requirements for Non-Significant Projects are provided in **Chapter 2**.

1.4.3.3 Exempt Projects

An Exempt Project is a project receiving state funding, federal funding, or both that has been preapproved to not have a determination completed. To be Exempt, the project must be listed as a qualifying project that meets ***all*** the qualitative requirements shown in **Table 1-2**. The qualifying projects generally have minimal impacts on traffic; if they meet the qualitative requirements, they are considered Exempt.

Table 1-2 Exempt Projects Qualifying List and Requirements

Qualifying Projects	
• Brush Control/Mulching	• Sweeping/Debris Removal
• Erosion Control	• Pavement Marking (moving)
• Litter Removal	• Pavement Patching
• Ditch Repair	• Pavement Marking
• Fence Repair	• Attenuator Installation/Repair
• Drainage Structure Repair (off-road)	• Sign Replacement
• Slide Repair (minor)	• Shoulder Repair
• Utility Projects w/o Motorist Impact	• Sign Repair
• Sinkhole Repair (minor)	• Bridge Inspection
• Brine/Snow Removal	• Guardrail Installation/Repair
• Flood Damage (minor)	• Tunnel Maintenance
• Vegetation Spraying	• Deck Patching
• Weather-Related Events (minor)	• Mowing
Qualitative Requirements	
Not on or over a controlled access facility (freeways and expressways)	
Less than three days in duration	
Work does not occur during peak traffic	

Freeways: full closed access.

Expressways: partially closed access.

Exempt Projects do not require a TMP, but all projects must comply with the *Manual on Uniform Traffic Control Devices (MUTCD)* and TDOT Standard Drawings with respect to the application of TCDs.

Consider *MUTCD* Typical Application 1 including the notes and Figure 6H-1.

Use the Work Zone Significance Determination Form to identify project requirements.

1.4.3.4 Work Zone Significance Determination Form

The Work Zone Significance Determination Form is a worksheet designed to help determine if a project is Significant or Non-Significant. This form must be completed for all projects that are not on the Exempt list. The Design Manager must sign this form. *(4)*

Work Zone Significance Determination Form

1.4.4 TDOT Project Coordination

Continuous collaboration within a multidisciplinary team throughout a project can verify that project goals are met and that early design decisions are communicated and brought forward to later design stages. This section provides an overview of the internal and external coordination that typically occurs for projects. In addition, this section includes detailed guidance for coordinating with contractors throughout a project's design and construction. Additional information about roles and responsibilities among a Design Team is provided in the TDOT *Roadway Design Guidelines* *(1)* and the TDOT *Traffic Design Manual* *(2)*.

1.4.4.1 Internal Coordination

As noted in **Section 1.4.1**, the Design Manager develops all traffic control plans and is responsible for leading the design activities, from Preliminary Design through the Construction (Design) stage. TDOT's Regional Offices lead most projects. Therefore, Regional Safety Coordinators and Regional Traffic Engineers review Traffic Control Plan documentation (and attend primary project meetings, such as the Preliminary Field Review, Site Review, Right-of-Way Field Review, and Construction Field Review meetings. The Design Team may coordinate with district personnel to obtain local information for a project. If the project involves a railroad, the Design Team will coordinate with the Railroad Coordinator.

At the TDOT headquarters, the State Work Zone Engineer is also engaged at various stages to discuss and review specific aspects of the traffic control plans. The State Work Zone Engineer is typically included in all projects that are identified as Significant and may be involved in other Non-Significant projects that may require additional oversight and statewide coordination.

1.4.4.2 External Coordination

Roadway projects typically require coordination with agencies outside of TDOT. The following external partners may require coordination, depending on the project's type and location.

- **Federal Highway Administration (FHWA):** If a work zone area interacts with the National Highway System (NHS) or involves federal funding, the Design Team is required to coordinate with the FHWA. See the *TDOT Work Zone Safety and Mobility Manual* for information about coordinating with FHWA. In addition, the FHWA Stewardship and Oversight Agreement provides additional resources for coordination with FHWA. *(5)*
- **Local Counties and Cities:** Work zone areas that impact local roadways not owned by TDOT require communication with local agencies to coordinate potential traffic impacts, freight mobility, and other potential projects. In addition, TDOT Design Teams may coordinate with local agencies on state roadways that are under local jurisdiction to discuss utilities and traffic signals.

- **Bordering States:** In some cases, work zone areas may extend beyond the state boundaries and impact roadways in adjacent states. For these projects, the TDOT Region Operations Director must communicate with the associated State Traffic Engineer of the neighboring state to identify any traffic mitigation needs and freight mobility requirements.

Figure 1-2 includes a map that shows the primary interstate system within Tennessee, the four TDOT regions, and the adjacent states that may require coordination for specific projects.

Figure 1-2
Agency Coordination Graphic/Map

1.4.4.3 Coordination and Communication with Contractors

Coordination with Project Contractor is an important aspect of verifying that the design and construction meet the intended project objectives. TDOT staff from Operations and Headquarter Construction Divisions are the primary personnel that communicate with the contractor. Specifically, the Operations Project Inspector maintains daily coordination and communication with the Contractor.

1.4.4.4 Design Change Requests

Despite consistent coordination and collaboration during the project design stages, some projects may require design changes during construction phase. The TDOT *Standard Specifications for Road and Bridge Construction (Standard Specifications)* *(6)* provide guidance on specification compliance and adjustments to plans.

The TDOT process for executing design change requests verifies that the change is thoroughly reviewed and confirmed by the appropriate TDOT staff and Design Teams. In some cases, the design change may be considered "minor" and not require any updates to the plan set or review by TDOT Regional staff. However, when "major" design changes are required, District personnel should fully document any proposed changes and review those changes with Regional Traffic Engineer. Projects previously designated as "Significant" through the TMP process should also alert State Traffic Engineer and State Work Zone Engineer of any "major" changes.

1.4.5 TDOT Resources

TDOT has numerous resources to support and guide work zone design activities. The following sections provide an overview of some key resources, and Design Teams should maintain a current understanding of these resources to verify any future changes to TDOT policies and practices.

1.4.5.1 Work Zone Analysis

The *WZDM* does not provide details about conducting work zone analysis. TDOT uses the following resources to analyze potential impacts of work zones and inform decisions regarding traffic control strategies.

- **TDOT Lane Closure Decision Support System (LCDSS):** The LCDSS allows an analyst to input a potential lane closure for a specific route, segment length, direction, and time to retrieve estimated queue data for that roadway facility during the potential closure. The LCDSS helps inform decision making for various traffic control strategies. *(7)*

  TDOT Lane Closure Decision Support System

- **Transportation Management Plan (TMP):** TMPs include a work zone impact assessment that provides additional information about projected queuing, traffic analysis, and delay criteria information. Additional information about TMPs is provided in **Chapter 2** of the *WZDM.*

1.4.5.2 Work Zone Field Manual for Maintenance Operations

The TDOT *Work Zone Field Manual* applies to projects of three days or less for maintenance. The *WZDM* focuses on long-term projects requiring a traffic control plan.

The TDOT *Work Zone Field Manual for Maintenance Operations* *(8)* supplements the information provided in Part 6 of the *MUTCD* and applies to temporary traffic control operations of three days or less for maintenance. The manual notes the need to follow temporary traffic control plans, specifications, and special provisions written for each specific project. The information in the manual intends to provide consistent statewide guidance about how to address common work operations for maintenance projects and is intended for TDOT use only.

TDOT Work Zone Field Manual for Maintenance Operations

1.4.5.3 Standard Drawings and Standard Specifications

TDOT Standard Drawings ensure that there is consistency in TDOT projects across the state *(9)*. Standard Drawings contain standard notes and details and are referenced from the contract plans. This reduces repetitiveness within the plans and prevents the designer from copying the commonly used notes and details into every set of plans. Standard Drawings help reduce both the number of drawings in project plans and the time it takes to prepare project plans. TDOT Standard Drawings are separated into eight sections; the Standard Drawings for Work Zones are located within the "Design-Traffic Control" Section.

Work Zone Standard Drawings

The *Standard Specifications for Road and Bridge Construction (Standard Specifications)* are TDOT's standards for work methods and materials that are used for construction. The Standard Specifications are part of all construction contracts and provide criteria for bidding, awarding, and executing the contract. The Standard Specifications are published in book form and can be accessed at the following website *(10)*:

Work Zone Standard Specifications

Specifications related to work zone design include Section 105: Control of Work and Section 712: Temporary Traffic Control.

1.4.5.4 Roadway Design Guidelines

Roadway Design Guidelines *(1)* ensure consistency in roadway design practices for TDOT projects across the State. The *Roadway Design Guidelines* outline the current recognized design standards for new construction or reconstruction of existing highways while giving due regard to topography, natural conditions, availability of road material, and prevailing traffic conditions. Traffic control plan development occurs within the overall TDOT roadway design process. Therefore, the Design Team should have a clear understanding of how the traffic control plan elements fit within the overall roadway construction design and plan development.

1.4.5.5 Traffic Design Manual

The *Traffic Design Manual* *(2)* is prepared in conjunction with the TDOT *Roadway Design Guidelines* to aid in the development of construction plans involving traffic signals, roadway lighting, signs, pavement markings, and minor intersection improvements. The purpose of this manual is to present the concepts and standard practices related to the design of traffic control systems within the State of Tennessee. While the TDOT *WZDM* will be the primary resource for developing traffic control plans, the *Traffic Design Manual* can provide additional details about specific design elements and other aspects of the overall construction plan set.

1.5 Integration with National Standards and Practices

There are additional resources beyond the *WZDM* that can support a Design Team in identifying traffic control strategies, developing traffic control plans, and implementing traffic control devices. Relevant publications from the FHWA and the American Association of State Highway Transportation Officials (AASHTO) along with accessibility guidelines from the United States Access Board should be reviewed and used to supplement the information in the *WZDM* to verify current design practice and national perspectives. The following sections briefly describe relevant national publications that may supplement and support the information in the *WZDM.* The most recent versions of the following publications should be used for reference, as needed.

1.5.1 Manual on Uniform Traffic Control Devices (MUTCD)

The *MUTCD* is published by the FHWA and contains national design, application, and placement standards, guidance, options, and support provisions for traffic control devices *(11)*. The *MUTCD's* purpose is to provide uniformity of these devices, which include signs, signals, and pavement markings, to promote highway safety and efficiency on the nation's streets and highways.

The *Rules of TDOT Chapter 1680-03-01: Adoption of the Tennessee Manual on Uniform Traffic Control Devices for Streets and Highways* outlines the State's adoption of the *MUTCD,* with specific exceptions *(12)*. TDOT has adopted most of the information in the *MUTCD* and outlines additional guidance on implementing traffic control devices using engineering judgment. It also provides different definitions for the terms *standard*, *guidance*, *option*, and *support*.

A traffic control plan developed for a TDOT-funded and/or managed project shall be consistent with the provisions under Part 6 of the *MUTCD* as adopted by the State. Traffic control plans may reference specific elements in the *MUTCD*, and the *MUTCD* can be used as a resource for additional details on traffic control devices and traffic control layouts. Additional information on the TDOT *MUTCD* adoption and exceptions can be found at the following website *(13)*:

Rules of TDOT Chapter 1680-03-01: Adoption of the Tennessee MUTCD

1.5.2 Standard Highway Signs and Markings Book

The *Standard Highway Signs and Markings Book* *(14)* contains the sign and marking designs that have been adopted by the *MUTCD*. This document is a companion to the *MUTCD* that provides additional sign and marking details that may be helpful when developing traffic control plans.

1.5.3 AASHTO Roadside Design Guide

The AASHTO *Roadside Design Guide (15)* presents the nationwide practices and guidance for roadside safety along highways and streets. It presents 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 *Roadside Design Guide* recommends 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. Traffic control plans developed for TDOT-funded projects shall be consistent with work zone hardware recommendations in Chapter 9 of the *Roadside Design Guide*.

1.5.4 AASHTO A Policy on Geometric Design of Highways and Streets

AASHTO's *A Policy on Geometric Design of Highways and Streets (16)*, more commonly known as the *Green Book*, discusses the nationwide policies, practices, and guidance for the geometric design of highways and streets. It presents a consensus view on the most widely accepted approach to designing a variety of geometric design elements, including design speed, horizontal and vertical alignment, cross-section widths, intersections, and interchanges. Geometric design information in the *Green Book* may supplement and provide additional details on the design guidance provided in the *WZDM.*

1.5.5 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, was also the compliance date for using the 2010 Standards for program accessibility and barrier removal *(17)*.

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 work zone design meets the needs of all users.

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

The draft *PROWAG* 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 pedestrians who are blind 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 *(18)*.

The *PROWAG* can be used as a resource for the Design Team to address accessibility considerations and ensure the work zone design meets the needs of all users. Design Teams should note that TDOT has adopted the draft guidelines, but the US Access Board and Department of Justice have yet to do so.

1.5.7 FHWA Applying the Americans with Disabilities Act in Work Zones: A Practitioner's Guide

The FHWA *Applying the American with Disabilities Act in Work Zones: A Practitioner's Guide* (19) uses national sources, such as the *MUTCD*, *ADA Accessibility Guidelines*, *PROWAG*, and others, to provide state and local transportation agencies with strategies and technical guidance on how to design traffic control plans that address pedestrian access during construction, including the needs of those with disabilities. The document describes the challenges that pedestrians with disabilities face, outlines considerations for planning and designing strategies to manage pedestrians in a work zone and provides examples to further assist practitioners in setting up work zones and making them safe for all pedestrians.

1.5.8 FHWA Handbook for Designing Roadways for the Aging Population.

The FHWA *Handbook for Designing Roadways for the Aging Population* (20) provides practitioners with a practical information source that links aging road user performance to highway design, operational, and traffic engineering features. This handbook supplements existing standards and guidelines in the areas of highway geometry, operations, and traffic control devices. Chapters 5 and 10 focus on construction and work zones.

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TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 2

GENERAL STANDARDS AND PRACTICES

March 2022

TN TDOT Department of Transportation

Contents

Chapter 2

General Standards and Practices

2.1 PRINCIPLES OF TRAFFIC CONTROL PLAN DESIGN

Chapter 2 introduces the key principles of traffic control plan design, emphasizes safety, and notes the importance of understanding the project context, project type, and user needs. This chapter illustrates the types of operations and the work zone area components and includes guidance for preparing transportation management plans and speed reduction requests.

The general standards and practices described in **Chapter 2** align with the overarching TDOT policy for work zone safety and mobility:

> ***"The Tennessee Department of Transportation's policy is to plan, design, construct, maintain, and operate safe and efficient work zones. The control of all road users (as defined by the MUTCD, Section 1A.13) through a work zone is an essential part of highway construction, utility work, maintenance, and right-of-way use permits." (1)***

The fundamental principles and objectives described in this chapter set the foundation for identifying appropriate traffic control devices (Chapter 5), developing traffic control strategies (Chapter 6), and developing traffic control plan sets (Chapter 7).

2.1.1 Guiding Principles and Key Objectives

Safety and mobility are the two key principles that guide the planning and implementation of work zones.

- **Safety:** The reasonable safety of each road user and worker is the top priority and must be an integral part of every project.
- **Mobility:** All forms of traffic movement through work zones should be managed to provide reasonable mobility for the context and conditions.

Traffic may be inhibited by reduced speeds, traffic congestion, and potential crashes. Speed reductions should be implemented according to TDOT's Work Zone Speed Limit Policy, described in Section 2.8.

As described in **Chapter 1**, the TDOT Work Zone Safety and Mobility Manual *(1)* outlines guidance on work zone assessment, impact management, training, review process, and coordination with local agencies. This manual outlines the following goals and objectives for work zone planning and design:

- Prioritize the maximization of reasonable safety in all work zones having TDOT oversight by reducing fatality, injury, and property damage crashes statewide.
    - Traffic may be inhibited by reduced speeds, traffic congestion, and potential crashes. Speed reductions should be implemented according to TDOT's Work Zone Speed Limit Policy, described in **Section 2.8**.
- Manage delay and other undesirable operational aspects of work zones.
- Promote consistency in all phases of work zone development, including planning, design, implementation, and operation.
- Integrate the needs of each road user, including vulnerable users, into the work zone design, and verify that traffic control measures and devices support access, safety, and mobility for each user.

Additional information about incident management is provided in the TDOT Incident Management Plan for each region.

Temporary traffic control may also be used at a traffic incident management area to inform road users of the incident and guide traffic along the route to follow through the incident area. Additional information on incident management is described in **Section 2.3.5**.

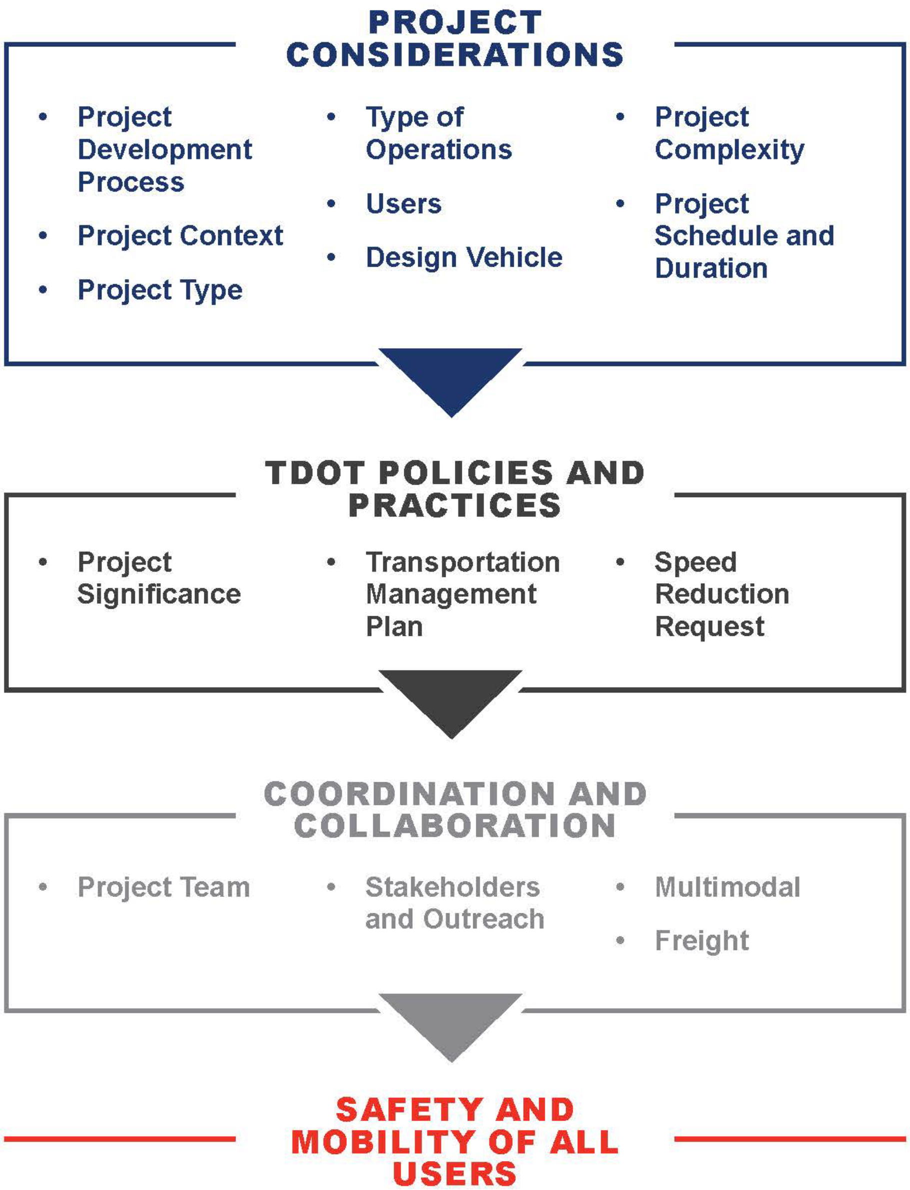
The Manual on Uniform Traffic Control Devices (*MUTCD*) *(2)* expands on fundamental principles and objectives to guide traffic control projects, as shown in **Table 2-1**. Additional details and considerations for each item are provided in the *MUTCD* and further described in this chapter.

Table 2-1 MUTCD Seven Fundamental Principles

MUTCD Section 6B.01 – Seven Fundamental Principles	
1.	General plans or guidelines should provide safety for motorists, bicyclists, pedestrians, workers, enforcement and other emergency officials, and equipment.
2.	Road user movement should be inhibited as little as practical.
3.	Motorists, bicyclists, and pedestrians should be guided in a clear and positive manner while approaching and traversing work zones.
4.	To provide acceptable levels of operations, routine day and night inspections of traffic control elements should be performed.
5.	Attention should be given to the maintenance of roadside safety during the life of the work zone.
6.	Each person whose actions affect work zone safety, from the upper-level management through the field workers, should receive training appropriate to the job decisions everyone is required to make.
7.	Good public relations should be maintained.

To develop traffic control plans that align with the principles and objectives established by TDOT and the *MUTCD*, the Design Team must understand how specific project considerations will affect the traffic control strategy decision making and implementation. **Figure 2-1** illustrates some of the key project considerations that **Chapter 2** describes as a basis for developing traffic control plans. If a Design Team clearly understands the project considerations, follows the appropriate TDOT policies and practices, and collaborates with other disciplines and offices, the team can more effectively work towards achieving safety and mobility for each road user.

Figure 2-1
Overarching Work Zone Design Flowchart



2.1.2 Work Zone Limits and Components

A Work Zone is an area within the right-of-way with construction, maintenance, or utility work.

TDOT defines a work zone as an area within the right-of-way with construction, maintenance, or utility work. A work zone is typically marked by some combination of signs, channelizing devices, barriers, pavement markings, and work vehicles. It extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last temporary traffic control device.

The work zone can be divided into several zones longitudinally and laterally. In the longitudinal direction, four distinct areas define the work zone design layout: the advance warning area, the transition area, the activity area, and the termination area. Within the activity area, the cross section of the work zone can be separated laterally into three spaces: work space, buffer space, and traffic space. **Table 2-2** provides an overview of each space and area, as outlined in Sections 6C.04 through 6C.07 of the *MUTCD (2)*. **Figure 2-2** illustrates the four areas for a typical work zone design.

Table 2-2
Work Zone Components

Work Zone Components	
Work Zone Layout	
Advanced Warning Area	The advanced warning area is where road users first recognize a work zone is approaching. This area includes the installation of advance warning signs and may change based on the traffic queues.
Transition Area	The transition area is the section of the highway where road users are redirected out of their normal path. Transition areas usually involve the strategic use of tapers.
Activity Area	The activity area is the section of the highway where the work activity takes place. It includes the work space, traffic space, and buffer space. A longitudinal buffer space may be used between the work space and the beginning of the downstream taper.
Termination Area	The termination area is the section of the highway where road users return to their normal driving path. The termination area extends from the downstream end of the work area to the last traffic control device, such as an END ROAD WORK sign, if posted.
Cross-Sectional Spaces within the Activity Area	
Work Space	The work space is the portion of the highway closed to road users and set aside for workers, equipment, material, and protective vehicles. Work spaces are usually delineated for road users by channelizing devices or barriers. The work space may be stationary or may move as work progresses.
Buffer Space	The buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area and may provide some recovery space for an errant vehicle. Neither work activity nor the storage of equipment, vehicles, or material should occur within a buffer space.
Traffic Space	The portion of the highway in which road users are routed through the activity area.

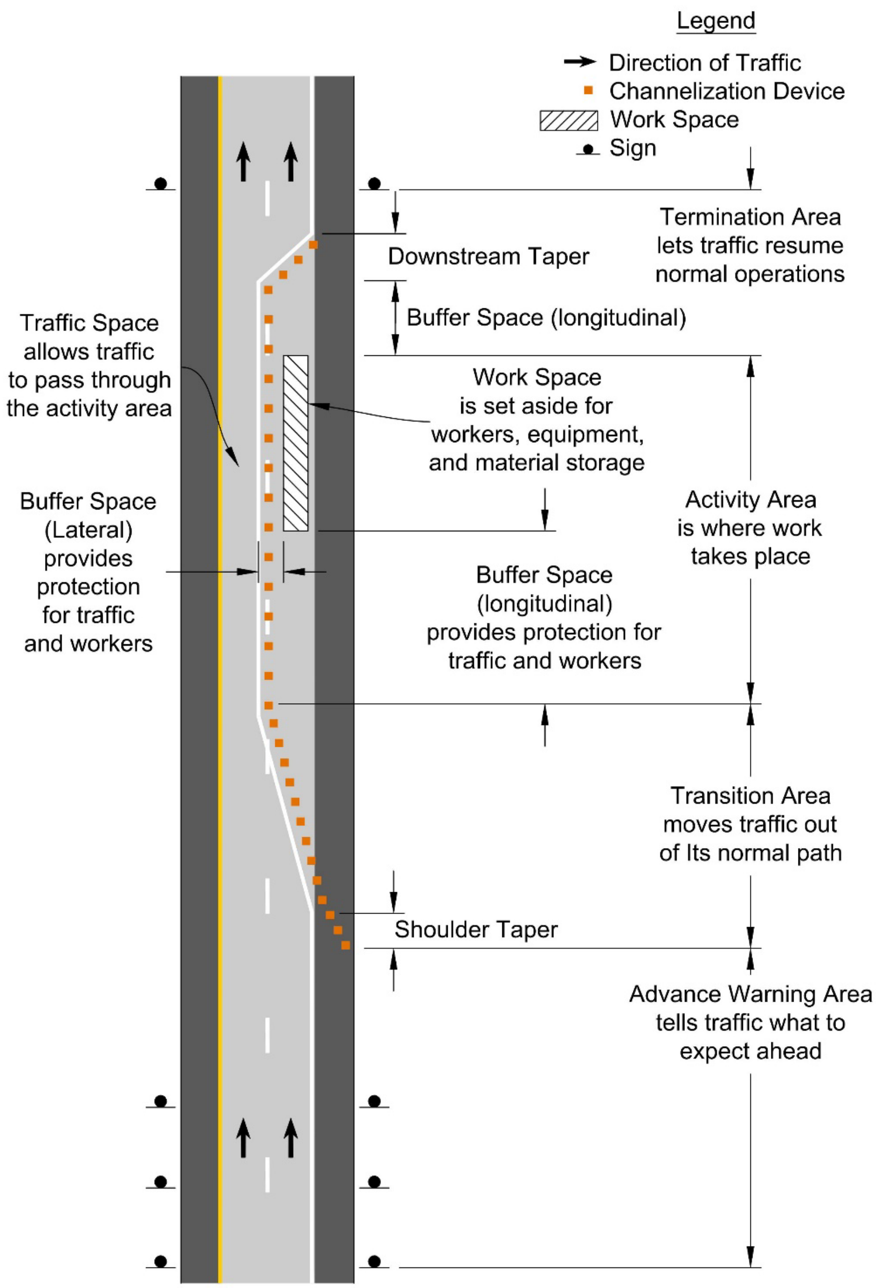


Figure 2-2
Work Zone Areas and Components

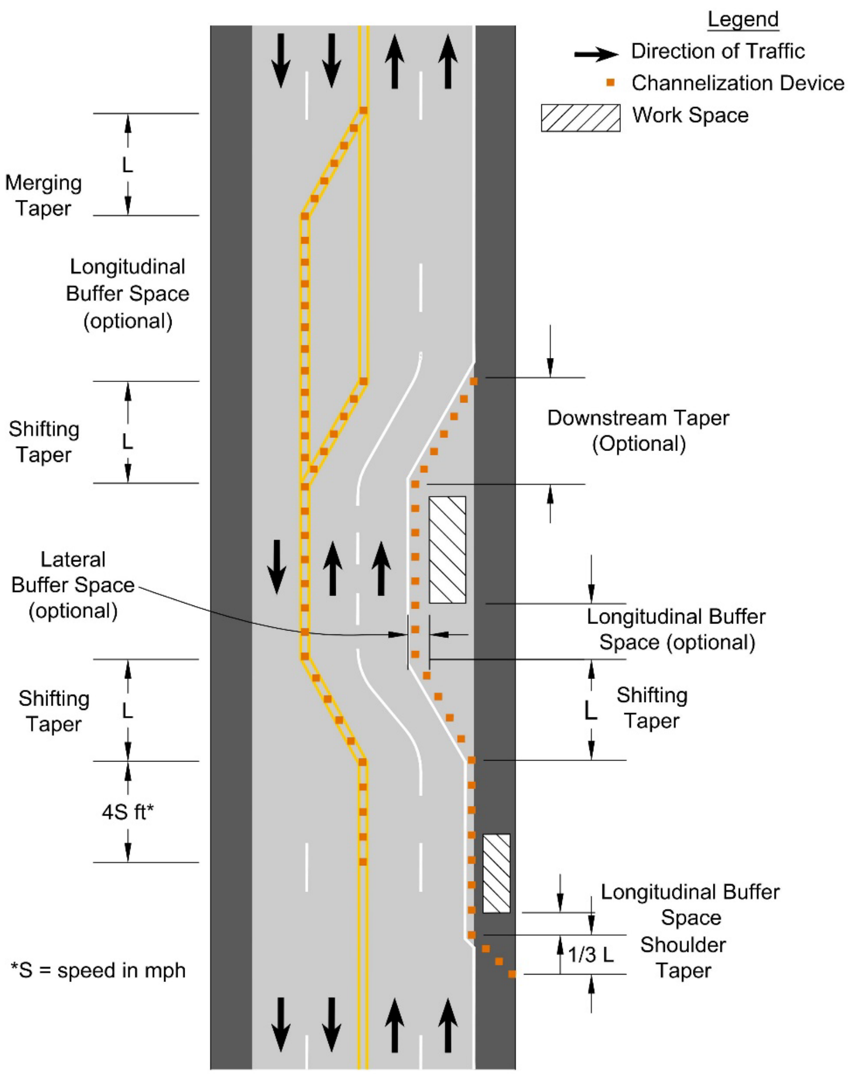
2.1.2.1 Tapers

Tapers may be used in both the transition and termination areas to adjust the number and position of lanes and shoulders. They are created by using a series of channelizing devices, pavement markings, or both to move traffic out of the normal path. Whenever tapers are to be used near an interchange ramp, crossroads, curves, or other influencing factors, the length of the tapers may increased, based on location-specific conditions. The appropriate length for tapers begins by determining the length, "L." **Table 2-3** summarizes the types of tapers that may be included, and **Figure 2-3** illustrates the location of the tapers within a typical work zone design example.

Table 2-3
Types of Tapers

Types of Tapers	
Merging Taper	A merging taper merges two traffic lanes into one lane. A merging taper requires the longest distance because drivers are required to merge into common road space. The length of a merging taper is equal to L. Successive or Multiple Tapers should be separated by a reasonable distance to allow drivers to accomplish one maneuver at a time and readjust their speed. TDOT specifies a minimum length of 2X L between the end of the first taper and the beginning of the next taper
Shifting Taper	A shifting taper is used when a lateral shift is needed. When more space is available, a longer than minimum taper distance can be beneficial. Horizontal curves designed for appropriate highway speeds can also accommodate changes in alignment. A shifting taper should have a length of approximately L.
Shoulder (Closure) Taper	A shoulder taper is beneficial on a high-speed roadway where shoulders are part of the activity area and are closed or when improved shoulders might be mistaken as driving lanes. In these instances, the same type, but abbreviated, closure procedures used on a typical portion of the roadway can be used. If used, shoulder tapers should have a length of approximately 1/3 L. If a shoulder is used as a travel lane, either through practice or during a traffic control activity, a typical merging or shifting taper should be used. Shoulder (Closure) tapers need to account for nonmotorized users that may be using the shoulder. See **Chapter 4** for further details.
One-Lane, Two-Way Traffic (Flagger) Taper	The one-lane, two-way taper is used in advance of an activity area that occupies part of a two-way roadway in a way that a portion of the road is used alternately by traffic in each direction. Traffic should be controlled by a flagger or temporary traffic control signal. A STOP or YIELD sign can accommodate low-volume conditions if one end of the work zone can be seen from the other end. A short taper with a minimum length of 50 feet and a maximum length of 100 feet with channelizing devices should guide traffic into the one-lane section, and a downstream taper should guide traffic back into their original lane.
Downstream Termination Taper	The downstream termination taper guides traffic back into its original lane at the end of the activity area. When used, this taper should have a minimum length of 50 feet and a maximum length of 100 feet with channelizing devices.

Figure 2-3
Types of Tapers



Chapter 6 provides additional guidance for designing tapers and calculating taper length.

Chapter 6 provides additional guidance for designing tapers and calculating taper lengths.

2.1.2.2 Detours and Diversions

Chapter 6 provides additional guidance for designing detours and diversions.

At times, it may be necessary to more aggressively separate traffic from the work area. In this case, there are two common traffic control measures available:

- **Detour:** Used to close a roadway to some or all users and move them from the existing facility to an alternate existing facility, often outside the project limits. Detours should be clearly signed over their entire length so that road users can easily use existing facilities to return to the original roadway.
- **On-site Diversion:** Used to move traffic out of its original alignment and onto another part of the existing roadway or onto a temporary surface constructed within the project right-of-way or a construction easement.

Traffic is diverted around the work area using a combination of signing, channelizing devices, barriers, and pavement markings. On-site diversions can be configured to accommodate all existing traffic lanes; a reduced number of lanes; or a single, reversible lane controlled by a temporary traffic signal or flagging operation.

Chapter 6 provides additional guidance for designing detours and diversions.

2.1.3 Communicating Traffic Control Design

The Transportation Management Plan (See Section 2.7) also provides additional information about what information is required in the TCP.

A TCP describes traffic control measures to be used for facilitating road user travel through a work zone area. TCPs provide continuity of effective road user flow when a work zone, incident, or other event temporarily disrupts normal road user flow. A TCP can take one of two basic forms: A Written TCP or a project-specific TCP with Plan Sheets. Understanding the project significance, as described in **Chapter 1**, can help determine the level of detail a TCP may require. However, ***the Design Team should confirm the type of TCP with the Regional Traffic Engineer.*** **Chapter 7** provides more details about TCPs.

2.1.3.1 Written Traffic Control Plan

A Written TCP includes project-specific Special Provisions and applies to TDOT Standard Drawings. Written TCPs are common for projects with the following attributes:

- construction details and instructions that can be conveyed solely using specification language and Standard Drawings
- shorter project duration (typically less than a few months)
- simple scope of work that may only include a few work activities (e.g., preservation work or a shoulder widening project).

Chapter 8 provides additional guidance for Special Provisions.

The Design Team is not involved in preparing Special Provisions or Circular Letters, but these documents may guide aspects of the overall project. Special Provisions are developed and coordinated at TDOT Headquarters.

2.1.3.2 Project-Specific Traffic Control Plans

Chapter 7 provides additional guidance for Traffic Control Plans.

Projects that are more complex make it impractical to rely solely on Standard Drawings and Special Provision language to relay vital and necessary construction staging information to the Contractor to help ensure road user safety, mobility, and accessibility. Under these circumstances, developing a project-specific TCP with plan sheets significantly enhances the TCP's success and effectiveness. Project-specific traffic control plan sheets are required when projects include one or more of the following features:

- One or more work activities cannot easily be described solely using project-specific Special Provisions (such as Special Provision 108b) or Standard Drawings.

- The scope of work is complex. This includes projects with multiple shifts in traffic that are not described in written Special Provisions or cannot be easily added to Special Notes. These projects are typically of a longer duration, such as several months to a year or more. Special Provisions are not created by the Design Team; TDOT Headquarters prepares Special Provisions.
- The project includes full or partial facility closures and detours for one or more modes of travel—motor vehicles, bicycles, pedestrians, or a combination.
- The project has pedestrian-specific construction staging or needs Temporary Pedestrian Accessible Routes.
- The project has a challenging location or site conditions.

Plan sheets are used to describe how the existing roadway area is to be divided between active traffic and the active construction area. Plan sheets also identify the types, quantities, and locations of temporary traffic control devices included in the TCP.

Chapter 7 includes information on traffic control plan sheet function and sequence, developing plan sheets, typical sections, and drafting standards related to work zone design.

2.2 SAFETY

The protection of life and property for all transportation modes in Tennessee is the most important element of TDOT's mission. TDOT takes great care to address safety through its programs, policies, and implementation of new technologies. The TDOT Strategic Highway Safety Plan (SHSP) outlines the state's mission:

"Using education, enforcement, engineering, and emergency response initiatives, work toward zero deaths and serious injuries by reducing the number and severity of crashes on Tennessee's roadways." (3)

Safety of the work zone personnel and public is the most significant priority when planning and designing traffic control plans. As noted in the *MUTCD*, the primary function of work zones is to provide for the reasonably safe and effective movement of road users through or around the work zone areas while reasonably protecting road users, workers, responders to traffic incidents, and equipment *(2).*

2.2.1 Public Safety

When work zones are designed based on the safety priorities noted above, the traffic control plan minimizes the probability and severity of traffic crashes and optimizes safety and efficiency for highway workers. The objective of a traffic control plan is to route road users through or around a work zone safely by:

- using signs and pavement markings that begin well in advance of the work zone and are adequately spaced throughout the work zone
- using devices that highlight or emphasize the appropriate path for each user
- avoiding frequent or abrupt changes in roadway geometry
- avoiding unanticipated or abrupt changes in speed

Figure 2-4 illustrates a work zone being installed to encourage public safety through the work area.

Figure 2-4
TDOT Work Zone Areas Demonstrating Public Safety *(4)*

2.2.2 Worker Safety

The safety of workers performing the many tasks within the work space is equally important to the safety of the public traveling through the work zones. The changing conditions and roadway configurations may be unexpected by the road user, which can increase vulnerability for the workers along with incident management responders on or near the roadway. Minimizing the volume of road users (through detours or diversions) and using traffic control devices that increase user awareness and provide clear direction can improve worker safety in the work zone area.

Within the work zone, itself, equipment and vehicles operating in the work zone area can create a risk to work zone personnel. Therefore, maximizing the separation between construction equipment and workers traveling on foot through the work zone is important. This includes verifying the separation clearance and sight lines for workers operating equipment.

Figure 2-5
TDOT Staff Demonstrating Worker Safety *(4)*

Based on the information in Section 6D.03 of the *MUTCD*, **Table 2-4** outlines key considerations for worker safety and work zone management *(2)*.

Table 2-4 Worker Safety Considerations

Worker Safety Considerations	
Training	All workers should be trained on how to work next to motor vehicle, bicyclist, and pedestrian traffic to minimize their vulnerability. Workers having specific traffic control responsibilities should be trained in traffic control techniques, device usage, and placements specific to their responsibility.
Worker Safety Planning	Trained work zone personnel should conduct a basic hazard assessment for the worksite and job classifications required in the activity area. These personnel should determine whether additional engineering, administrative, or personal protection measures should be implemented.
Speed Reduction	Reducing the speed of vehicular traffic may be considered. Additional information on Speed Reduction Request is provided in **Section 2.8**.
Activity Area	The internal work activity area should be planned so that backing-up maneuvers of construction vehicles are minimized. This reduces the risk to workers.
Shadow Vehicle	For mobile and constantly moving operations, such as pothole patching and striping operations, a shadow vehicle, equipped with appropriate lights and warning signs, may be used to protect the workers from impacts by errant vehicles. The shadow vehicle may be equipped with a rear-mounted impact attenuator.
Queue Protection	TDOT's Protect the Queue campaign emphasizes the importance of protecting drivers caught in a traffic queue. Work zone personnel consider implementing queue management techniques, such as a queue protection truck or portable queue warning system.
Road Closure/Detours	If alternate routes are available to handle road users, the road under construction may be closed temporarily. This may also facilitate project completion and thus further reduce worker vulnerability.
Law Enforcement	In highly exposed work areas, law enforcement units may be stationed to heighten the awareness of passing vehicular traffic and to improve safety through the work zone.
Lighting	For nighttime work, the work zone and approaches shall be lighted.
Special Devices	Special devices may be used to alert workers of approaching errant vehicles. These include rumble strips, changeable message signs, hazard identification beacons, flags, and warning lights.

Section 2.8 provides additional guidance for Speed Reduction Requests.

2.3 TYPES OF OPERATIONS

The types of construction operations can be classified into four categories:

- **Mobile operations:** work that moves intermittently or continuously.
- **Short duration operations:** work that occupies a location for up to one hour.
- **Short-term stationary operations:** daytime work that occupies a location for more than 1 hour within a single daylight period.
- **Intermediate-term and/or night operations:** work that occupies a location for more than one daylight period for up to three days or nighttime work lasting more than 1 hour.
- **Long-term stationary operations:** work that occupies a location for more than three days.

The TDOT *Work Zone Field Manual for Maintenance Operations* (*Field Manual, 5*) provides guidelines and typical applications for use in mobile operations, short-term stationary operations, and intermediate-term/night operations. The *Field Manual*, which contains temporary traffic control (TTC) zone layouts, has been organized so that field personnel can determine the proper temporary traffic control layout or layouts for the work zone they need. The layouts are divided primarily by the type of roadway and type of work space needed.

Chapter 4 provides additional guidance for pedestrians and bicycles.

Each type of operation should consider impacts to pedestrians, bicyclists, and transit facilities, and traffic control should be implemented as necessary to facilitate their travel through the work zone. **Figure 2-6** provides an example of a long-term stationary work zone.

Figure 2-6 Example Work Zone Operations *(7)*

2.3.1 Mobile Operations

Mobile operations include work that moves intermittently or continuously. Traffic control devices are typically mounted on vehicles that move with the work zone. Examples of mobile operations include:

- interstate overhead sign installation
- raised pavement markers
- pavement/pothole patching
- crack/Joint Sealing
- maintenance Contracts (sweeping, mowing)
- striping operations (case specific)
- litter removal

Most mobile operations can be accomplished using "typical" TTC layouts contained in the *Field Manual*. The *Field Manual* provides additional details and considerations for this type of operation, including a checklist and framework for items that should be considered.

Mobile operations may be used as interim TTC measures to provide safe working conditions for the setup of longer-term stationary work zones. Early notification and consistent communication are important to adequately plan the projects. For example, a mobile operation may be used to set up a lane or ramp closure on a freeway or other high-speed or high-volume highway. A rolling roadblock is a type of mobile operation that may be considered for providing the temporary closure of a facility. The rolling roadblock provides for the short-duration closure of the highway while generally maintaining the movement of public traffic. **Chapter 6** expands on this operation.

Early notification and consistent communication are important to adequately plan projects.

2.3.2 Short Duration and Short-Term Stationary Operations

Short duration operations include work that occupies a location for up to one hour and involves minimal traffic control devices are. Examples of short duration operations include:

- fixing potholes
- blasting operations
- maintaining roadside hardware (guardrail, signs, street lights, barriers, etc.)
- minor utility work and access to manholes

Short-term stationary refers to daytime work that occupies a location for more than 1 hour within a single daylight period. These operations include advance signing and channelizing devices. Examples of short-term operations are:

- roadside slope excavation
- minor utility work
- paving
- bridge repair
- beam setting
- striping

Most short-duration and short-term operations can be accomplished using "typical" TTC layouts contained in the *Field Manual*. The *Field Manual* provides additional guidance for these types of operations, including a checklist and framework for items to consider. The decision to use a short duration or short-term operation should consider the length of time needed for work zone setup as well as the exposure of workers during that setup relative to the actual construction or maintenance work necessitating the work zone. For projects with relatively low speed or low volume roadways, a minimal work zone setup may be warranted.

Short duration or short-term operations may facilitate the transitions between phases of construction for long-term stationary operations. Examples include:

- placing or moving temporary barriers at the onset of the project or shifting between phases
- erecting overhead signs or structures
- paving operations for temporary on-site diversions

Figure 2-7 illustrates an example of a short-term operation.

Figure 2-7 Example of Short Duration/Short-Term Operations *(8)*

2.3.3 Intermediate-Term Stationary

Intermediate-term stationary is work that occupies a location more than one daylight period for up to 3 days or nighttime work lasting more than 1 hour. Advance signing and larger channelizing devices are required and may include temporary plastic drums and other reflective panels and barricades. These traffic control devices are discussed in further detail in **Chapter 5**. Examples of intermediate-term and night operations include:

- paving operations
- temporary widening
- bridge repair
- utility work

Most intermediate-term and night operations can be accomplished using "typical" TTC layouts contained in the *Field Manual*. However, some projects require more detailed traffic control plans (similar to what would typically be required for a long-term duration operation). For example, patching a pothole on a high-volume, high-speed freeway may require less than 15 minutes of time (such as what could be served with a mobile operation), but a stationary lane closure may be needed because of high traffic volumes. The *Field Manual* provides additional guidance for these types of operations, including a checklist and framework for items to consider. **Figure 2-8** illustrates an example of night operations.

Figure 2-8 Intermediate/Night Operations *(9)*

2.3.4 Long-Term Stationary Operations

Long-term stationary operations are the primary focus of the *WZDM*. Long-term stationary is work that occupies a location for more than three days. A project-specific Traffic Control Plan is typically required.

Typical long-term operations include:

- roadway reconstruction or rehabilitation
- projects on the existing alignment
- new construction
- roadway or intersection widening
- major utility or drainage work
- construction of traffic structures or traffic signals
- bridge repair
- emergency repair (e.g., landslides)

Long-term stationary operations typically present greater impacts to mobility and safety for the traveling public and construction personnel than the mobile, short-term, and intermediate-term operations described above. This includes a greater length of exposure to construction impacts, a larger overall project area, and increased complexity of the impacts. Therefore, long-term operations require additional attention to traffic control strategies that avoid or mitigate these impacts.

2.3.5 Incident Management

The *MUTCD* defines a traffic incident as *"an emergency road user occurrence, a natural disaster, or other unplanned event that affects or impedes the normal flow of traffic" (2).*

Traffic incidents can be divided into three general classes of duration, each of which has unique traffic control characteristics and needs:

- **Major incidents:** expected duration of more than 2 hours.
- **Intermediate incidents:** expected duration of 30 minutes to 2 hours.
- **Minor incidents:** expected duration under 30 minutes *(2).*

The primary functions of temporary traffic control at a traffic incident management area are to inform road users of the incident and to provide guidance information along the route to follow through the incident area. Alerting road users and establishing a well-defined path to guide road users through the incident area will:

- serve to protect the incident responders and those involved in working at the incident scene
- help with moving road users expeditiously past or around the traffic incident
- reduce the likelihood of secondary traffic crashes
- preclude unnecessary use of the surrounding local road system *(2)*

Examples include a stalled vehicle blocking a lane, a traffic crash blocking the traveled way, a hazardous material spill along a highway, and natural disasters (e.g., floods and severe storm damage).

To decrease response time during incidents on the Interstate Highway System, TDOT has created an Interstate Incident Management Plan for each region. The plans provide all regional staff, especially Maintenance and Incident Management offices, with action plans and pre-established detours based on the location of an incident on the Region's Interstate system. The plans for each region can be found online at the following link *(10)*:

Interstate Incident Management Plan by Region

Traffic control designers should be aware of the Incident Management Plan for the given section of highway their project may impact and should determine if a temporary change to the plan will be required during construction. Coordination should take place with the Region Maintenance and Incident Management offices to implement any changes and to notify Emergency Responders and other applicable parties of construction activities.

If the project proposes to reduce the number of lanes on a roadway, answers to the following questions should be determined:

- How will emergency responders travel through or around the work zone?
- How will emergency responders access the incident within a work zone?
- If an incident requires the closure of additional lanes beyond those closed for construction, will a full closure and detour be required? Is a detour route available?
- In the event of an incident or detour, will large trucks need to follow a different route than general traffic?

2.4 PROJECT ELEMENTS

The unique nature of each work zone presents Design Teams with a broad range of design challenges. These challenges should be explored throughout the project development process to identify the safest and most effective traffic control strategies to address those challenges.

As project development begins, Design Teams should carefully investigate each facet of the project, looking for details, conditions, restrictions, opportunities, and other factors that must be addressed to determine the most appropriate design of traffic control for the project. Some key project considerations discussed in this section include:

- project context
- project type and scope
- project complexity
- project duration and schedule

2.4.1 Project Context

Project context refers to a project's environment, such as urban versus rural, high-speed facility versus low-speed facility, or all travel modes present versus mostly trucks. Identifying and understanding the project context is one of the first steps in planning and designing a work zone. Gathering information and documenting existing roadway characteristics, adjacent land uses, and key roadway users can help the Design Team consider project needs and constraints. For example, a work zone design in an urban location may necessitate slower design configurations and emphasize pedestrians and bicycle users, while a rural highway application may emphasize oversize and overweight trucks. Freeway and limited access facilities go through urban and rural environments and typically have higher speeds and volumes, large trucks, and limited pedestrian and bicycle activities.

Based on the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets (5)*, projects may include the following contexts:

- Rural
- Rural Town
- Suburban
- Urban
- Urban Core

Table 2-5 outlines some of the characteristics that may be associated with rural and urban areas. The information in the table is not meant to be a recommendation or standard practice. The table provides a starting point for Design Teams to begin considering how design elements may change depending on the context. In addition, the differences in driver expectations for various contexts should be considered, particularly if nighttime work is included in the projects.

Table 2-5 Project Context Considerations

Chapter 4 provides additional guidance for pedestrians and bicycles.

Chapter 6 provides additional guidance on speed management techniques.

Consider the differences in driver expectations for each context.

The Design Team and construction staff should collaborate early in the project regarding constructability and potentially challenging project activities.

Project Context Considerations		
Design Element	**Urban**	**Rural**
Speed	Low to Moderate 25 mph to 45 mph	Moderate to High 35 mph to 70 mph
Design Vehicle	Lower percentage of total traffic. Limited oversize/overweight trucks.	Higher percentage of total traffic. Consider oversize/overweight trucks.
Traffic Volume	High volumes Multiple peaks Omni-directional patterns	Moderate Volumes Fewer peaks Directional patterns
Pedestrians and Bicycles	Increased presence of each user Consider influence on traffic control May require additional facilities and treatments	Reduce presence of each user Less influence on overall traffic control

NOTE: Use “urban” for context information for rural town, suburban, urban, and urban core.

The transition area between rural and urban areas can become an important space for drivers to adapt to changing roadway conditions. If a work zone is in a transition area, it can be designed to encourage speed reduction with specific design elements and treatments. **Chapter 6** provides additional information on speed management and treatments.

2.4.2 Project Type and Scope

While all projects should follow the same general principles for traffic control design, different project types or scopes may warrant different approaches to maintaining safety and mobility during construction. The Design Team must clearly understand the type of work that is being completed and how it may impact the design approach. Work zone design may be involved in the following types of projects at TDOT:

- pavement preservation or rehabilitation
- projects on the existing alignment
- new construction
- bridge repair
- emergency repair (e.g., landslides)
- intersection modifications

In addition, there may be other unique project types that require work zone design support, such as intelligent transportation system (ITS) projects, safety projects, enhancement projects, and local program projects (e.g., sidewalks).

When assessing the project type and work activities, the Design Team should identify any work that may involve complex construction or use highly specialized materials and equipment. **Collaboration between the Design Team and construction staff about constructability and potentially challenging project activities early in the process can help the team to adapt and prepare for the implementation of the work zone.**

As noted in **Chapter 1**, understanding the project significance is the first step to understanding the project type, developing a Transportation Management Plan (TMP), and initiate planning of the traffic control design approach. The project significance and TMP process can guide understanding the key project attributes that may impact the design.

Table 2-6 summarizes some key questions to answer for each type of project.

Table 2-6 Project Type Considerations

Project Type	Key Questions to Answer
General (All Projects)	• What is the roadway type and terrain? • What are the Annual Average Daily Traffic (AADT) and traffic volume characteristics? • What is the extent of the work? • Can multiple lanes be closed to accelerate the work? • Can the road be closed completely (long or short-term)? • How extensive is the access control within the project limits? • What are the expected types and sizes of vehicles traveling/turning through the roadway and/or intersection? • Are flagging operations necessary or practical to manage traffic during work activities? • Should the project be accelerated?
Pavement preservation/ rehabilitation	• Is the project an overlay, grinding, and full-depth reconstruction? • What type of material is being used to repair/replace the existing pavement?

Projects on the existing alignment	• Are geometric changes being made to the alignment?
	• Is capacity being added to the new facility?
	  ○ Additional lanes or widening?
	• Is the control of traffic being changed?
	  ○ Is the project adding or removing a traffic signal(s)?
	• Are local public services (transit, mail, schools, police/fire) being affected?

New construction	• How does the new construction interact with existing roadway facilities? • Are any existing roadways affected by the new construction?

Bridge repair	• Is the project building a new bridge, or repairing an existing bridge?
	  ○ If new, is the bridge being built in a different location or the same location?
	  ○ Are there plans for demolition and removal of the existing bridge?
	  ○ How is the existing bridge configured?
	• Would the structural configuration allow the bridge to be partitioned to allow for staging traffic on a portion of the bridge?
	  ○ Are there in-water work limitations?
	  ○ Can traffic capacity on the existing bridge be reduced during construction?
	  ○ Can the road be closed (long or short-term), and traffic detoured?
	• Are practical alternate routes available as detours?
	  ○ Is the construction schedule being accelerated? If not, can it be?
	• Are there geometric, topographical, or other environmental constraints?

Table 2-6 (*continued)*
Project Type Considerations

Project Type	Key Questions to Answer
Emergency repair	• What type of emergency repair is required? ○ Landslide? • What space and/or capacity is available for routing traffic during the repair? • What is the estimated length of time to complete the repair? Does the project need to be accelerated? • Are there alternate routes available for traffic?

Intersection Project	• What is the intersection control type?
	• Does the project include widening or capacity improvements, pedestrian improvements, bicycle improvements, traffic signal work, other?
	• What are the space requirements for construction activities?
	  ○ Can the work take place outside existing travel lanes, or are lane closures required?
	  ○ Where will construction equipment and materials be staged? Will this require additional space within the intersection?
	• What are the capacity needs of the intersection during construction?
	  ○ Do lanes need to be re-opened during specific times (i.e., peak commute hours)?
	  ○ Are there adjacent intersections or interchange ramps that might be impacted negatively by traffic queuing during construction?
	• Are there alternate routes available for pedestrians impacted by construction activities?

Figure 2-9 provides an example of a reconstruction project.

Figure 2-9
Example Reconstruction Project *(11)*

2.4.3 Project Complexity

Project complexity refers to the level of detail required within the traffic control plans to communicate project staging, the existing project constraints that may require innovative design approaches, and the interaction between the work activities and the road users during the project. Complex projects may require adding more plan sheets to clarify unique construction features or processes that are not easily conveyed through the Special Provision language or Standard Drawings.

One of the first steps to determining the project complexity is understanding the project significance, as noted in **Chapter 1**. The project significance and complexity will determine the level of detail required in the Transportation Management Plan (TMP). The TMP will include project details and considerations that summarize the complexity and staging of work activities.

Project complexity is often (but not always) proportionate to the project type and project significance. For example, some significant, large projects may include simple, straightforward traffic control plans with little complexity. This could include, for example, a project that involves widening or repaving a freeway, where work can be completed parallel to the freeway on the shoulder or lane during off-peak time periods.

On the other hand, some simple projects may benefit from added complexity within the staging plans to integrate each roadway user or to accommodate traffic mobility during various times of the day. Some examples include:

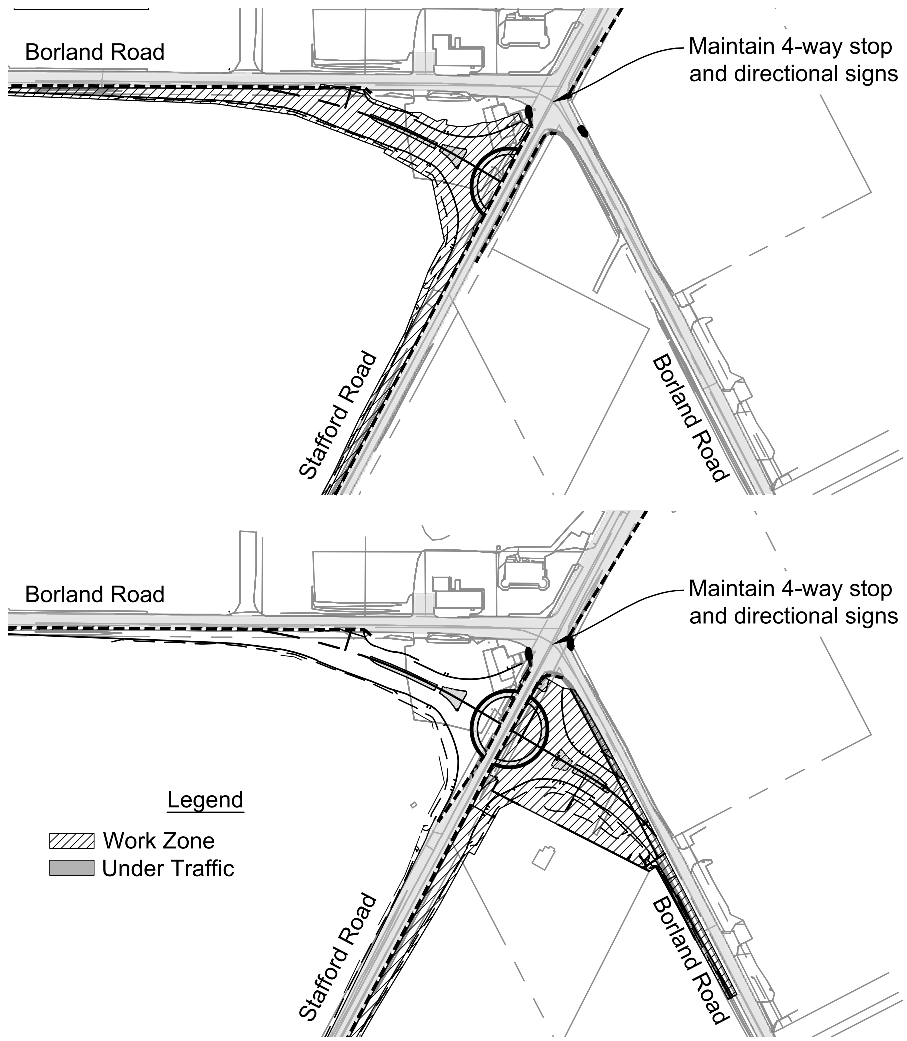
- a project that involves converting an intersection to a roundabout
- a project that involves sidewalk construction, where even though the sidewalk is off the road, there is a need to consider the work zone equipment (dump trucks, concrete trucks, excavators, work zone vehicles) that needs to access the area to complete the work.

The complexity of the traffic control plans may apply to the entire project or to an isolated portion of the project that requires a higher level of detail.

Figure 2-10 illustrates an example of converting an intersection to a roundabout and the phased construction plans that were developed to reduce the impact on roadway users during construction.

Chapter 1 provides additional information on determining the project significance. Chapter 2, Section 2.7 provides information on the transportation management plan (TMP).

Figure 2-10
Roundabout Construction



Design Teams should limit the use of multiple minimum design dimensions, also referred to as "stacking minimums."

In complex, challenging projects that include a range of constraints and tradeoffs (such as right-of-way, project schedule, multiple user types, and design vehicles), Design teams may need to consider design requirements to balance the user needs and project objectives. In cases where design minimums are considered, as well as design exceptions, Design Teams should limit the use of multiple minimum design dimensions, also referred to as "stacking minimums." This applies to sign spacing, tapers, lane widths, and other design characteristics and details.

For example, road users need adequate time to process the road conditions and messaging to make safe decisions. An example of this may include sign spacing and geometrics in an urban environment. Short block spacing often dictates a sign spacing that is at or close to the minimum, rather than ideal spacing for the prevailing speed. Similarly, lane widths, taper rates, and other geometric dimensions may also be reduced to minimum values to fit within the existing roadway cross section and block spacing. When both of these minimums are combined ("stacked"), a driver may have insufficient time to process both the sign messages and the geometric features needed for safely navigating their vehicle.

In this case, it would be better to stretch out the sign spacing, the geometrics, or both to give drivers adequate time to process the road environment. Alternatively, if the pairing of geometric features and sign spacing can be used to create a lower speed environment, this can also result in a safe outcome with a more compressed set of geometrics and sign spacing. Ultimately a good outcome is a result of the safe driver performance (the output) rather than specific design dimensions (the inputs) that produce that outcome.

The overall objective is to develop TCPs with sufficient detail to allow construction activities and work zone implementation to adequately protect public traffic and workers while allowing the project to be completed within a reasonable timeframe and budget. The additional time and cost to develop detailed plan sheets during project development may reduce time and cost during the project's construction.

The following questions can help a Design Team assess the complexity of the project:

- Is your project significant or non-significant? (See **Section 1.4.3** for definitions.)
- Are there other adjacent construction projects that may impact the work zone area and/or placement of traffic control devices?
- Does your project require multiple construction phases that will need additional phasing plans and associated sub-phases?
- Does your project impact existing pedestrian and bicycle facilities that may require detours or temporary facilities?
- Are there project constraints that may require additional plan details and/or communication with stakeholders to identify innovative design approaches?
- Does your project include a roadway that is a designated freight route?

2.4.4 Project Duration and Schedule

The project duration refers to the length of time that road users are exposed to the potential hazard of construction activities. As described in **Section 2.3**, the type of operation is primarily dictated by the project's duration. Mobile, short duration, short-term, and intermediate-term operations occur within three days or less and can often be accomplished using "typical" TTC layouts contained in the *Field Manual* *(6)*. Long-term stationary operations stay in one location for more than three days.

Table 2-7 compares traffic control measures and devices based on the project's duration. Additional information on traffic control devices and traffic control measures is provided in **Chapters 5 and 6**, respectively. **Table 2-7** is meant to be a starting point for Design Teams to consider how the project duration may impact design decision making.

Table 2-7
Project Duration Considerations

Feature	Short Duration (< 3 days)	Long Duration (> 3 days)
Sign supports	Roll-up signs on portable sign supports	Static, rigid, post-mounted signs
Active temporary traffic control	24-hour Flagging operations	Temporary traffic signal
Channelizing treatments	Channelizing devices (cones, tubular markers, drums)	Temporary concrete barrier
Lane alignment cues	Temporary pavement markings	Channelizing devices
Methods for handling full roadway closures	On-site diversion	Full road closure with detour In-place staging plan

2.4.4.1 Project Duration and Device Quantities

Chapter 8 provides additional information on Special Provisions and information about estimating quantities.

Project durations that extend beyond one year need to adjust pay items for traffic control devices that may need to be replaced. Over time, pavement markings, channelizing devices, impact attenuators, and other devices may become worn, faded, dirty, damaged, or vandalized and, therefore, are not as effective at properly communicating messages to drivers. Design Teams should consider increasing traffic control quantities for devices most susceptible to these conditions. In particular, projects that extend through the winter season with inclement weather, low temperatures, and exposure to vehicles with traction devices may need to consider replacements and repairs to pavement markings and channelizing devices.

2.4.4.2 Project Schedule

The overall construction project schedule and any associated requirements and constraints may also impact the traffic control measures and devices that are integrated into the traffic control plan. Projects that have an accelerated construction schedule or projects that include time-critical components may influence the use of unique construction materials and equipment. Examples of projects that may require an accelerated schedule include:

- detours
- bridges on critical highways or freight routes
- routes with high traffic volumes and a high level of importance to the region or local infrastructure

In addition, some projects may have schedules that accommodate other projects or anticipated workloads. Smaller projects may be combined with larger projects to optimize cost, funding opportunities, and seasonal timing. Emergency repair projects require immediate attention and accelerated project schedules. These types of projects should maintain design standards and protocols while identifying ways to maximize the efficiency of the repair.

2.5 DESIGNING FOR EACH ROAD USER

The work zone design shall consider the needs of each user throughout the design process. Each project will have different strategies and measures for integrating each user based on the context and needs of the community. **Chapter 4** provides key considerations and design guidance for pedestrians and bicycles, and **Chapter 6** provides additional information about traffic control measures for various users. **Table 2-8 through Table 2-13** provide outline considerations for each roadway user.

Table 2-8
Motor Vehicle Considerations

Motor Vehicle Considerations
• Fundamental safety, operations, and design principles governing the design of permanent roadways and roadsides should also govern the design of work zones. • Work zone designs should route motor vehicles using roadway geometrics, roadside features, and traffic control devices that replicate, as much as possible, the conditions of normal highway situations. • Consider prohibiting steel plating on high-speed roadways.

Table 2-9
Freight Considerations

Freight

• Identify classification of the roadway for freight accommodation and consider strategies based on the classification and designated route.
• Maintain reasonable freight access and mobility within the work zone.
  o A map of the project location and possible detours need to be sent to the TDOT.permitoffice@tn.gov
• Coordinate and communicate with the TDOT Freight and Logistics Division and TDOT Permit Office to identify needs, requirements, constraints, and objectives.
  o Communicate the potential duration of the construction work zone, as well as potential closures.
  o Consider alternate routes and communicate with local Regions to verify routes for each user.
  o Documentation and Traffic Control Plans will be provided to the TDOT Regional Construction Manager.
  o Provide at least two weeks of notice to the TDOT Permit Office and provide continual updates throughout the project, as needed.
• Consider how lane closures and reductions may impact freight mobility.
  o Lane width restrictions are required to provide at least two weeks' notice to the TDOT Freight and Logistics Division and provide Lane Width Restriction Form.
• Coordinate with the TDOT Oversize/Overweight (OS/OW) Permit Office for oversize/overweight routes
• Consider how vertical/horizontal clearances within the work zone design may impact freight vehicles.
• See **Section 2.6** for additional information on truck considerations.

Table 2-10
Motorcycle Considerations

Motorcycle Considerations

• Motorcycles generally fall under the category of “motor vehicle” traffic and will follow the same routes through work zones.
• Design features that relate specifically to motorcycles include:
  ○ **Vertical edges:** vertical or uneven edges created by construction activities (pavement grinding, new pavement layers, trench excavations, etc.) create hazards for motorcycles traveling longitudinally along the edge.
    ▪ The Design Manager should identify whether specific activities or phases of the project will introduce these elements and identify mitigation strategies.
    ▪ Additional signing or marking along the vertical edge may be needed to warn motorcyclists of the hazard.
  ○ **Steel plates:** metal surfaces such as steel plates in the roadway can pose traction issues for motorcycles, especially in inclement weather. Advance signing of these elements should be included when they cannot be avoided.
  ○ **Loose gravel:** Provide advance signing where trenches are temporarily filled with gravel, or where construction activities are such that loose gravel is expected to be present in the roadway.
• **Horizontal alignments:** horizontal curvature and tapers should be designed to avoid potential “pinch points” where over-tracking of large trucks into adjacent lanes could encroach on motorcycles that may not be as visible as other motor vehicles.
• Consider prohibiting steel plating on high-speed roadways.

Table 2-11
Pedestrian Considerations

Pedestrian Considerations
• All pre-existing ADA-compliant pedestrian facilities within the work zone must continue to comply with ADA requirements for access during work operations. • The temporary pedestrian route should replicate existing facilities as closely as possible, especially with consideration to path width, pedestrian activity, and pedestrian characteristics. • Whenever possible, work should be done in a manner that does not create a need to detour pedestrians from existing routes or crossings.

Table 2-12
Bicycle Considerations

Bicycle Considerations

• If the work zone area will impact an existing bicycle lane or a wide shoulder used by bicycle traffic, a convenient and accessible bicycle path should be provided that replicates the most desirable characteristics of the existing bicycling route.
• The project should maintain surface pavement for bicycles, including strategic placement of traffic control devices and consideration of pavement conditions and a minimum clear path.
• Providing safe accommodations for bicyclists should be prioritized as follows:
  ○ Provide a bicycle lane on the same roadway past the work zone by shifting and narrowing the adjacent traffic lanes.
  ○ Merging bicyclists and adjacent traffic into a shared travel lane.
  ○ Provide a bicycle detour route.

Table 2-13
Transit Considerations

Transit Considerations

- Transit service should be incorporated into the traffic control planning and design process.
  - Often public transit buses cannot efficiently be detoured in the same manner as other vehicles due to scheduling and transit stops.
- Identify impacts to transit early in the project development process and work with the transit agency to identify mitigation strategies for minimizing delay to operations.
- As needed, traffic control plans should include transit features such as:
  - accessible temporary bus stops
  - pull-outs
  - satisfactory waiting areas for transit riders, including persons with disabilities, if applicable.
- Consider vertical and horizontal clearances for buses.
  - Travel lanes less than 10-feet wide will not accommodate buses.
  - At intersections, bus turning requirements should be taken into consideration when designing channelization.
- If possible, maintain transit stops within the work zone
  - If the work zone activities allow, existing transit stops should be kept open and traffic control measures provided to allow for safe access to the stop for riders as well as transit vehicles.
  - Temporary accessible pathways may be required to get riders to the transit stop.
  - Temporary waiting areas may need to be created and protected from the work zone.
- If needed, transit stops can temporarily be relocated a short distance upstream or downstream of the existing stop affected by the work zone.
  - Signage notifying riders of the temporary relocation should be included by the transit agency or as part of the traffic control plans.
  - If the relocated transit stop cannot be located within a reasonable distance to the existing stop (due to the large influence area), temporary closure of the stop should be considered.
    - The next closest stop should be within a reasonable distance, or alternate service should be considered (e.g., shuttle service).
- If the work zone activities are anticipated to significantly impact transit operations by introducing unreasonable delays or eliminating access to transit stops, an alternate route should be considered.
- Shuttle service or other accommodations may be required to mitigate the lack of access to the new route for some users.
- Consider prohibiting steel plating on high-speed roadways.

Figure 2-11 illustrates an example of pedestrians and bicycles traveling through a work zone area.

Figure 2-11 Examples of Pedestrian and Bicycle Users in the Work Zone *(12)*

2.6 DESIGN VEHICLE

The design vehicle for a work zone helps determine important design elements to verify that a wide range of road users can safely travel through the work zone area. Some design vehicles may be allowed through the work zone area without a permit (e.g., WB-67 tractor-trailer combination), whereas other oversize/overweight (OS/OW) vehicles require additional coordination to obtain specialized permits for traveling on specific routes. The Design Team needs to understand the characteristics related to the design vehicle that may impact work zone design, including geometric design, traffic control devices, detours, safety considerations, and the associated procedures and processes. This includes coordinating with the TDOT Freight and Logistics Office early in the project development process to confirm design vehicles and the types of vehicles that the traffic control plan needs to accommodate.

2.6.1 TDOT Truck Policies and Guidance

TDOT uses the American Association of State Highway Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets* (Green Book, *5*) as the primary reference for geometric design and guidance specific to trucks. Below are specific TDOT policies and guidance related to trucks:

- The *Roadway Design Guidelines* emphasize the AASHTO Green Book thresholds and design guidelines for truck climbing lanes *(13).*
- The *Standard Specifications for Road and Bridge Construction* *(14)* provides truck guidance in Section 104 (Scope of Work), including:
  - **Section 104.04 Maintenance of Traffic:** The Department will maintain all public highways, roads, and streets that are designated on the Plans as detours, but not designated as "Haul Roads."

    Section 104.06 Movement of Heavy Equipment: The Contractor's attention is called to the application of local, State, and Federal regulations governing construction work. Various municipalities, as well as the Department, require a permit for moving heavy equipment. The Contractor is responsible for applying for and procuring such permits, when required, from the appropriate municipal officials and the Department of Transportation.

- *The TDOT Project Development Directive – 2 Work Zone Traffic Control Plans for Projects on Freeways (15)* requires a minimum of 11-foot lanes and 2-foot shoulders maintained at all times through freeway work zones.
    - Exceptions to the directive are considered a significant project that would cause a sustained work zone impact, and a transportation management plan with mitigating strategies must be completed per the TDOT *Work Zone Safety and Mobility Manual (1).*
- The TDOT *Construction Circular Letter 109.01-02 Truck Weight Limits* identifies truck weight limits for interstates, including ramps entering and exiting the interstate system, any portion of an existing or new interstate facility, and existing or new structures on interstates (16). The letter also includes specifications for trucks delivering materials to construction projects and the Weight Distribution Formula (Bridge Formula) for calculation.
- The TDOT Standard Drawing T-WZ-16 *Typical Lane Shift Application (14)* includes options for lane widths, shoulders, and buffer and guidance related to off-tracking. Off-tracking is the shorter path that the rear wheels follow as a vehicle moves around a corner.

2.6.2 Types of Design Vehicles

A range of design vehicles should be considered during work zone design. In most cases, the design vehicle will focus on large truck traffic; however, transit buses, recreational vehicles, and agricultural equipment should also be considered to verify that they can safely travel through the work zone area. **Table 2-14** provides a range of design vehicles to consider.

Table 2-14
Type of Design Vehicles

Type	Applicability and Considerations
Interstate Semitrailer WB-67	The most common type of design vehicle used in work zone design.
Oversize/Overweight	Must be coordinated with the TDOT Freight and Logistics Division to establish the route and permitting requirements.
Bus	Coordinate with the TDOT Transit Coordinator to identify design requirements and specifications of transit vehicles.
Recreational and Agricultural Vehicles and Equipment	May be considered depending on the project context and time of year. Unique design specifications for these vehicles and associated equipment may need to be considered.

The AASHTO *Green Book* provides detailed design criteria for a wide range of design vehicles, including those that are described in **Table 2-14**. Design Managers should reference the AASHTO *Green Book* to obtain additional design requirements for the specific project design vehicle *(5).*

2.6.3 Truck Considerations

Geometric design considerations related to trucks can help the Design Team establish minimum horizontal and vertical clearances required for the work zone design. In addition, trucks may impact the selection and placement of traffic control devices and detours. With safety as a priority, the designer must verify that the appropriate design vehicle can safely travel through the work zone while maintaining safety for other motor vehicles, pedestrians, bicycles, and workers within the work zone area. Providing median barriers and reducing speeds can potentially reduce crash severity for truck-involved work zone crashes. In addition, reducing speed variance between trucks and other vehicles by limiting slow-moving or stopped trucks can also reduce crashes in the work zone. **Table 2-15** provides an overview of key considerations and resources for designing work zones with trucks.

Table 2-15
Design Elements Related to Trucks

Off-tracking is the shorter path that the rear wheels follow as a vehicle moves around a corner.

Work Zone Design Elements Related to Trucks
Geometric Design

• Consider truck off-tracking when determining whether a narrowed lane width will be acceptable.
  ○ Software to model vehicle tracking is recommended to be used to check truck tracking for the required design vehicle.
• For crossover and on-site diversion design, consider truck volumes and design vehicles using the alignment.
  ○ Large trucks are sensitive to sharp reversing curves and adverse superelevation.
• Identify the minimum thresholds for horizontal and vertical clearances to accommodate commercial and oversized vehicles. Anything below these minimums requires a Work Zone Design Deviation (see **Chapter 6** for additional information).
  ○ For high-speed roadways (45 mph or higher), minimum lane width is 11 feet and minimum shoulder is 2 feet.
  ○ For speeds less than 45 mph minimum lane width is 10 feet with a 1-foot shy distance.
  ○ When in a horizontal curve less than 2,500 feet radius, the minimum lane width increases by 12 feet with a 2-foot shoulder.

Traffic Control Devices

• **Chapter 5 and Chapter 6** of the *WZDM* include specific TDOT guidance and recommendations for selecting and implementing traffic control devices associated with trucks.
• AASHTO *Manual for Assessing Safety Hardware (MASH)* and National Cooperative Highway Research Program (NCHRP*) Report 350* include federal standards for testing of highway safety devices. *(16)*
  ○ Longitudinal barriers are the only safety equipment tested with a tractor-trailer.
• The MUTCD provides guidance on traffic control devices associated with trucks. *(2)*
  ○ Per the MUTCD, glare screens should be used where heavy truck traffic may cause glare for oncoming traffic.
• Truck-mounted attenuators (TMAs) are effective in reducing general crash severity.
  ○ Consider the placement of TMAs in relation to the work zone to provide the required "roll ahead distance" after an impact.
• Concrete barriers may be used in areas with high truck traffic to protect against median crossover crashes.
• Consider prohibiting steel plating on high-speed roadways.
• Oversize vehicle warning systems should be considered for use when the roadway cross section places motorists, especially commercial traffic, into close proximity to fixed objects due to lane width restrictions, overhead restrictions, or in corridors that have a history of over-dimension crashes.

Table 2-15 *(continued)* Design Elements Related to Trucks

Work Zone Design Elements Related to Trucks
Detour
• Coordinate with the TDOT Freight and Logistics Division to identify the need to accommodate OS/OW vehicles. • Detours should consider the need for separate detour routes based on bridge, weight, clearance, or geometric restrictions. • Detours and alternate routes should be reviewed for upgrades to existing signing, pavement marking, and traffic signals.   ○ Considerations must be given to the adequacy of shoulders, lane widths, turning radius and off-tracking for commercial vehicles, and structural condition of the pavement.

2.6.4 Freight Coordination and Permitting

The project team should coordinate with the TDOT Freight & Logistics Division and TDOT Permitting Office early in the project development process to identify freight mobility needs through the work zone area. This includes identifying permitting needs, project scheduling coordination, and horizontal and vertical clearance requirements.

The Design Manager should contact the TDOT Freight & Logistics and TDOT Permitting Office during the Preliminary Design stage to coordinate about upcoming and ongoing projects and annual permits. The Design Manager should provide information about the potential location and length of closures. In addition, alternate routes should be considered and communicated with local Regions to verify routes for each user. The Freight & Logistics Division is in close communication with various parties utilizing all modes of freight transportation and can facilitate communication between all parties.

Based on the Fixing America's Surface Transportation (FAST) Act, the Federal Highway Administration (FHWA) encourages using Freight Advisory Committees (FACs) to review all freight-related activities. TDOT utilizes FACs in freight activities. Additional information and guidance on the requirements for State Freight Plans and State Freight Advisory Committees are in the Federal Register (October 2016) *(17)*.

For FACs, TDOT separates the state into four regions. Each region addresses freight issues, potential projects, policy, transportation research, multimodal opportunities, and best practices in other states regarding the freight industry. The regions review supply chain flows from different perspectives (specifically water, rail, and highway), which could help identify alternate routes and modes when work zone limitations could apply. Shifting traffic patterns and flows could help reduce the amount of traffic through the work zones, increasing safety for both the traveling public and employees in the work zone. Regionalized work zone area closures and limitations can be communicated with the various distribution lists that reside within the Freight & Logistics Division.

Early coordination with the TDOT Freight & Logistics Division can help facilitate effective communication with the Tennessee Trucking Association.

The Freight & Logistics Division also consistently communicates with the Tennessee Trucking Association to collaborate on issues, such as road closures, legislative topics, and temporary closures at welcome centers and rest areas. This partnership allows the trucking industry to use its distribution list to notify all truckers who are traveling in and out of Tennessee. Early coordination with the TDOT Freight & Logistics Division can help facilitate effective communication with the Tennessee Trucking Association.

2.7 TRANSPORTATION MANAGEMENT PLAN

A Transportation Management Plan (TMP) is a complete evaluation of work zone issues for a project. It describes all projected impacts of the work zone and lays out a set of coordinated transportation management strategies along with how they will be used to mitigate those impacts. Transportation management strategies for a work zone include temporary traffic control measures and devices, transportation operations strategies, and public information strategies.

Chapter 1 provides an overview of how the TMP development progresses through the overall project development process. The TMP will typically go through multiple drafts, reviews, and revisions before being finalized and included in the final plan set. The TMP development should be an ongoing process, from the scoping process through project development, and should continue through the design and construction phases of a project. Early and continued coordination with TDOT's Community Relations and Communication Division (also known as the Public Involvement and Communication Office) is required.

2.7.1 Resources

The TDOT *Work Zone Safety and Mobility Manual* outlines the TMP process and requirements. It also includes additional resources to support Design Teams as they develop plans.

If there are more than 30-minutes of delay, the project is considered significant.

- **TMP Template:** This provides an overview of the TMP organization and individual components that the plan requires. This includes descriptions and examples of the type of information to include in each component. Appendix C provides examples of completed TDOT TMPs. *(18)*
- **Delay and Qualitative Criteria Determination:** As part of determining the project significance (described in **Chapter 1**) and developing the TMP, Design Teams are required to assess the level of traffic operational impacts associated with the planned work zone and construction activities by estimating the delay. The Delay Criteria Table presented in the *Work Zone Safety and Mobility Manual* provides volume thresholds for various lane configurations for facility types. This information supports the Design Team in decision making associated with traffic operation *(19).*
- **TMP Form**: The TMP Summary Sheet (TMP Form) shall be completed for all significant and non-significant projects. Traffic control and traffic operation strategies considered must be discussed in detail, such as a description of the strategy, the reason for using or not using the strategy, and any assumptions made. If the traffic control plan is altered at any time in the field, the TMP shall be updated and reapproved, as coordinated with the Operations District Engineer *(20).*

2.7.2 Requirements

A TMP should be developed for both significant and non-significant projects (as described in **Chapter 1**). The TMP should include the significance determination and all relevant information regarding the project background and anticipated project challenges, and it should reflect the engineering judgment used in developing the work zone strategies. The TMP requirements depend on the project's significance. **Table 2-16** summarizes this information.

The Design Team can use the TMP to document the evaluation of various traffic control measures and design decisions, including positive protection opportunities and other traffic control measures used to optimize public traffic and worker safety.

Table 2-16
TMP Requirements by Project Significance

Requirement	Significant	Non-Significant	Exempt
TMP Form (Form C)	Yes	Yes	Does not require a formal TMP document. All projects must comply with MUTCD and TDOT Standard Drawings.
Personnel Roles and Responsibilities	Yes	Yes	
Project Description/ Context	Yes	Yes	
Work Zone Impact Assessment	Yes	Yes	
Traffic Control Plan	Yes May require detailed traffic control plan set including construction phases.	Yes May be accomplished through "typical" TTC layouts contained in the *Field Manual* or TDOT Standard Drawings.	
Traffic Operations Strategy	Yes	Optional, depending on project specifics.	
Public Involvement Strategy	Yes Coordinate with TDOT Community Relations and Communication Division.	Coordinate with TDOT Community Relations and Communication Division (See **Chapter 3**). Optional, depending on project specifics.	
TMP Monitoring	Yes	Optional, depending on project specifics.	
Contingency Plan	Yes	Optional, depending on project specifics.	
Special TMP Implementation	Yes	Optional, depending on project specifics.	

Table 2-17
TMP Documentation

Table 2-17 provides additional considerations and information associated with each of the TMP requirements shown in **Table 2-16**.

TMP Required Documentation	
Personnel Roles and Responsibilities	• All personnel that are involved with TMP implementation. • TMP management, monitoring, and emergency contacts.
Project Description and Context	• Project scope and background • Project limits • Traffic restrictions • Project schedule • Connecting roadways that may be impacted and concurrent projects
Work Zone Impact Assessment	• Roadway classification • Evaluation of detour routes (if applicable) • Pedestrian and bicycle impact (See **Chapter 4** of the *WZDM)* • Projected queuing and associated traffic analysis • Specifics of work zone impacts • Special events occurring during the project
Traffic Control Plan	• See **Chapters 5, 6, and 7** of the *WZDM* for additional information on developing traffic control plans.
Traffic Operations	• Identification of strategies that will be used to mitigate impacts of the work zone on the operation and management of the transportation system within the work zone impact area. • Consider common transportation operations strategies described in Appendix A of the TDOT Work Zone Safety and Mobility Manual. *(1)*
Public Information Strategies	• Coordinate with the TDOT Community Relations and Communication Division. • See **Chapter 3** of the *WZDM* for outreach activities and stakeholder considerations. • Consider common public information strategies described in Appendix A of the TDOT Work Zone Safety and Mobility Manual. *(1)*

Coordinate with the TDOT Community Relations and Communication Division regarding Public Information

2.8 SPEED REDUCTION REQUESTS

Design Managers and Contractors may consider speed reduction requests to maintain safety for all users within the work zone. This is necessary when it is desirable to include design elements that require a lower design speed than what is typical for the facility type. For requesting speed reduction within the work zone, TDOT has established a clear process that must be followed to obtain appropriate reviews and approvals for this type of request and to verify communication with staff and stakeholders. Design Teams should evaluate the need for a speed reduction request and initiate coordination early in the project development process.

2.8.1 Guidance on Setting Speed Limits

The TDOT publication *Guidance on Setting Speed Limits* *(21)* identifies the speed control types, procedures for requesting a regulatory speed reduction, and description and factors for speed reduction. TDOT Regional Traffic Engineers should use this guidance to determine if they must recommend a speed limit change to the State Traffic Engineer. This guidance can also help determine if an advisory speed limit will be necessary on the state highway system.

A work zone speed is the speed motorists may safely travel through a work zone. Work zone speed may be either advisory or regulatory; **Table 2-18** determines which speed control method is most appropriate. Speed compliance will be greater when motorists perceive that the limit is justified and consistent with geometrics and the surrounding environment; therefore, choosing an appropriate speed limit is important.

Table 2-18
Speed Control Types, Descriptions and Examples *(21)*

Speed Control Type	Description	Examples
Advisory Speed	For driver and/or worker safety, warning signs with speed advisory plates call for the reduction of speed by the driver to safely negotiate potentially hazardous conditions caused by the work zone activity or worker proximity to the roadway for work taking less than 3 days. Advisory speed limits should be the first consideration.	Bumps, low shoulders, drop-offs, narrow lanes, no shoulder, sight distance restrictions, poor surface condition, maintenance operations at spot locations
Regulatory Speed Limit (Variable)	Regulatory speed limit established in short-term projects during continuous worker activity when the workers are present and are adjacent to moving traffic or during nighttime only work.	Pavement repair, bridge repair, loop detector installation, mill and overlay projects, concrete repair, etc.
Regulatory Speed Limit (Continuous)	The regulatory speed limit in work zones intended for 24-hour continuous posting is established in long-term projects where it is imperative for the motorist to reduce speeds to safely navigate through hazards over the length of the project.	Bypasses, shoulder drop-offs, narrow lanes, grade separation, lane shifts, and pavement repair

Figure 2-12 provides examples of speed reduction signs typically used in work zones.

Figure 2-12
Example Speed Reduction Sign *(2)*

In addition to the conditions described in **Table 2-18**, the Guidance on Setting Speed Limits references *NCHRP Research Results Digest 192: Procedures for Determining Work Zone Speed Limits* for contractors and designers to identify which conditions and factors are present *(22)*.

Figure 2-13 and **Table 2-19** show the conditions, factors, and recommended maximum speed limit reduction. While the guidance identifies 10 mph as the recommended maximum speed reduction, reductions greater than 10 mph can be warranted in extenuating circumstances. Information in **Figure 2-13** and **Table 2-19** can help justify the speed reduction request described in **Section 2.8.2**.

Figure 2-13
Conditions for Speed Reduction

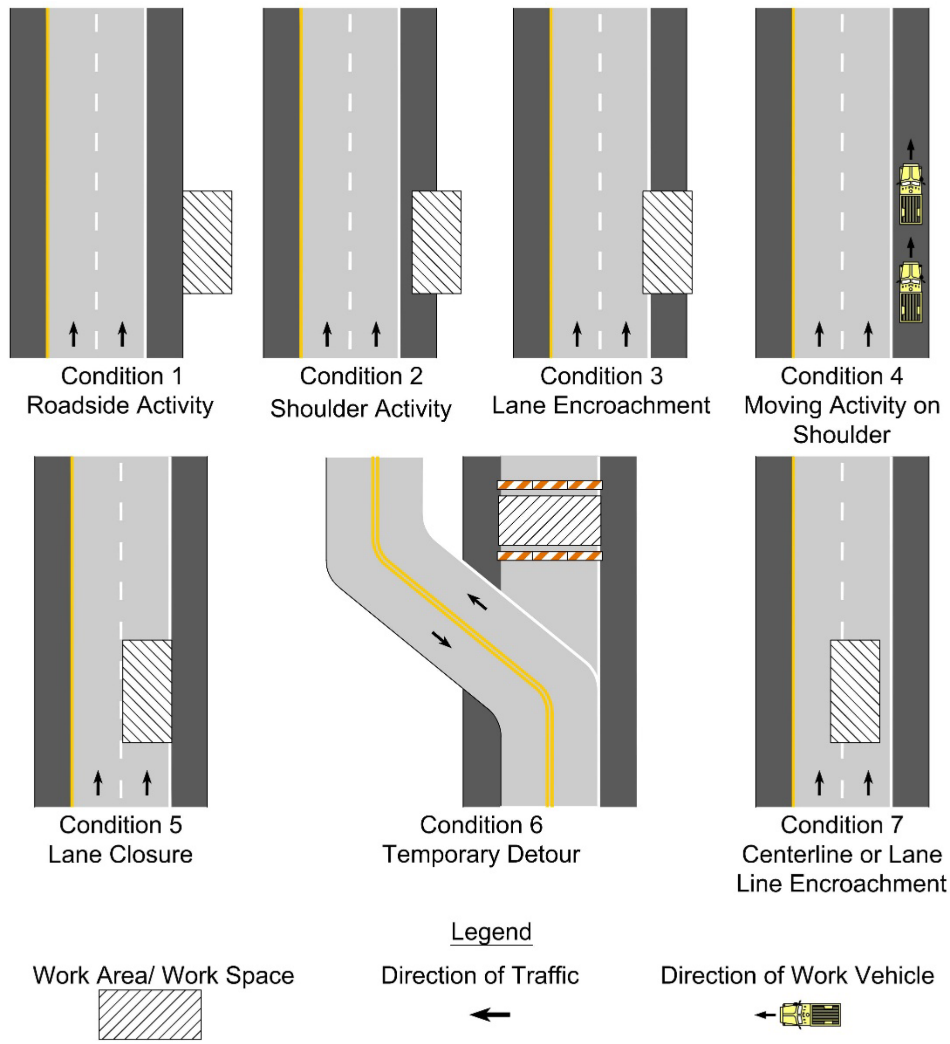


Table 2-19 Factors and Conditions for Speed Limit Reduction

Condition	Maximum Speed Limit Reduction	Factors That Justify Speed Limit Reduction
1. Roadside activity (greater than 10 ft from travel lanes)	None	• None
2. Shoulder activity (2 to 10 ft from travel lanes)	10 mph	• Workers present for extended periods within 10 feet of the travel lane(s) not protected by barriers Horizontal curvature that might increase vehicle encroachment rate
3. Lane encroachment (from edge to within 2 ft of travel lanes)	10 mph	• Workers present for extended periods within 2 feet of the travel lane(s) not protected by barriers • Horizontal curvature that might increase vehicle encroachment rate • Barrier or pavement edge drop-off within 2 feet of the travel lane(s) • Reduced design speed for stopping sight distance • Unexpected conditions
4. Moving activity on shoulder	None	• None
5. Lane closure (between the center line and edge line)	10 mph	• Workers present for extended periods in the closed lane unprotected by barriers • Lane width reduction of 1 foot. • TCDs encroaching on a lane open to traffic or in a closed lane within 2 ft of the edge of the open lane • Reduced design speed for taper length or speed change lane length • Barrier or pavement edge drop-off within 2 feet of the travel lane(s) • Reduced design speed for horizontal curve • Reduced design speed for stopping sight distance • Traffic congestion created by a lane closure • Unexpected conditions
6. Temporary diversion	10 mph	• Lane width reduction of 1 foot. • Reduced design speed for detour roadway or transitions • Unexpected conditions
7. Center line or lane line encroachment	10 mph	• Workers present on foot for extended periods in the travel or closed lanes unprotected by barriers • Remaining lane plus shoulder width is less than 11 feet • Reduced design speed for taper length or speed change lane length • Barrier or pavement edge drop-off within 2 feet of the travel lane(s) • Reduced design speed for horizontal curve • Reduced design speed for stopping sight distance • Traffic congestion created by a lane closure • Unexpected conditions

2.8.2 Request Process

Project teams should evaluate the need for a speed reduction request and initiate the coordination for this early in the project.

Design Managers and Contractors may request a speed reduction as part of the work zone design and implementation. **Table 2-20** describes TDOT's process for requesting speed reduction. In addition, the Design Manager must complete the Speed Limit Reduction Request Form, which the State Traffic Engineer must then review and approve. The form can be found at the following website:

Speed Limit Reduction Request Form

Table 2-20
Speed Control Types, Descriptions, and Examples

Design Manager Request Process
1. Review the factors and conditions presented in **Figure 2-14** and **Table 2-19** to identify an appropriate speed limit for the work zone activities.
2. Complete the Speed Limit Reduction Request Form.
3. Submit the Request Form via email (See the TDOT Roadway Design Guidelines, Table 1-12) to the State Traffic Engineer, identifying the type of reduction (continuous or variable), and identifying the condition and factors from **Figure 2-14** and **Table 2-19**.
4. Receive a response from the State Traffic Engineer, either approving the request, requesting updates to the request, or denying the request.
Contractor Request Process
1. Review the factors and conditions presented in **Figure 2-14** and **Table 2-19** to identify an appropriate speed limit for the work zone activities.
2. Complete the Speed Limit Reduction Request Form.
3. Submit the Request Form via email (See the TDOT Roadway Design Guidelines, Table 1-12) to the District Operations Engineer identifying the type of reduction (continuous or variable) and identifying the condition and factors from **Figure 2-14** and **Table 2-19**.
4. If the District Operations Engineer agrees that a reduction is warranted, submit the request to the Region Traffic Engineer (RTE) and identify if the request is continuous or variable. Then if the RTE agrees that a reduction is warranted, submit the request to the State Traffic Engineer for approval.
5. The State Traffic Engineer's approval is required before making any regulatory speed adjustment.
6. Receive a response from the State Traffic Engineer, either approving the request, requesting updates to the request, or denying the request.

Speed reductions should be modified to return to the original speed once the construction phase that required the speed reduction is complete. This will require coordination from the Construction Manager and may include updating signs and other temporary traffic control devices associated with the speed reduction for the work zone.

2.9 REFERENCES

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TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 3

STAKEHOLDER OUTREACH AND PUBLIC ENGAGEMENT

March 2022

TN TDOT Department of Transportation

Contents

Chapter 3

Stakeholder Outreach and Public Engagement

Chapter 3 guides effective stakeholder outreach and public engagement for TDOT projects involving traffic control plans. The information in this chapter will help Design Teams understand what type of engagement is appropriate for various project types. This chapter will also help Design Teams understand when and how to engage the TDOT Community Relations and Communication Division (also known as the Public Involvement and Communication Office) and TDOT Regional Communication Offices. Each project has unique characteristics, and Design Teams should review outreach strategies that should individually be based on the community stakeholders' needs. All types of projects, large or small, can benefit from communicating with stakeholders. The TDOT Community Relations and Communication Division is equipped to support Design Teams in identifying and implementing the most effective approach.

The primary objectives for public involvement and outreach related to work zone design are summarized in **Table 3-1**.

Table 3-1
Outreach Objectives

Outreach Objectives
• Provide opportunities for stakeholders to provide input to the work zone design through an involved process that begins early and is convenient and meaningful.
• Develop partnerships with local community leaders, groups, and organizations to provide an integrated, environmentally aware, and multimodal approach to work zone design.
• Provide timely and easily understood information to stakeholders affected by the work zone area.
• Integrate stakeholder concerns and needs into the development of work zone designs.
• Build credibility and trust between TDOT and the stakeholders.
• Provide for periodic review of how the stakeholder input is being integrated into the work zone design process and approach to allow for adjustments as needed.

3.1 TDOT OUTREACH RESOURCES

The TDOT Community Relations and Communication Division executes all outreach planning and activities for projects.

The Design Manager and Design Team are not responsible for executing outreach activities.

TDOT has specific resources to support Design Teams in identifying and implementing effective outreach approaches. By engaging the appropriate resources early in project development, Design Teams can communicate adequately with stakeholders and integrate community goals throughout the planning, design, and construction processes. Understanding how the work zone design can impact stakeholders can lead to project efficiency and positive community collaboration.

The TDOT Community Relations and Communication Division is responsible for enhancing and improving communication between TDOT and its stakeholders/customers and for providing the public with accurate and timely information. This office coordinates and implements multiple communication tools, such as websites, press releases, publications, social media, and online videos. All public involvement and stakeholder outreach should be coordinated with this office to support Design Teams during the planning, design, and construction stages.

The TDOT Community Relations and Communication Division oversees the Community Relations Officers within each TDOT region. This Division executes the public involvement process at TDOT and serves as the central point for assisting Design Teams with public outreach and public involvement.

The Community Relations and Communication Division aims to implement strategies and verify that the public is fully informed and has the opportunity to be involved in developing, building, and maintaining Tennessee's state transportation system. Additional information about the TDOT Community Relations and Communication Division is provided at the following website *(1)*:

[TDOT Community Relations and Communication Division]

The TDOT Public Involvement Plan *(2)* documents the public involvement procedures and states the public involvement principles of the Tennessee Department of Transportation (TDOT). It works to fulfill Federal Highway Administration (FHWA) and Federal Transit Authority (FTA) requirements related to public involvement plans, programs, and projects that TDOT considers undertakes. The document outlines public involvement considerations and procedures to be used by TDOT staff on all Federal-aid projects. Additional information about the plan is on the following website *(3)*:

[TDOT Public Involvement Plan]

3.2 STAKEHOLDERS

Stakeholders are a wide range of public and private organizations and individuals with a vested interest in the outcome of a project. Helping Design Teams identify users and needs during the work zone design process can support mobility and safety for the public and workers. The project location and project type principally influence the kind of stakeholders a project has. Local agencies adjacent to the work zone area, particularly those who own and maintain adjacent roadway facilities that are integral to the transportation management plan for the work zone, should become part of the decision-making process.

Similarly, projects that involve the interstate and national state highway system require additional coordination with the FHWA. **Table 3-2** summarizes the range of potential stakeholders to consider integrating into the outreach process.

Table 3-2
Potential Stakeholders

Stakeholder Groups	Examples
Federal agencies	Federal Highway Administration (FHWA)
Local agencies	Cities, Counties
Border States	Departments of Transportation from Kentucky, Missouri, Arkansas, Mississippi, Alabama, Georgia, North Carolina, Virginia
Freight	TDOT Freight and Logistics Division
Public Transit	Coordinate with TDOT Office of Public Transportation
Local Business Owners	Adjacent restaurants, shops, offices, etc.
School representatives	School District, Bus Route Coordinators
Pedestrian and Bicycle Groups	Coordinate with TDOT Multimodal Division
Emergency Responders	First responders, fire stations, hospitals
Major Traffic Generators	Commercial development Industrial area Large employment centers Hotel industry Sports Areas Music Venues
Neighborhood Associations	Coordinate with local agencies to identify.
Agricultural Industry	Coordinate with local agencies to identify

Figure 3-1
Stakeholder Collaboration *(4)*

3.3 IDENTIFYING AN OUTREACH APPROACH

The outreach approach depends on the type, complexity, and duration of the work zone. Outreach activities can be as limited as coordinating what kind of emergency response vehicles may be used in the project area, or they can be as involved as conducting meetings with freight industry leaders to understand specific trucking needs. Some projects may require extensive public communication and outreach campaigns involving the TDOT Community Relations and Communication Division. Other projects may be limited to signing and responding to public questions. With clear documentation of stakeholder interaction and feedback, the Design Team can verify that project decisions align with community goals and justify outreach strategies.

3.3.1 PROJECT CHARACTERISTICS

Each project has specific characteristics that will affect the outreach and public involvement approach. **Table 3-3** summarizes the project characteristics that Design Teams should consider and how certain characteristics may impact outreach considerations.

Table 3-3 Summary of Project Characteristics that Affect Outreach Decisions

Project Characteristics	Outreach Considerations

Project Type	• What is the project type?
	  ○ Bridge repair projects, for example, will require a different outreach approach compared to a repaving project.
	• Is the project new construction or a modification to an existing alignment?
	  ○ A new construction project may not have the same type of impact on stakeholders that a project on existing roadway alignment may have.
	• Does the project include intersections?
	  ○ Construction projects involving intersections are challenging to maintain full access for all users.

Project Context	• What is the project context? ○ See **Chapter 2** for additional context information. • Is the project in a rural or urban area? Or is it in a transition area between urban and rural? • Is the project in a constrained urban environment impacting numerous local businesses, driveway access, signal timing, pedestrian crossings, and transit? • Is the project in a rural area with fewer physical constraints but higher speeds that may increase the need for outreach that encourages speed reduction?
Adjacent Land Uses	• What are the adjacent land uses? ○ Understanding the adjacent land uses is important to identifying stakeholders involved in the project vicinity.

Facility Type	• Is the project on an interstate freeway, multilane highway, two-lane highway, or local road?
	  ○ Construction projects on local roads, for example, require different outreach activities than projects involving interstate facilities.
	• Does the project affect local and collector roadway?
	  ○ These impacts may require coordination with local agencies (cities and counties).
	• Does the project involve interstate facilities?
	  ○ Projects involving interstate facilities require FHWA coordination.

Geographic Location	• Are there any geographic characteristics that may impact the work zone design?
	  ○ Communication approaches with smaller communities may differ from communicating with large metropolitan areas.
	• Are there any adjacent work zone projects?
	  ○ Adjacent work zone projects will require coordination between Design Managers to verify a consistent outreach approach.
	• Does the work zone extend into a bordering state?
	• A work zone area adjacent or extends into a bordering state will require coordination with that state to help manage mobility impacts, determine the potential for overlapping work zone areas, and initiate the collaboration of determining the sequencing of construction activities for multiple projects.

Table 3-3 *(continued)* Summary of Project Characteristics that Affect Outreach Decisions

Project Characteristics	Outreach Considerations
Project Schedule	• Time of Day ○ Is the project occurring during the peak period when traffic volumes are the highest? ○ Is the project occurring at night, when traffic volumes are typically lower, but communication needs to be more visual? ○ Is the project near a school, where the drop-off and pick-up times need to be considered? ○ Are the project work activities concentrated into certain times of day, or are impacts experienced throughout the day and night? • Day of the Week ○ Is construction planned for the weekend or weekday? A weekend timeframe may need to consider recreational or commercial traffic generators, whereas a weekday timeframe needs to consider commuter traffic. • Time of Year ○ Can the project be planned for summer when school is not in session if the project is near a school? ○ Is the project planned during seasons when recreational traffic needs to be considered compared to typical commuter traffic? ○ Is the project potentially affected by special events, including sporting events, festivals, and other similar gatherings?
Duration	• How long will the project take to complete? ○ A project that impacts stakeholders for one to two weeks will require different outreach than a project expected to last months or even years.
Work Zone Activities	• What work zone strategies are being considered? ○ Road closures, detours, diversions, and construction staging will have unique impacts on stakeholders and the adjacent roadways within a work zone. • What type of lane closures is being considered? ○ A closure that impacts one lane versus multiple lanes versus an entire roadway will have different needs to communicate to the public adequately. • What are the construction phases and associated sub-phases? • Does the project impact intersections and require any modifications to the intersection traffic control?

3.3.2 PROJECT OUTREACH INFORMATION CHECKLIST

The TDOT Project Outreach Information Checklist summarizes the type of information that contributes to outreach decision making and strategy. Using the project characteristic considerations in **Table 3-3**, the Design Team can use the checklist to provide summary information to the TDOT Community Relations and Communication Division. The checklist is provided in **Appendix B** and includes the following type of project information:

- general project contacts, number, geographic location
- project type
- project context and adjacent land use

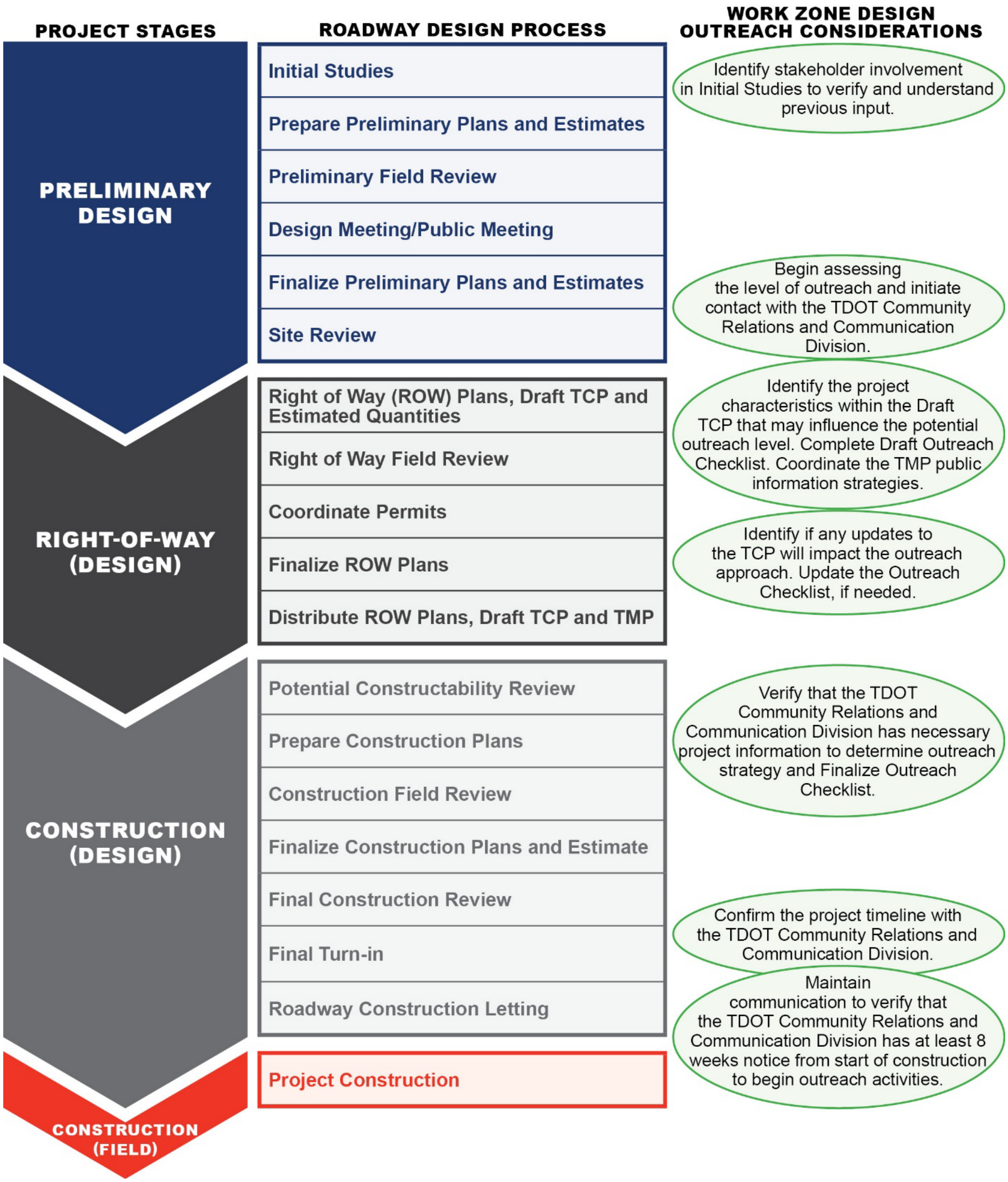
- presence of user types (pedestrians, bicycles, transit, and trucks)
- work zone activities
- expected stakeholders

3.3.3 CONNECTION TO THE PROJECT DEVELOPMENT PROCESS

Chapter 1 of the *WZDM* provides an overview of the TDOT project development process and the associated work zone design activities at each project stage. Similarly, stakeholder outreach activities occur at specific project stages, as shown in **Figure 3-2**.

A key component of successful public engagement and stakeholder outreach is identifying stakeholders early in the project and understanding the most important community goals, needs, and constraints. As shown in **Figure 3-2**, during the Preliminary Design stage, the Roadway Designer will begin assessing the outreach activities needed and contact the TDOT Community Relations and Communication Division to alert them of the upcoming project. The Roadway Designer will begin filling out the Outreach Information Checklist during the Right-of-Way stage as the Draft Traffic Control Plans develop. During the Construction (Design) and Construction stages, the Roadway Designer will finalize the Outreach Information Checklist and coordinate with the TDOT Community Relations and Communication Division on the project schedule and construction start dates. The key is to provide the TDOT Community Relations and Communication Division with the information to identify an appropriate outreach strategy and execute the strategy before and during construction.

Figure 3-2 Connection between Stakeholder Outreach and Overall TDOT Project Development Process



3.3.4 CONNECTION TO THE TRANSPORTATION MANAGEMENT PLAN

As described in **Chapter 1, Section 1.4.3**, the TDOT Work Zone Safety and Mobility Program requires that all projects be classified as significant, non-significant, or exempt. These classifications allow TDOT to manage work zone impacts of individual projects and help determine what mitigation strategies should be considered in the Transportation Management Plan (TMP). The significance of a project can also help guide the outreach plan and public involvement activities identified for the project.

A TMP for a project classified as significant shall include public involvement strategies. Depending on the project, a project classified as non-significant may or may not have public information strategies as part of the TMP. The TDOT Community Relations and Communication Division will determine if a public information plan is needed and will develop the necessary public information documentation for the TMP. If the TDOT Community Relations and Communication Division determines that a plan is not required, smaller strategies may still be implemented based on the Division's direction. Examples of public information strategies include:

- digital message signs
- highway advisory radio (HAR)
- 511 messages
- portable message boards

Additional information about the public information strategies is provided in the TDOT Work Zone Safety and Mobility Manual *(5)*, **Appendix A, Form C** and provided at the following website *(6)*:

TMP Summary Sheet – Form C

3.4 OUTREACH TIERS

The TDOT Community Relations and Communication Division execute all outreach planning and activities for projects. Based on the project information, this Division will determine the appropriate outreach activities, engage with all stakeholders, and implement various outreach strategies. While input from the Design Team and Design Manager early in the project development process supports the outreach work conducted by the TDOT Community Relations and Communication Division, the Design Manager and Design Team are not responsible for executing outreach activities.

The TDOT Community Relations and Communication Division executes all outreach planning and activities for projects.

The Design Manager and Design Team are not responsible for executing outreach activities.

There are four different tiers of outreach that outline the types of activities that may be needed, depending on the type of project. The project characteristics information described in **Section 3.3.1** and the Project Information Outreach Checklist described in **Section 3.3.2** inform selection of the outreach tier and types of activities associated. **Table 3-4** summarizes the TDOT Outreach Tiers.

Table 3-4
Outreach Tiers

<table>
<tr><th>Outreach Tier</th><th>Description</th><th>Potential Outreach Activities (Led by TDOT Community Relations and Communication Division)</th></tr>
<tr><td>Tier 1</td><td>The project is noncontroversial, causes negligible accessibility impacts, and causes minimal traffic disruption.

Examples include:
maintenance
rural resurfacing
night-time rural operations</td><td>Inclusion in TDOT’s Weekly Lane Closure Report, which is distributed to media outlets statewide.
Email to appropriate media outlets and city/county officials.</td></tr>
<tr><td>Tier 2</td><td>The project has general public acceptance, little impact on access to adjacent property or traffic, and a moderate degree of traffic disruption.

Examples include:
Urban resurfacing
Bridge repair projects
Other construction activities that may require lane closures</td><td>Inclusion in TDOT’s Weekly Lane Closure Report, which is distributed to media outlets statewide.
Email to appropriate media outlets and city/county officials.</td></tr>
<tr><td>Tier 3</td><td>The project may be controversial, will significantly impact traffic flow, or substantially affect accessibility to properties (temporary and/or permanent).

Examples include:
median openings or closures (e.g., access management issues)
traffic signal removal
roadway widening
major reconstruction
projects including detours</td><td>A communication plan that begins before the start of construction.
Press release to announce project and detail lane closures, detours, and other possible impacts.
Potential videos to explain the process.
Project-specific webpage.
On-going communication via press releases and possible list serves.
On-site events to update progress.</td></tr>
<tr><td>Tier 4</td><td>The project involves road widening or major reconstruction, bridge widening or replacement, new interchange, or closures (temporary and/or permanent) of the roadway, ramps, bridges, or railroad crossings.
Alternative Delivery Projects also require Tier 4 outreach activities.</td><td>A communication plan that begins before the start of construction.
Press release to announce project and detail lane closures, detours, and other possible impacts.
Potential videos to explain the process.
Project-specific webpage.
On-going communication via press releases and possible list serves.
On-site events to update progress.</td></tr>
</table>

3.5 OUTREACH EXAMPLES

TDOT has conducted a variety of outreach activities for projects involving work zones. **Figures 3-1** through 3-6 provide examples of stakeholder engagement activities based on the type of project and stakeholder considerations.

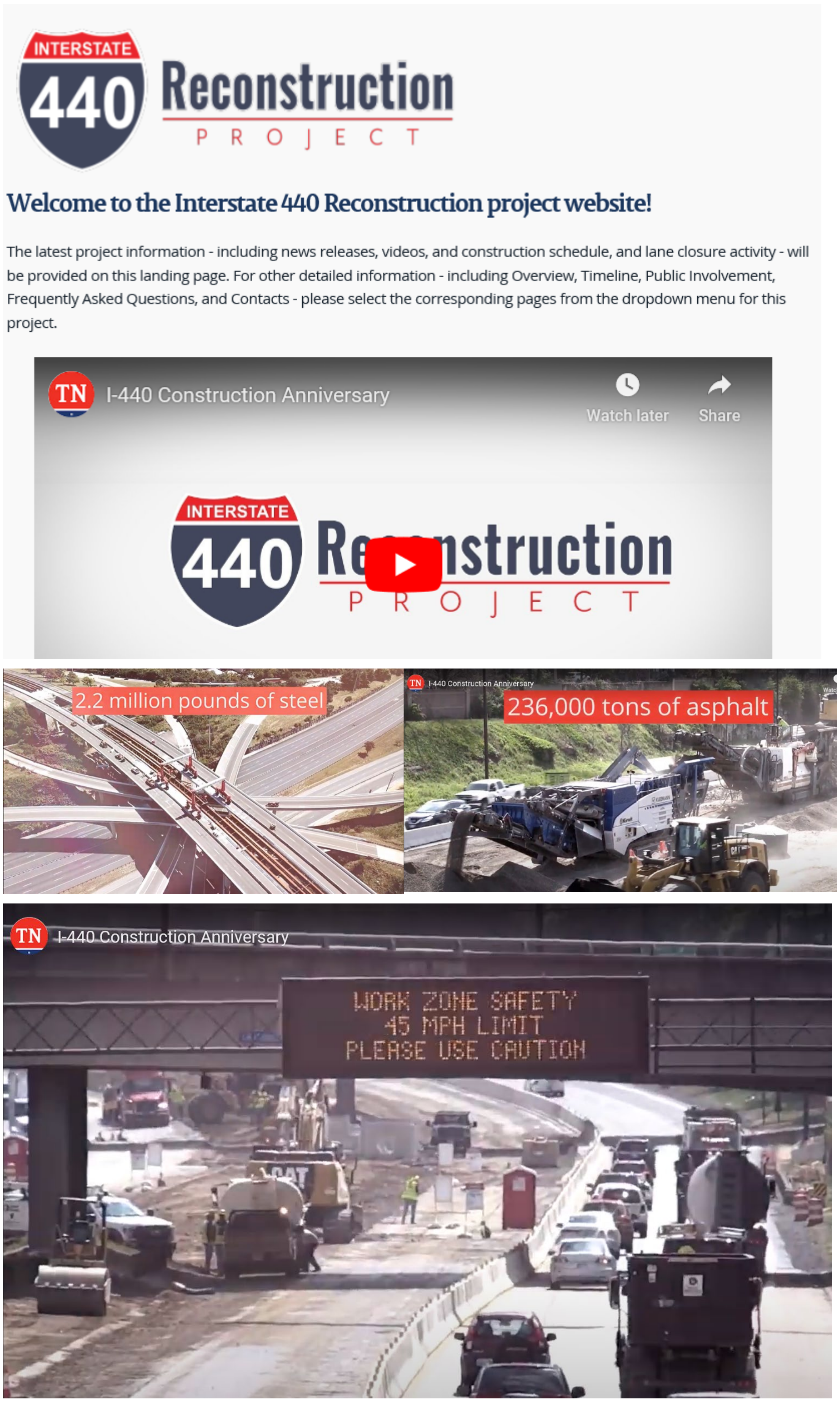
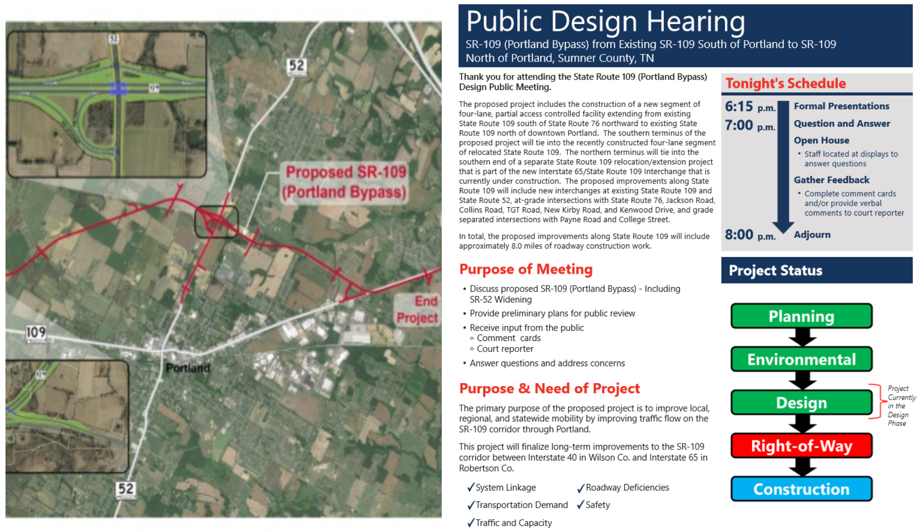


Figure 3-3
Project Website Example ***(7)***

Figure 3-4
Public Meeting Handout Example *(8)*



Public Design Hearing

SR-109 (Portland Bypass) from Existing SR-109 South of Portland to SR-109 North of Portland, Sumner County, TN

Thank you for attending the State Route 109 (Portland Bypass) Design Public Meeting.

The proposed project includes the construction of a new segment of four-lane, partial access controlled facility extending from existing State Route 109 south of State Route 76 northward to existing State Route 109 north of downtown Portland. The southern terminus of the proposed project will tie into the recently constructed four-lane segment of relocated State Route 109. The northern terminus will tie into the southern end of a separate State Route 109 relocation/extension project that is part of the new Interstate 65/State Route 109 Interchange that is currently under construction. The proposed improvements along State Route 109 will include new interchanges at existing State Route 109 and State Route 52, at-grade intersections with State Route 76, Jackson Road, Collins Road, TGT Road, New Kirby Road, and Kenwood Drive, and grade separated intersections with Payne Road and College Street.

In total, the proposed improvements along State Route 109 will include approximately 8.0 miles of roadway construction work.

Purpose of Meeting

- Discuss proposed SR-109 (Portland Bypass) - Including SR-52 Widening
- Provide preliminary plans for public review
- Receive input from the public
  - Comment cards
  - Court reporter
- Answer questions and address concerns

Purpose & Need of Project

The primary purpose of the proposed project is to improve local, regional, and statewide mobility by improving traffic flow on the SR-109 corridor through Portland.

This project will finalize long-term improvements to the SR-109 corridor between Interstate 40 in Wilson Co. and Interstate 65 in Robertson Co.

✓System Linkage
✓Roadway Deficiencies
✓Transportation Demand
✓Safety
✓Traffic and Capacity

Tonight's Schedule

6:15 p.m. **Formal Presentations**
7:00 p.m. **Question and Answer**
Open House
- Staff located at displays to answer questions

Gather Feedback
- Complete comment cards and/or provide verbal comments to court reporter

8:00 p.m. **Adjourn**

Project Status

Planning
Environmental
Design — *Project Currently in the Design Phase*
Right-of-Way
Construction

Figure 3-5
Press Release Example Project Map

Figure 3-6
TDOT YouTube Channel Examples *(9)*

3.6 REFERENCES

1. Tennessee Department of Transportation (TDOT). TDOT Public Involvement and Communication Office. C:\Users\jbbansen\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\LZO5O1CA\TDOT https:\www.tn.gov\tdot\community-relations\public-involvement---communication.html. Accessed March 2020.
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3. TDOT. TDOT Public Involvement Plan. https://www.tn.gov/content/dam/tn/tdot/community-relations/public-involvement-plan.pdf. Accessed March 2020.
4. TDOT, Nathan Vatter. Photo Credit.
5. TDOT. *Work Zone Safety and Mobility Manual*. TDOT, Nashville, TN, 2019.
6. TDOT. TDOT TMP Summary Sheet, Form C. https://www.tn.gov/content/dam/tn/tdot/documents/TDOT_WZ_Appendix_A_-_Forms_A,_B,__C.pdf. Accessed March 2020.
7. TDOT. TDOT I-440 Reconstruction Project Webpage: https://www.tn.gov/tdot/projects/region-3/interstate-440.html
8. TDOT. TDOT SR-109 Portland Bypass Project, Public Meeting Handouts, Website: https://www.tn.gov/content/dam/tn/tdot/region-3-documents/sr-109-portland-bypass/SR-109_Portland_Bypass_Handout_081519.pdf
9. TDOT. TDOT News, YouTube Channel, I-75/ I-24 Interchange Modification Project Video.

TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 4

PEDESTRIANS AND BICYCLES

March 2022

TDOT Department of Transportation

Contents

Chapter 4

Pedestrians and Bicycles

Chapter 4 provides an overview of the design considerations for pedestrians and bicycles within the work zone area. When developing traffic control plans, designs should integrate safety, mobility, and accessibility needs for all road users, including bicycles and pedestrians, as well as access to transit. The design should consider each user's needs throughout the project duration and through the selected features, alignments, guidance, surfaces, and safety appurtenances. Identifying user needs and understanding the design considerations early in the design process can help inform the decision-making process, both when developing the traffic control plans and when implementing the temporary traffic control (TTC) devices in the work zone area.

Pedestrians and bicyclists can be found in a wide range of environments and need to be an integral part of work zone design and implementation. While pedestrians and bicyclists should be considered for all work zones, activity levels are generally higher in urban areas. Fewer pedestrians and bicyclists are typically present in rural areas; however, their existing facilities are likely more limited and become further constrained under construction activities. The typical characteristics in urban and rural environments can be found in **Section 2.4.1** of the *WZDM*.

Chapter 2 provides an overview of the types of traffic control operations, and **Chapters 5 and 6** provide additional information about traffic control devices and strategies involving pedestrians and bicycles.

4.1 PEDESTRIAN CONSIDERATIONS

The work zone area may affect a range of pedestrians. Pedestrians need to navigate through the work zone area, and this can be particularly challenging for vulnerable users who rely heavily on well-maintained and well-defined sidewalks for safe mobility. In addition, for work zones that may include different phasing and sequencing during construction, the pedestrian route may change throughout the project, causing more challenges. The Americans with Disabilities Act (ADA) requires that facilities open to pedestrians must be accessible to and usable by everyone. **Figure 4-1** illustrates an example of signage displayed for change to a pedestrian route in a Portland, Oregon, construction project.

Figure 4-1
Example of Pedestrians in the Work Zone and Pedestrian Treatments used in Work Zones (*1*)

Design principles for pedestrians under non-work zone conditions remain relevant in the work zone: provide separation from vehicles, including construction and non-construction vehicles and equipment, and provide a safe, accessible, and convenient route, whether temporary or permanent. This section provides an overview of design principles for pedestrians in work zones, including ADA compliance, detour considerations, and temporary traffic control device principles. **Chapters 5 and 6** of the *WZDM* provide further information about traffic control devices and strategies.

TDOT has the following guidance for serving pedestrians during construction, especially in the urban environment:

- Closure of a sidewalk **should** be deemed the last resort in the absence of other practicable routing or accommodation options needed to assure pedestrian safety.
- A temporary route **shall** be clearly marked and include advance notification of sidewalk closures, detours, or diversions.
- Pedestrians **should** be separated from motor vehicles and bicyclists.
- A pedestrian route **shall** be free of obstructions and surface hazards.
- The method for providing safe accommodations for pedestrians **should** be prioritized as follows:
    - Protect pedestrians on the existing sidewalk; consider covered walkways where overhead hazards are present.
    - Provide a temporary pedestrian route in a parking lane and protect it from adjacent motor vehicle traffic, with accessible connections between the temporary and permanent pedestrian facilities.
    - Convert an existing bicycle lane into a multiuse path.

- Convert an existing bicycle lane into an exclusive pedestrian path, protect it from motor vehicles and bicyclists, and merge bicyclists with motor vehicles.
- Provide a pedestrian route in an existing motor vehicle lane and protect it from motor vehicles.
- Provide a pedestrian detour route.

All pre-existing, ADA-compliant pedestrian facilities within the work zone must continue to comply with ADA requirements for access during work operations. This includes providing adequate path width, ADA-compliant slopes, and detectable devices for temporary ramps and keeping paths free of construction equipment and vehicles, signs, barricades, or other temporary traffic control devices. Pedestrian accommodation requirements are described in the draft *Public Right-of-Way Accessibility Guidelines* (*PROWAG*), Section R205 (*2*) as adopted by TDOT:

All pre-existing, ADA-compliant pedestrian facilities within the work zone must continue to comply with ADA requirements for access during work operations.

> *"When a pedestrian circulation path is temporarily closed by construction, alterations, maintenance operations, or other conditions, an alternate pedestrian access route complying with Sections 6D.01, 6D.02, and 6G.05 of the MUTCD shall be provided. Where provided, pedestrian barricades and channelizing devices shall comply with Sections 6F.63, 6F.68, and 6F.71 of the MUTCD."*

A Work Zone Design Deviation Form is required when these designs requirements cannot be met. Design deviations should be identified early in the project development process—at least by the Right-of-Way stage—to allow for adequate documentation, review, and coordination to take place. **Chapter 6** elaborates on this form and process.

The temporary pedestrian route should replicate existing facilities as closely as possible, especially with consideration to path width, pedestrian activity, and pedestrian characteristics. More information about temporary pedestrian accessible routes (TPAR) is included in **Section 4.1.2**.

More information about temporary pedestrian accessible routes (TPAR) is included in Section 4.1.2.

The *Manual on Uniform Traffic Control Devices (MUTCD)* states that pedestrian detours should be avoided because pedestrians rarely observe them, and the cost of providing accessibility and detectability might outweigh the cost of maintaining a route along the existing facility. Whenever possible, work should be done in a manner that does not create a need to detour pedestrians from existing routes or crossings *(3)*.

Where pedestrian detours cannot be avoided, out-of-direction travel should be minimized to encourage compliance and safety. Pedestrians should not be led into conflicts with motor vehicles; any construction vehicles, equipment, or operations; or hazardous materials.

Figure 4-1 shows considerations for pedestrian facilities and guiding principles for decision making.

Table 4-1
Pedestrian Facilities Considerations

Chapter 5 provides additional information about temporary traffic control devices.

Specific product information can be found in the TDOT Qualified Products List (QPL). Chapter 8 provides additional information about the QPL.

Topic	Consideration
Temporary Traffic Control Devices	

Signage	• For sidewalk closures, provide advance closure/direction signs at the nearest upstream crossing to minimize the need for someone to retrace their steps.
	• If closing a pedestrian route, sign the closure in two locations:
	  o In advance of the closure point at the nearest alternate crossing or diversion point, and
	  o At the closure point itself.
	• Pay careful attention to details on signing sidewalk closures to provide proper instructions and directions. Closure signing may be different at each location.
	• Be sure that any signs and other devices mounted lower than 7 feet above the temporary pedestrian pathway do not project more than 4 inches into accessible pedestrian facilities.
	• Place signs so that they do not obstruct a pedestrian route. Consider placing signs at the back of the sidewalk or using a temporary single post to mount signs at the front of the sidewalk to maintain the pedestrian route.

Traffic Barriers & Fencing	• When pedestrian and motor vehicle paths are close to each other, consider separating them with a temporary traffic barrier. • If fences are used, be sure they are 8 feet or higher to discourage climbing and cutting across work zones. Fencing should not create sight distance restrictions for road users. • Use barriers constructed of materials such as wood, water-filled plastic, chain link, rail barrier, etc., rather than solely consisting of tape or other markings. Pedestrians with visual impairments need to be able to detect the barriers. • Avoid using fence materials that may be hazardous if impacted by vehicles. Wooden railing, fencing, and similar systems placed immediately adjacent to motor vehicle traffic should not be used as substitutes for crashworthy temporary traffic barriers.
Covered Walkways	• Consider using a covered or canopied walkway to protect pedestrians from falling debris and to provide a covered passage for pedestrians. The coverings or canopies should be sturdily constructed and adequately lighted for nighttime use.

Illumination	• Provide illumination of pedestrian and bicyclist facilities. Fatal and injury crashes with pedestrians and bicyclists are more likely to occur at night or in dim conditions. Illumination can increase visibility and reduce crashes, especially in work zones. *(4)* Temporary lighting of pedestrian and bicyclist facilities in work zones serves three main functions:
	  1. Deterring collisions between motor vehicles, bicyclists, and pedestrians.
	  2. Improving the visibility of potential tripping hazards such as uneven pavement, drop-offs, and steps.
	  3. Enhancing personal security. *(4)*

Table 4-1 ***(continued)***
Pedestrian Facilities Considerations

Pedestrian Crossings and Conflict Areas	
Pedestrian Crossings	• Maintain crossing facilities for pedestrians. • Where practical, use existing intersection corners and crosswalks – marked or unmarked. In urban settings, for route continuity and to meet pedestrian expectancy, the application of temporary mid-block crossings should be limited to sections where existing crossings are more than 600 feet apart (*5*). An existing marked midblock crossing may be used to shorten pedestrian routes. • Per the MUTCD, prohibit curb parking for at least 50 feet in advance of a midblock crosswalk. • Avoid having a pedestrian route double-back on itself. Pedestrians are not likely to walk one block beyond the closure to the next crossing and then one block back on the other side of the road. They will likely cross before the work zone impact (if visible), or mid-block – which may be unsafe or leave the pedestrian within the work area.
Construction Site Access	• Minimize movement by work vehicles and equipment across designated pedestrian paths and, when necessary, control such movements with flaggers or other temporary traffic control. Avoid staging or stopping of work vehicles or equipment along the side of pedestrian paths, as this encourages the movement of workers, equipment, and materials across the pedestrian path. • Minimize access to the work space by workers and equipment across pedestrian walkways because the access often creates unacceptable changes in grade and rough or muddy terrain, and pedestrians will tend to avoid these areas by attempting non-intersection crossings where no curb ramps are available.

Chapter 6 provides additional information about traffic control strategies and design for pedestrian facilities.

The *MUTCD* provides typical applications of a pedestrian detour to the adjacent parking lane, a pedestrian detour to the other side of a street, and a pedestrian midblock crossing. These are incorporated into TDOT Standing Drawing T-WZ-55, which shows three typical applications with similar signage, crossing, and detour configurations as the *MUTCD*. Three typical applications are illustrated: **Figure 4-2** shows a typical sidewalk diversion, **Figure 4-3** shows a typical midblock sidewalk closure, and **Figure 4-4** shows a typical corner sidewalk closure. These typical applications reflect several of the routing and traffic control device considerations discussed above. In some cases, Design Teams may need to consider covered walkways.

Figure 4-2
TDOT Standard Drawing T-WZ-55–Sidewalk Diversion

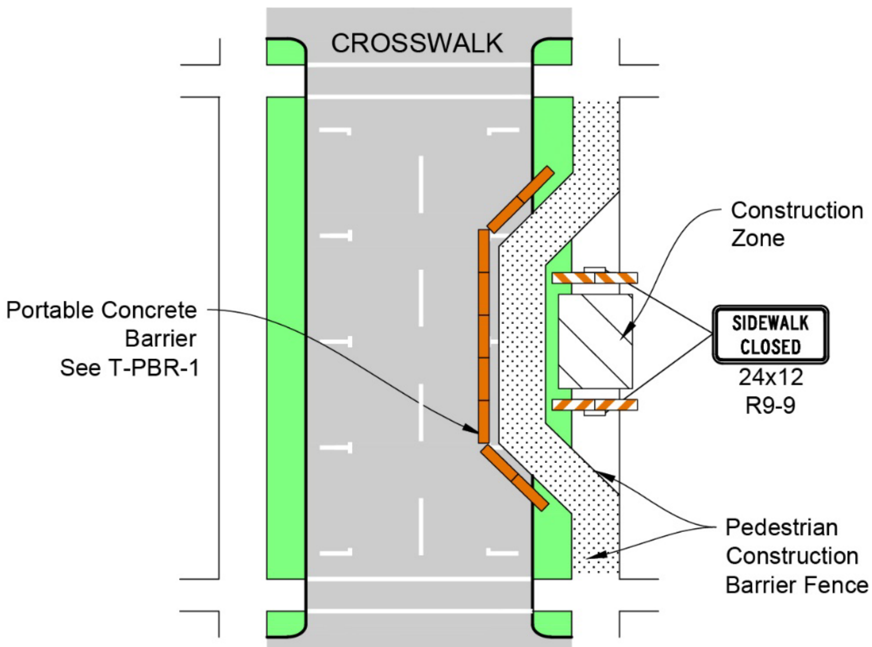
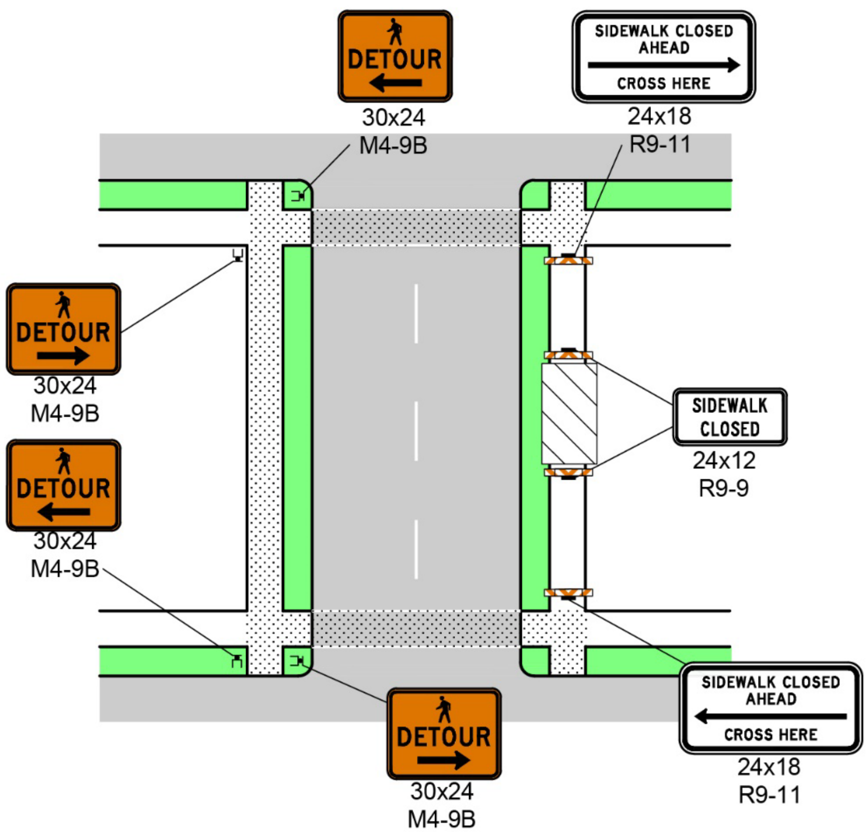


Figure 4-3
TDOT Standard Drawing T-WZ-55–Sidewalk Closure, Midblock



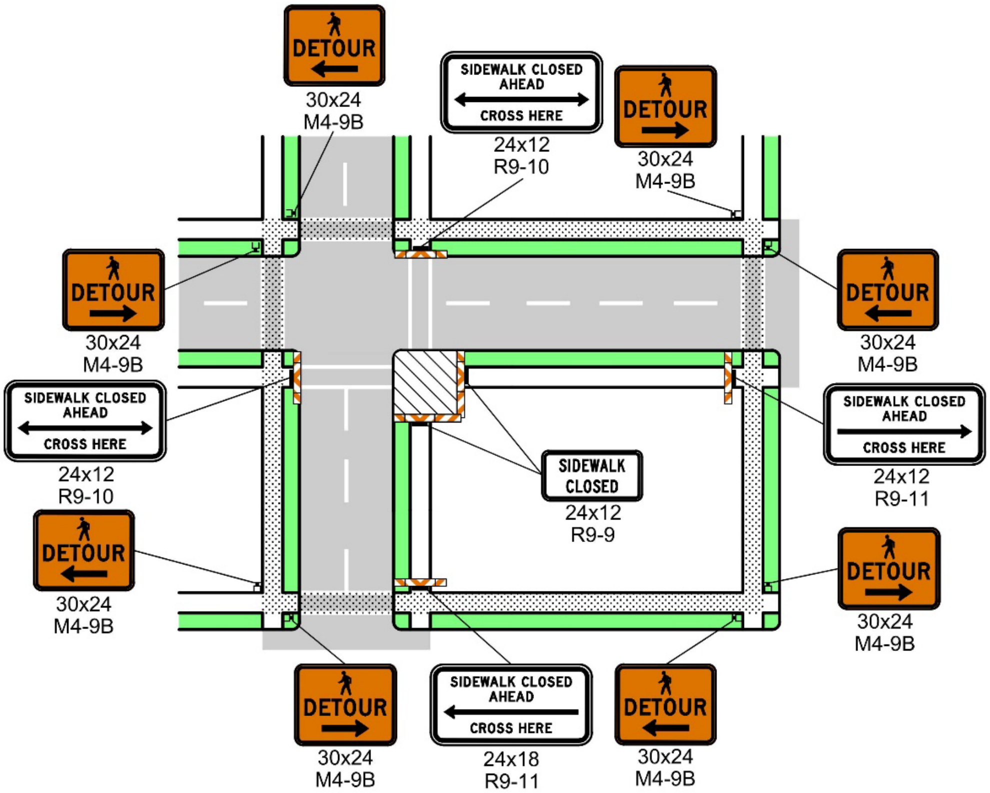


Figure 4-4
TDOT Standard Drawing T-WZ-55–Sidewalk Closure, Corner

4.1.2 PEDESTRIAN TPAR DESIGN DETAILS

A temporary pedestrian accessible route (TPAR) is an area within a work zone that is marked by signing, delineation, and other traffic control devices so that pedestrians can navigate through or around the work area. The TPAR is included as an integral part of the traffic control plan. Coordination with the TDOT Multimodal Transportation Resources Division and ADA Coordinator is recommended to ensure ADA compliance and appropriate pedestrian accommodation on a TPAR.

A TPAR that matches or exceeds the existing level of accessibility shall be provided as part of the traffic control plan when existing pedestrian facilities are impacted by construction or construction staging. Key design considerations for a TPAR include:

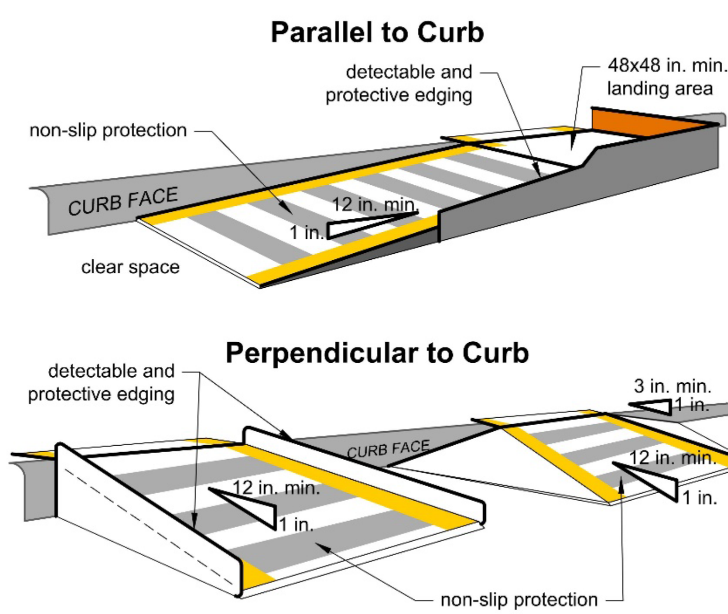
- A level of accessibility equal to or better than the existing pedestrian facility.
    - NOTE: An "existing pedestrian facility" may not necessarily include a sidewalk. Pedestrians may be using the roadway shoulder or some other pathway.
- Accessible features include curb ramps, landing pads, traversable surfaces, and manageable grades and cross slopes.

A TPAR that matches or exceeds the existing level of accessibility shall be provided as part of the traffic control plan when existing pedestrian facilities are impacted by construction or construction staging.

- Detectable warning features include truncated domes, detectable edges, curbs around fountains or pools, hazardous vehicular pathway warnings, and audible and vibrotactile indicators.
- Route and route features shall meet applicable TDOT standards, such as:
  - sidewalk ramps with a maximum running slope of 8.33%
  - constructed temporary sidewalks, paths, and sidewalk ramps with a maximum cross slope of 1.5%
  - 60-inch continuous sidewalk widths or,48-inch widths with 60-inch x 60-inch level landings (maximum 1.5% slope) every 200 feet
  - a 60 x 60-inch passing space at least every 200 feet to allow individuals in wheelchairs to pass (when it is not possible to maintain a minimum width of 60 inches throughout the entire length of the pedestrian pathway)
  - continuous and detectable surfaces with vertical drops or edges less than 1/4 inch
  - a continuous detectable edging—compliant with the provisions of Section 6F.74 of the MUTCD (*3*)—throughout the length of the facility so that pedestrians using a long cane can follow it (when channelization is used to delineate a pedestrian pathway)

Figure 4-5 shows typical temporary ramp designs that are either parallel or perpendicular to the curb. These show accessible and detectable features (as described above) as well as appropriate widths and slopes.

Figure 4-5
Capturing Key Design Considerations Related to Pedestrians



Coordinate the TPAR design with local agencies, as necessary, where the TPAR incorporates local facilities. Ensure pedestrian access and traffic control device placement on local agency facilities are approved before releasing the project for advertisement.

In **Table 4-2**, TDOT includes the following guidelines for selecting the most practical traffic control measure for pedestrian separation and guidance. All treatments must include a detectable edge.

Table 4-2
TPAR Traffic Control Measure Selection Guide

	Pre-Construction Posted Speed (mph)	Using Shoulder, or Making No/Minimal Changes to Pedestrian Pathway Alignment*: Between Motor Vehicles & TPAR	Using Shoulder, or Making No/Minimal Changes to Pedestrian Pathway Alignment*: Between TPAR & Work Area	Using Closed/Partial Lane, or Making Major Changes to Pedestrian Pathway Alignment**: Between Motor Vehicles & TPAR	Using Closed/Partial Lane, or Making Major Changes to Pedestrian Pathway Alignment**: Between TPAR & Work Area
Urban	≤ 40 mph	If Off Sidewalk: PCD or similar.	PCD or other barrier system. Consider adding Contractor escort for long, elaborate TPARs.	PCD or similar.	PCD, or other barrier system. Consider adding Contractor escort for long, elaborate TPARs.
Rural	≥ 45 mph	If Off Sidewalk: Rigid barrier system (e.g., steel, concrete), with protected ends.	PCD or other barrier system. Consider adding Contractor escort for long, elaborate TPARs.	If Off Sidewalk: Rigid barrier system (e.g., steel, concrete), with protected ends.	PCD, or other barrier system. Consider adding Contractor escort for long, elaborate TPARs.
Urban	≤ 40 mph	Existing/ temporary pavement markings; PCD.	PCD. Consider substituting Contractor escort for very long TPARs.	PCD or similar.	PCD, or other barrier system. Consider substituting Contractor escort for very long TPARs.
Rural	≥ 45 mph	Existing/ temporary pavement markings; PCD.	PCD. Consider substituting Contractor escort for very long TPARs.	Rigid barrier system (e.g., steel or concrete), with protected ends.	PCD, or other barrier system. Consider substituting Contractor escort for very long TPARs.

If space is available, channelization devices should provide guidance for pedestrians with visual impairments. Refer to TDOT's QPL for potential devices.

NOTES:
PCD: Pedestrian Channelizing Device
***Minimal Change**: Shifting alignment by one or two feet, without encroaching onto a separate portion of the roadway (e.g., traffic lane).

****Major Change:** Examples might include shifting from a sidewalk to a full/partial traffic lane; or multi-use path onto a shoulder. Provide traffic lane closures, lane shifts, and shoulder closures according to ODOT Standard Drawings. Use a Buffer Space "B" between the end of the lane closure taper and the start of the TPAR shift where it moves pedestrians into the roadway shoulder or traffic lane.

"Other Barrier System": Refers to temporary concrete or steel barrier or other continuous system that includes a handrail and detectable edge; and will restrict pedestrian access from the work area. All barrier systems must include crashworthy end treatments for ends exposed to vehicular traffic.

Urban: Higher traffic volumes; multiple pedestrian facilities/crossings; high anticipated pedestrian presence/usage; large pedestrian traffic generators.

Rural: Low traffic volumes; few to no specific pedestrian facilities; low to very-low anticipated pedestrian presence/usage.

4.2 BICYCLE CONSIDERATIONS

Traffic control plan design should incorporate bicyclists' needs into the work zone area to maintain their safety, accessibility, and movement through or around the work zone. The principles outlined in *MUTCD,* Section 6C apply to designing for bicycles in the work zone (*3*). **Figure 4-6** illustrates an example of a bicycle lane in a work zone.

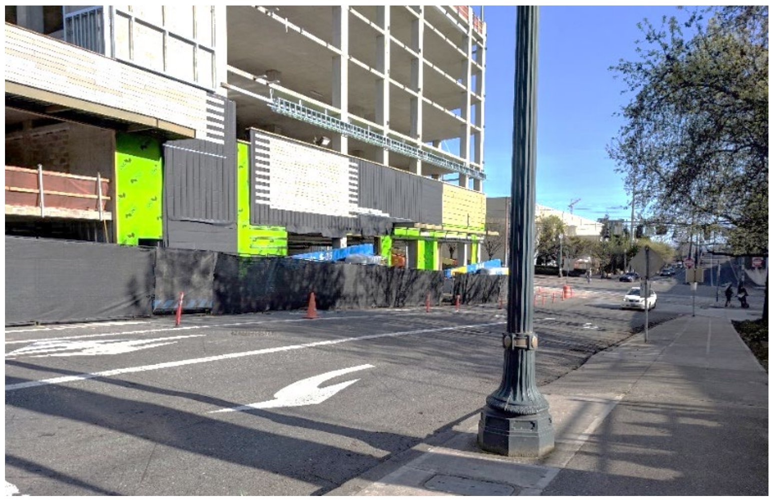


Figure 4-6 Bicycles in Work Zones, Bicycle Treatments, and Various Ways of Designing for Bicycles *(1)*

4.2.1 DESIGN PRINCIPLES

Electric mobility devices, such as scooters, are classified as "bicycles" in Tennessee. Therefore, the same principles that are described for bicycles should also be considered for electric mobility devices.

Bicyclists have a legal right to use most highway facilities, and provisions for their safe conduct through work zones are necessary. When separate bicycle facilities are provided on a roadway, riders expect a certain level of safety and service that Design Teams should consider and maintain as much as feasible when designing TCPs. At times, there may be low-impact projects that may not have a direct impact on vehicles but may block an existing bicycle lane. However, Design Teams should still fully consider the impacts on all existing facilities and users when designing a TCP. The Design Team should be conscious of bicyclist use of the shoulder when considering a work zone involving the shoulder. The project should maintain adequate surface pavement for bicycles that is clear of rumble strips and is at least 4-feet wide, per the *MUTCD (3)*. Electric mobility devices, such as scooters, are classified as "bicycles" in Tennessee. Therefore, the same principles that are described for bicycles should also be considered for electric mobility devices.

TDOT has the following guidance for serving bicyclists during construction:

- A temporary route **should** be clearly marked and include advance notification of bicycle lane closures, detours, or diversions.
- Bicyclists **should** be separated from motor vehicle traffic and pedestrians, when feasible.
- A bicycle route **shall** be free of obstructions and surface hazards.
- The method for providing safe facilities for bicyclists **should** be prioritized as follows:

- Maintain existing bicycle lanes on the same roadway through the work zone by shifting and narrowing the adjacent motor vehicle lanes.
- Merge bicyclists and adjacent motor vehicle traffic into a shared travel lane. Adequate advanced warning for bicycles and motor vehicles is required. Speeds should be considered when using shared lanes for bicycles and motor vehicles.
  - Note: this should only be done if motor vehicle speeds are low (35 mph or less with appropriate speed management treatments).
- Provide a bicycle detour route.

For permanent bicycle facilities on urban roadways, TDOT recommends a minimum bicycle lane of 4 feet. It is desirable to continue providing separate bicycle facilities during construction, and the Design Team should consider identifying space to accommodate a minimum 4-foot bicycle lane.

Table 4-3 shows considerations for bicycle facilities and guiding principles for decision making.

Table 4-3
Bicycle Considerations

Topic	Consideration
Bicycle Facility during Construction	
Bicycle Space	• Provide a convenient, contiguous, and traversable path with an equal or better degree of accessibility than the existing bicycling route. • Maintain the same level of condition of the surface the bicyclist will be required to use. Riding surfaces are important for safe bicycle operation. Loose gravel, uneven surfaces, milled pavement, and various asphaltic tack coats can cause a bicyclist to lose traction. • Provide a separate roadway space (e.g., shoulder, bicycle lane) for bicycles wherever possible. Use channelizing devices to separate bicycles from motor vehicle traffic if delineating a temporary pathway or alignment.
Detours	• Where roadway width is not available, consider detour routes. Develop a thorough signing plan for the detour. Include regulatory bicycle exclusion signs to keep bicyclists out of the work area and encourage detour routes. • Avoid directing on-road bicyclists onto a path or sidewalk except where such a path or sidewalk is sized appropriately to serve as a shared-use path, or there is no practical alternative during a rehabilitation project. • Coordinate with local agencies, as necessary, if alternate bicycling routes would utilize their facilities. Ensure bicycle traffic and traffic control device placement on their facilities are approved before the project is released for advertisement. • Provide for and sign an appropriate alternate route when activities close a designated (signed) bicycle path or shoulder bikeway. Where horizontal separation for bicycles and pedestrians existed prior to work, maintain separation to the maximum extent possible. • When laying out alternative bicycle paths, make sure no overhead obstructions present a direct hazard to normal bicycle operation.
Shared Space	• For pre-construction posted speeds of 35 mph or lower and where neither roadway width nor alternate routes are available, a “shared roadway” condition could be provided. • Designers should review the bicycle volumes (or level of activity) and may consider a temporary Speed Zone Reduction for the section where bicycles will be on the roadway. Identify speed management treatments.

Chapter 6 provides more information about speed management devices and strategies.

Chapter 2 provides more information about speed reduction requests.

Table 4-3 *(Continued)*
Bicycle Considerations

Chapter 5 provides additional information on temporary traffic control devices.

Specific product information can be found in the [TDOT Quality Products List (QPL)](). Additional information on the QPL is provided in Chapter 8.

Topic	Consideration
Temporary Traffic Control Devices	

Signage	• Place signs so that neither the sign nor support restrict bicycle lanes or sidewalks to less than 4 feet in width.
	• Ensure that signs and other devices mounted lower than 10 feet above the temporary bicycle pathway do not project into bicycle facilities.
	• Along roads with bicycle lanes adjacent to the curb with curb-tight sidewalks, or other locations where typical sign placement may restrict sidewalks, bike lanes, paths, or vehicle lanes, consider the following:
	  o Place sign behind the sidewalk;
	  o Adjust sign spacing so that the sign can be placed behind the sidewalk;
	  o Install the signs on an existing utility pole, street light pole, or other sign support with permission from the owner of the support;
	  o Install the sign on a new perforated steel tube sign support (PSST) with a flange base;
	  o Use more prominent devices (PCMS, arrow boards); or
	  o Install the sign on a traffic barrier sign support.

Pavement Markings	• Use paint for temporary pavement markings applied with a stencil, such as bicycle symbols, to delineate temporary paths. • Cover conflicting pavement markings. For example, a closed bicycle lane should have the bicycle symbol covered to deter bicyclists from using the facility. • Consider temporary rumble strip buffers in urban areas to protect bicycle lanes. Contact the TDOT Bike Coordinator for guidance (6).
Traffic Barriers & Fencing	• When bicycle and vehicle paths are rerouted to closer proximity to each other, separate them with a temporary traffic barrier. • Locate traffic barriers for bicyclists so that they enable transitions to and from the bicycle path; flexible delineators on a temporary path can allow for bicyclists to merge into or out of the path.
Illumination (*4*)	• Provide temporary lighting for bicycle facilities, as it serves three main functions: 1) Lighting deters collisions between motor vehicles, bicyclists, and pedestrians. 2) Lighting allows bicyclists and pedestrians to see hazards such as uneven pavement. 3) Lighting enhances personal security.
Bicycle Conflict Areas	
Construction Site Access	• Do not lead bicyclists into conflicts with motor vehicle traffic, construction vehicles, equipment, operations, or hazardous materials.

Table 4-4 provides recommended bicycle accommodation during construction based on the roadway speed, traffic volumes, and bicycle volumes. These recommendations are primarily associated with urban areas, as rural areas typically have higher vehicular speeds and lower levels of bicycle activity. The facility type should consider time-of-day traffic volumes, construction activity, and bicycle volumes. Design Teams should coordinate with the TDOT Multimodal Division about all facilities.

Table 4-4
Bicycle Accommodation During Construction

Roadway Speed	Vehicle and Bicycle Traffic Volumes	Bicycle Accommodation Considerations
≤ 35 mph	Low – Moderate	Bicycles within 11-foot Travel Lane
≤ 35 mph	Moderate – High	Bicycles within 14-foot Travel Lane
35-45 mph	Low – Moderate	Bicycles within 11-foot Travel Lane with an approved 10-mph temporary speed reduction request Bicycles within 14-foot Travel Lane
35-45 mph	Moderate – High	Bicycles within 14-foot Travel Lane Separated; 4 feet minimum width
≥ 45 mph	N/A	Bicycles within 14-foot Travel Lane Separated; 4 feet minimum width

4.2.2 SERVING BICYCLES WITHIN THE TRAVEL LANE

For shared roadways, speeds, volumes, advance warning, and outreach coordination should be carefully considered.

Where it is not feasible to maintain separate bicycle facilities, Design Teams can consider serving bicycles within the travel lane. Design Teams should review speed, traffic volumes, and levels of bicycle activity when considering a shared roadway condition. Adequate advanced warning for bicycles and motor vehicles is required to appropriately communicate the shared usage of the travel lane. **Table 4-4** identifies conditions where a shared facility may be used. In the 35-45 mph range, the Design Team may need to apply for a temporary Speed Reduction Request in a constrained environment. This section describes the considerations and speed management treatments to encourage slower vehicle speeds and support the mobility and safety of bicycles as well as that of vehicles.

Where bicycles and motorists will share the travel lane, speed reduction strategies should be implemented in advance of and throughout the shared space. In addition to advance signage, speed reduction strategies may include:

- stationary and automated enforcement
- speed feedback displays
- rumble strips (end before bicycle facility to preserve pavement conditions)
- transverse pavement markings
- speed tables
- portable changeable message signs

Figure 4-7 provides an example of signing for bicycles in the work zone.

Figure 4-7
Bicycles in Travel Lanes During Construction (7)

Figure 4-8 provides examples of bicycle facilities approaching, within, and departing a work zone. These include recommendations for traveling within the motor vehicle travel lane or providing a separate facility, width and taper lengths, and signage.

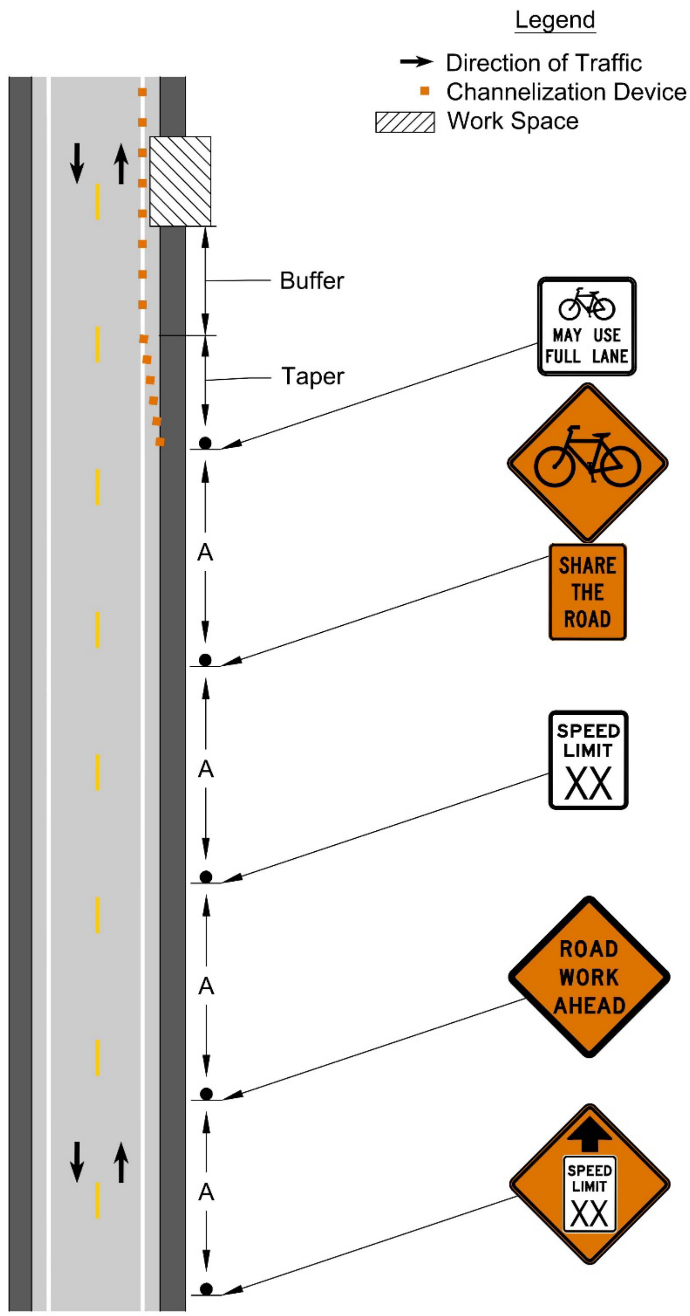


Figure 4-8
Example of Bicycle Facilities in the Work Zone

4.2.3 DESIGNING SEPARATE BICYCLE FACILITIES

Separate bicycle facilities are preferred to provide separation from motor vehicles near work zones when speeds are over 35 mph. Bicycle facility width, presence and width of a buffer, and striping and signage should match or exceed the existing facilities. Where separate bicycle facilities can be provided but are constrained, Design Teams should consider the vehicle speed of the adjacent travel lane.

Preferred bicycle lane widths based on speeds are as follows (*10, 11*):

- 50 mph or greater: 6 feet minimum, 8 feet preferred
- 45 mph or less or when rigid barrier present: 5 feet minimum
- 40 mph or less with no rigid barrier: 4 feet minimum

Figure 4-9 illustrates how to maintain a bicycle lane during construction. Refer to **Section 6.6.1** for applications where work affects bicycle facilities. When Design teams are unable to maintain a bicycle lane, and a vehicle-bicycle shared-lane is required, refer to **Section 4.2.1** for principles and **Section 4.2.2** for guidance.

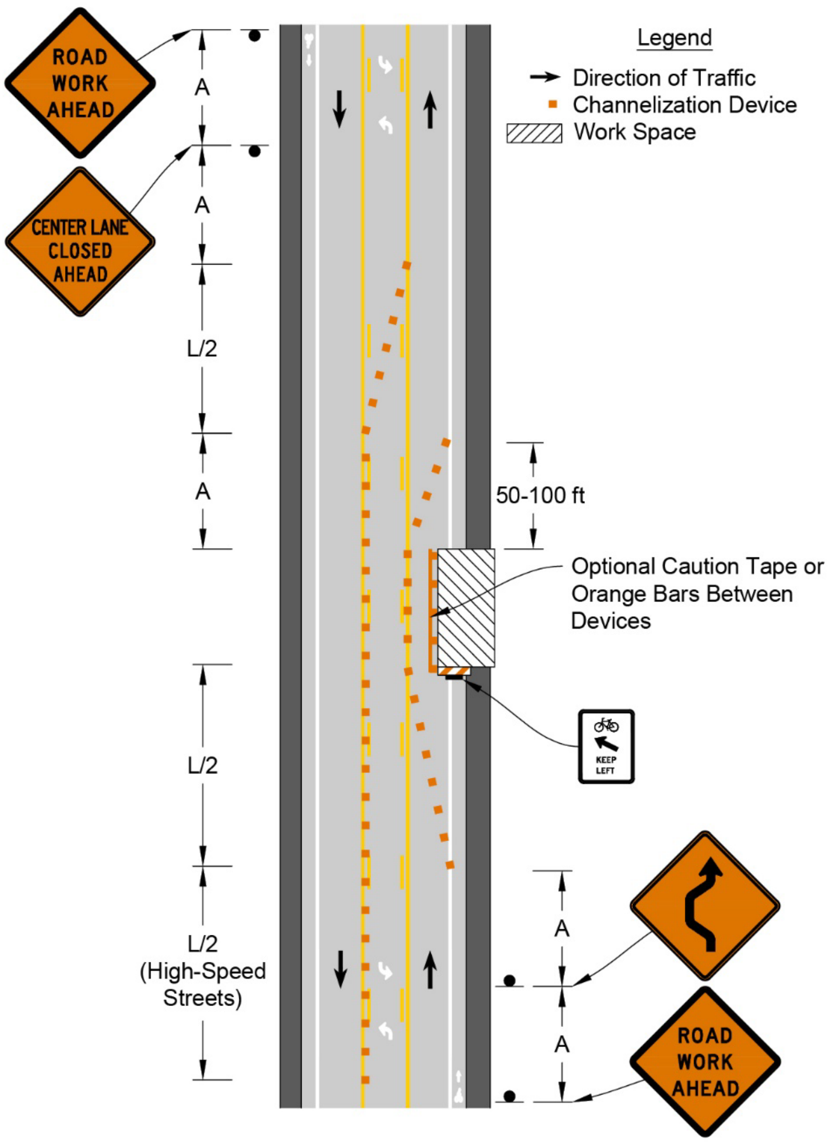


Figure 4-9
Accommodate Bicycle Lane during Construction

4.3 COORDINATION WITH STAKEHOLDERS

Pedestrian and bicycle facilities should be coordinated with transit agencies, schools, railroads, and businesses. **Table 4-5** shows considerations for this coordination.

Table 4-5
Pedestrian and Bicycle Coordination Considerations

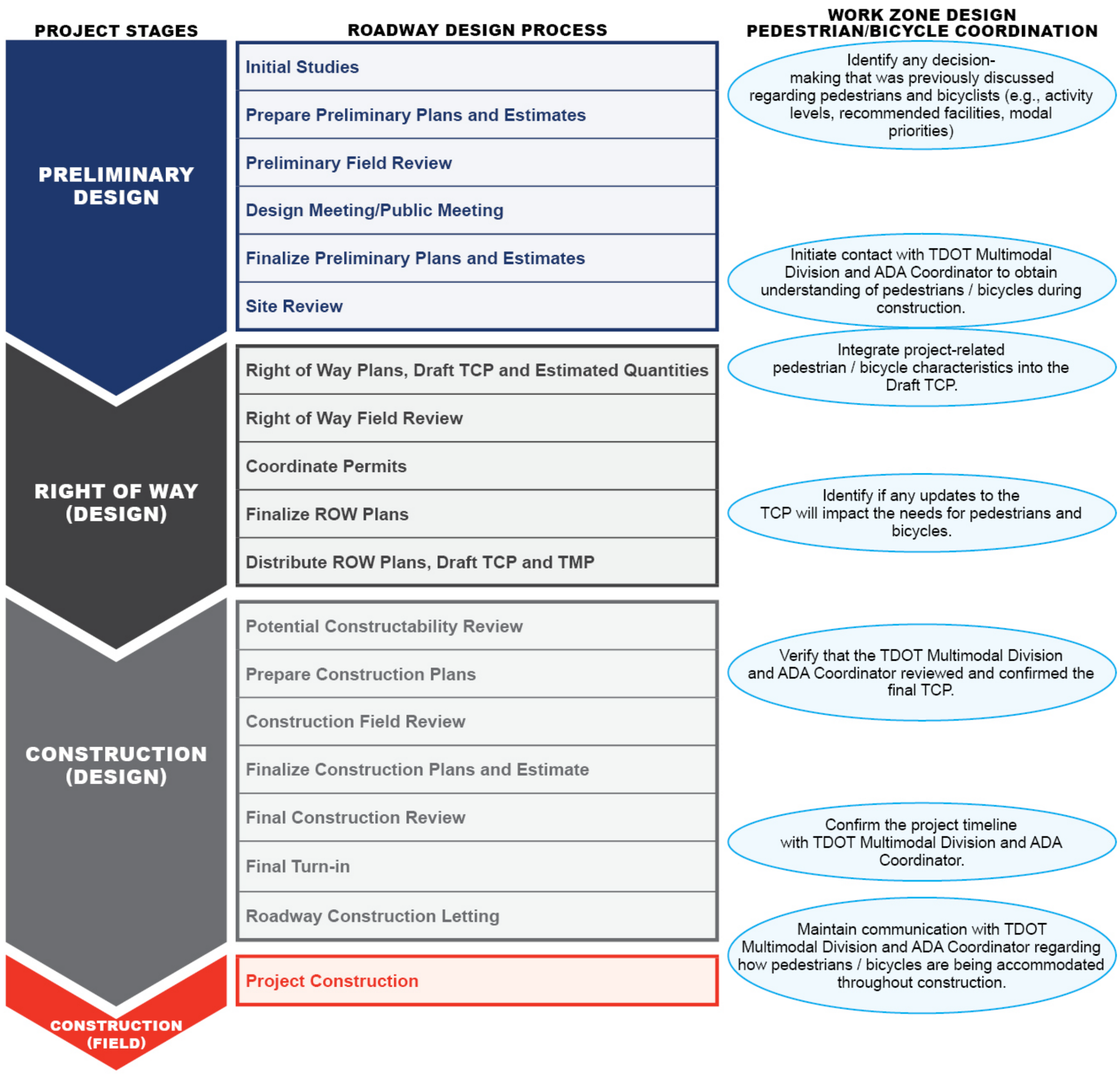
Topic	Public & Stakeholder Outreach
Transit	• Coordinate with transit agencies early in the process to develop workable detours and temporarily relocated transit stop locations and to communicate changes to riders. • Walking is necessary to and from transit stops, and bicycling is also common. Provide clear paths and guidance to transit stops near work zones. • When relocating transit stops, consider pedestrian and bicycle access to the stop and advanced signage and guidance so pedestrians and bicyclists minimize out-of-direction travel to the relocated stop.
Schools	• Coordinate with adjacent and nearby schools early in the process to determine school bus routing and stop locations and any paths/routes. • Consider the need for flaggers and/or crossing guards at work zones near schools.
Railroads	• Coordinate with railroad company early in the project to identify pedestrian and bicycle crossing relocations, if needed.
Business and Building Access	• Maintain accessible paths to building entrances, including general public access points, and loading and delivery areas. • If detouring pedestrians or bicycles into a parking lane, consider relocating passenger and freight loading areas for adjacent and nearby buildings.

Chapter 3 provides additional information on outreach strategies and timeline within the project development process.

4.4 CONNECTION TO THE PROJECT DEVELOPMENT PROCESS

Chapter 1 of the *WZDM* provides an overview of the TDOT project development process and the associated work zone design activities that occur at each project stage. Several of these work zone design activities relate to pedestrians and bicycles, as shown in **Figure 4-10**.

Figure 4-10 Connection between Pedestrians/Bicycles and Overall TDOT Project Development Process



The Design Team should understand key community goals, needs, and constraints regarding pedestrian and bicycle usage within the project area. As shown in **Figure 4-10**, during the Preliminary Design stage, the Roadway Designer will need to coordinate with the TDOT Multimodal Division and ADA Coordinator regarding the upcoming project to assess the needs based on the local context. During the Right-of-Way stage, as the Draft Traffic Control Plans are developed, the Roadway Designer will verify that the construction strategy is consistent with earlier coordination and continues to reflect originally agreed upon accommodations for pedestrians and bicycles during construction. If there are any changes to the original intended strategy, the Roadway Designer should coordinate with the TDOT Multimodal Division and ADA Coordinator to determine if the change strategy is acceptable. It is important to reach an agreement before proceeding to the next stage. During the Construction (Design) and Construction stages, the Roadway Designer will continue to coordinate with the TDOT Multimodal Division and ADA Coordinator to verify that pedestrians and bicycles are accommodated.

4.5 REFERENCES

1. Purser, K. Photo Credit. 2020.
2. United States Access Board, Public Rights-of-Way Accessibility Guidelines (PROWAG). Revised 2013.
3. FHWA, USDOT, Manual on Uniform Traffic Control Devices. Revised 2012.
4. FHWA, University of Wisconsin – Madison, Guidelines for Work Zone Designers – Pedestrian and Bicycle Accommodation. 2018.
5. Oregon Department of Transportation, Temporary Pedestrian Accessible Routes Overview. 2018.
6. TDOT, MM-PM-2 Signing and Pavement Markings for Bicycle Lanes on Urban Roadways. 2019.
7. McCormick, M. Photo Credit. 2020.

TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 5

TEMPORARY TRAFFIC CONTROL DEVICES

March 2022

TN TDOT Department of Transportation

Contents

CHAPTER 5 TEMPORARY TRAFFIC CONTROL DEVICES . 5-1

Chapter 5

Temporary Traffic Control Devices

Chapter 5 provides details and guidance for installing temporary traffic control devices in the work zone. A traffic control device (TCD) is a sign, signal, pavement marking, or other device used to regulate, warn, or guide traffic. A TCD is placed on, over, or adjacent to a street, highway, pedestrian facility, or shared-use path and can be either permanent or temporary; this chapter focuses on temporary TCDs to facilitate movement through and around a work zone. When installed appropriately and consistently in the work zone, temporary TCDs can help optimize driver expectancy and overall compliance.

Chapter 5 includes device descriptions, images, purpose, typical applications, implementation notes, and references to additional information about devices. **Chapter 5** provides basic information about the types of devices, while **Chapter 6** includes information about applying the devices and guidance for selecting appropriate devices in various contexts. Design Teams should reference the most recent versions of the primary sources for this chapter, including the *Manual on Uniform Traffic Control Devices (MUTCD) (1)* and TDOT *Work Zone Field Manual for Maintenance Operations* (*Field Manual) (2).* These resources are at the following website links *(1,2)*:

Chapter 5 provides basic information about the types of devices.

Chapter 6 includes information about applying the devices and guidance on selecting appropriate devices in various contexts.

[Manual on Uniform Traffic Control Devices (MUTCD)]

[TDOT Work Zone Field Manual for Maintenance Operations]

Additional details about the quality and wear of devices in work zones and how to ensure devices effectively meet desired functions are included in the Quality Classification and Requirement of Devices section in the TDOT *Field Manual*. **Chapter 8** of the *WZDM* has additional information about pay items and measurement of devices.

5.1 TYPES OF CRASHWORTHY DEVICES

This section overviews crashworthy devices and introduces the device categories, test levels, and visibility types.

5.1.1 Crashworthy Testing Compliance

All temporary traffic control devices used on any roadway open to public travel shall be crashworthy when installed within the clear zone.

The Federal Highway Administration's (FHWA) policy requires that all roadside appurtenances, including temporary traffic control devices, have been successfully crash tested in accordance with the National Cooperative Highway Research Program (NCHRP) *Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features (3)* or the American Association of State Highway and Transportation Officials (AASHTO) *Manual for Assessing Safety Hardware (MASH) (4).*

For contracts on the National Highway System with a letting date after the dates below, only safety hardware evaluated using the 2016 edition of AASHTO MASH criteria will be allowed for new permanent installations and full replacements. Exceptions and clarifications to the AASHTO/FHWA MASH Implementation Agreement are available on AASHTO's website *(5).*

- December 31, 2017: w-beam barriers and cast-in-place concrete barriers
- June 30, 2018: w-beam terminals
- December 31, 2018: cable barriers, cable terminals, and crash cushions
- December 31, 2019: bridge rails, transitions, all other longitudinal barriers (including portable barriers installer permanently), all other terminals, sign supports, all other breakaway hardware, and temporary work zone devices.

5.1.2 Crashworthy Device Categories

The FHWA has classified work zone traffic control devices into four categories, each with its own testing requirements. **Table 5-1** summarizes each traffic control device category.

Table 5-1
Crashworthy Device Categories

Traffic Control Device Categories
Category 1
• Category 1 consists of low-mass devices with known performance history. Vendors may self-certify the crashworthiness of these devices. • Examples include tubular markers, conical markers, and flexible drums.
Category 2
• Category 2 includes devices with a higher mass that can pose a greater risk to the public if struck. • Due to the higher mass, Category 2 devices typically require crash testing. • Examples include barricades, sign supports, and most temporary signing.
Category 3
• Category 3 includes devices that pose a more significant risk to the public if not adequately protected or installed correctly. • Devices require more complex crash testing. • Examples include impact attenuators, concrete barriers, and guard rail systems, etc.
Category 4
• Category 4 includes devices that pose the greatest risk to motorists as temporary TCD. • Devices are usually trailer-mounted and should be shielded from traffic, when practical. • At a minimum, if used on the roadside and not placed behind a barrier system, these devices should be heavily delineated using other Category 1 and 2 retro-reflective devices. • Currently, Category 4 devices do not require crash testing, as FHWA is in the process of developing specific crash testing standards for them. • Examples include sequential arrow boards, portable changeable message signs (PCMS), portable traffic signals, and automated flagger assistance devices (AFAD).

5.1.3 Crashworthy Test Level

The AASHTO *MASH* describes six crashworthy test levels. Longitudinal barriers may be tested to six test levels, and other roadside features may be tested to three test levels. A test level is defined by impact conditions (speed and angle of approach) and the type of test vehicle (ranging in size from a small car to a fully-loaded tractor-trailer truck). The first three test levels are limited to passenger vehicles, while the last three incorporate some form of heavy truck. Note that longitudinal barriers are the only safety features for which all six test levels are defined at this time.

A feature designed and tested for one of the lower test levels is generally used on a roadway that has low speeds, low volumes, or both, such as a rural collector, local road, or urban street. A feature designed and tested for one of the higher test levels is typically used on a roadway that has high speeds, high volumes, or both, such as a freeway. Devices that meet a given test level will generally have different performance characteristics from those that meet other test levels.

In general, devices used on state highways should be tested to the speeds used on each highway. It is recommended to use Test Level 3 (TL-3) or higher devices for all highways, regardless of the posted speeds. Additional details about the Test Levels are defined in the AASHTO Roadside Design Guide *(6)*, *NCHRP Report 350 (3)*, and MASH *(4)*. **Table 5-2** summarizes the test levels most applicable to TDOT temporary traffic control devices.

Table 5-2
Crashworthy Test Levels

Crashworthy Test Levels
Test Level 1 (TL-1)
• Devices can be used on highways with speeds of 35 mph or less.
Test Level 2 (TL-2)
• Devices can be used on highways with speeds of 45 mph or less.
Test Level 3 (TL-3)
• Devices are used on highways with speeds greater than 45 mph.

5.2 CATEGORY 1 DEVICES

Category 1 devices used in work zones consist primarily of channelization devices, such as flexible drums, tubular and conical markers, temporary delineators, pavement markings, and pavement markers. The function of channelizing devices is to delineate the desired user path, mark specific hazards on or near the roadway, separate opposing traffic flows, and partially or totally close the roadway. **Table 5-3** summarizes the types of devices in Category 1.

Table 5-3
Category 1 Devices

Category 1
• Category 1 includes lightweight devices less than 100 lbs. • These devices have no potential to penetrate a vehicle windshield or cabin. • There is no significant effect on the control or trajectory of an impacted vehicle.
Types
• **Flexible Drums** • **Tubular and Conical Markers** ○ Surface Mounted Delineators ○ Tubular Markers (36” and 18”) ○ Opposing Traffic Lane Divider ○ Cones (28”-36” and 18”) ○ Weighted Channelizer • **Temporary Delineators** ○ White (MUTCD Type W-1) ○ Yellow (MUTCD Type Y-1) • **Temporary Pavement Markings** ○ Temporary Striping ○ Temporary Pavement Legends, Crosswalks, and Stop Bars ○ Durable Striping ○ Temporary Tape • **Temporary Pavement Markers** ○ Temporary Reflective Pavement Markers ○ Flexible Overlay Pavement Markers

5.2.1 Flexible Drums

Description	
• A flexible drum is a deformable channelizing device. • It provides a visual separation between the work area and functional travel lanes via drum sizes. • Drums have alternating bands of orange and silver-white, retro-reflective sheeting for high visibility.	 Source: TDOT
Purpose	
• Delineate travel lanes. • Identify work areas. • Construct lane closure tapers. • Delineate PCMS and temporary traffic signal installations.	
Typical Applications	
• High-speed divided highways and freeways. • Daytime and nighttime conditions. • Varied weather conditions. • Drums and Barricades: Flexible drums shall be used instead of Type II barricades due to better performance in terms of durability and target value.	
Implementation Notes	
• Drums may shift out of place due to the close proximity of passing vehicles or high wind conditions. • Design Teams should install a rubber ring (at least 10 lbs) around the drum base to add ballast to the drum while not impeding crashworthiness. • A second ring may be added to resist further movement. • No other means of ballast are permitted. • Type B channelizing devices shall be used if the temporary traffic control zone will be installed for more than 12 hours or if it is left unattended.	
Additional Resources	
MUTCD Reference	• Section 6F.63 • Section 6F.67
Pay Item	• 712-04.01 Flexible Drums (Channelizing)
TDOT Standard Drawings	• T-WZ-11 thru T-WZ-16 • T-WZ-18, T-WZ-19 • T-WZ-21, T-WZ-32, T-WZ-36 • T-WZ-40 thru T-WZ-42
TDOT Specifications	• 712.02, Item H
TDOT QPL	• QPL.01.005 - Work Zone Traffic Drums

Plastic drums shall be used in lieu of Type II barricades due to better durability performance and target value.

5.2.2 Tubular Markers and Cones

Description

- Tubular markers and cones are deformable channelizing devices on a weighted and/or glued base.
- They are predominantly orange with reflective white striping.

Source: TDOT

Source: TDOT

Source: Ver-Mac

Purpose

- Temporarily redirect traffic through work zone or incident response area.
- Used to override existing pavement markings for shorter-duration applications.
- Use in tapers or along tangent areas to separate traffic from workspace.
- Guide traffic along a desired path.
- Divide opposing vehicular traffic lanes or road users.
- Divide lanes when two or more lanes are kept open in the same direction.
- Tubular markers: Delineate the edge of a pavement drop off where space limitations do not allow the use of larger devices.

Typical Applications

- High-speed highways (typically cones, taller height, longer spacing).
- Low-speed facilities (typically tubular markers, shorter height, shorter spacing).
- Daytime and nighttime conditions, except for 18” tubular markers and cones that are for daytime, low-speed facility use only.
- Typically used in attended temporary traffic control zones.

Implementation Notes

- Retro reflectorize for maximum visibility during nighttime. If approved product, lighting devices may be used but does not alter reflectivity requirements.
- **Tubular markers**: Install a sandbag ring/weighted base (minimum amount) around the base to affix to pavement for stability. Use only where space restrictions do not allow for use of more visible devices.
- **Cones**: Double up cones to increase weight; minimum of 28” high; Use cones constructed with bases that can be filled with ballast (minimum amount) or install weighted bases/sandbag rings that can be dropped over cones onto the base to provide stability.

Additional Resources

MUTCD Reference	• Tubular markers: Section 6F.65 • Opposing traffic lane divider: Section 6F.72 • Cones: Section 6F.64
Pay Item	• 712-01 Traffic Control
TDOT Standard Drawings	• T-WZ-11 thru T-WZ-16 • T-WZ-18, T-WZ-19 • T-WZ-21, T-WZ-32, T-WZ-36 • T-WZ-40 thru T-WZ-42 • T-WZ-PBR2 • T-WZ-56
TDOT Specifications	• 712.02, Item C
TDOT QPL	• 916.08.027- Flexible Surf & Ground Delineator Posts

5.2.3 Temporary Delineators

Description

Source: TDOT

- Temporary delineators are flexible delineators with a retroreflective component.
- They may be ground-mounted, surface-mounted, or barrier-mounted.
- The standard color for delineators used along both sides of two-way streets and highways, and the right-hand side of one-way roadways shall be white (*MUTCD*, Type W-1).
- Delineators used along the left-hand side of one-way roadways shall be yellow (*MUTCD* Type Y-1).

Purpose

- Delineators indicate the alignment of the roadway and to outline the required vehicle path through the work zone.
- Delineators supplement normal pavement edge delineation (tubular markers, striping, etc.) to indicate the roadway alignment.

Typical Applications

- Delineators are used to signal changes to a roadway and/or lane alignment.
- They can be used with daytime and nighttime operations.

Implementation Notes

- Temporary Delineators shall be mounted on crashworthy supports so that the reflecting unit is approximately 4 feet above the near roadway edge.
- The retroreflective sheeting strip shall be a minimum 9 inches in length and 3 inches in width profile facing approaching traffic.
- **Barrier-mounted:** Spacing for delineators not in a taper should be a distance in feet approximately equal to two times the posted speed limit in miles per hour. Spacing for delineators in a taper should be approximately equal to the posted speed in miles per hour but will not exceed one half the spacing of the delineators not in a taper.
- **Ground- and surface-mounted:** Spacing for delineators shall be 20 feet or less.
- Barrier Rail Delineators shall be used on portable barrier rail in accordance with the Roadway Standard Drawings T-WZ-Series.
- Temporary Pavement Marking for use on pavement surface other than final.
- Portable barrier rail delineator reflective sheeting shall meet ASTM D4956, Type V specifications.
- Delineator should have 4” x 3” dimensions. Delineators with dimensions other than 4” x 3” may be used if the product is on the approved products list. The variations in delineator dimension should not exceed ±10%.
- Different types of barrier rail delineators should not be mixed in the same line.
- Portable Barrier Rail Delineators shall be high impact, UV-stabilized, engineered thermoplastic or polycarbonate substrate.

Additional Resources

MUTCD Reference	• Section 6F.80
Pay Item	• 712-01.51 Portable Barrier Rail Delineator (Double) • 712-04.10 Temporary Flexible Delineator • 712-04.50 Barrier Rail Delineator • 712-12.10 Temporary Curb w/Flexible Delineator
TDOT Standard Drawings	• T-WZ-14, T-WZ-16, T-WZ-18, T-WZ-19, T-WZ-32 • T-WZ-PBR2
TDOT Specifications	• 712.09
TDOT QPL	• 916.06.024 - Flex. Delineators & Ty2 Object Markers

5.2.4 Temporary Pavement Markings

Description

- Temporary pavement markings are placed within work zones to provide road users with a clearly defined path of travel through work zone when permanent markings are either removed or obliterated during the work activities.
- Warning signs, channelizing devices, and delineation indicate required road user paths in work zones where it is not possible to provide a clear path by pavement markings.

Source: TDOT

Purpose

- Temporary pavement markings guide traffic passing through a work zone where the normal traffic path has been disrupted by construction staging.
- They help enhance and delineate runs of temporary concrete barrier and temporary on-site diversions.

Typical Applications

- Temporary pavement markings can be used with daytime and nighttime operations.
- Markings can be used for road reconstruction while it is open to traffic, such as overlays or surface treatments or where lanes are temporarily shifted on pavement that is to remain in place.
- They can signal surface detours, temporary roadways, or other changed or new travel lane alignments.

Implementation Notes

- **Temporary pavement markings:**
  - TDOT requires work zone pavement markings to be applied using the TDOT permanent pavement marking standards.
  - Half-cycle lengths with a minimum of 2-foot stripes may be used on roadways with severe curvature for broken line center lines in passing zones and for lane lines.
  - Inclement weather, sanding treatments, snowplows, and studded tire wear can have a significant impact on the durability and visibility of markings.
- **Temporary pavement legends, crosswalks, and stop bars**: Pavement Legends (e.g., Right Turn or Left Turn Arrows, “ONLY”, “RR XING”) are used to inform the driver of the direction that they are allowed to take in a particular lane or to warn them of an approaching condition. Temporary pavement markings (striping and tape) are also used for crosswalks and stop bars in areas where work obscures existing markings or markings are relocated due to staged construction.

See next page for additional resources.

Additional Resources	
MUTCD Reference	• Section 6F.78
Pay Item	• 712-09 Removable Pavement Marking (Types) ○ 712-09.01 Removable Pavement Marking Line ○ 712-09.02 Removable Pavement Marking (8" barrier line) ○ 712-09.03 Removable Pavement Marking (channelizing striping) ○ 712-09.04 Removable Pavement Marking (stop line) ○ 712-09.05 Removable Pavement Marking (arrow) ○ 712-09.07 Removable Pavement Marking (stop ahead) ○ 712-09.08 Removable Pavement Marking (6" line) ○ 712-09.09 Removable Pavement Marking (4" line) ○ 712-09.20 Temporary Plastic Pavement Marking (noise strip) ○ 712-09.21 Removable Wet Reflective Pavement Marking Tape ○ 712-09.30 Removable Black-Out Tape (6") ○ 712-09.31 Removable Black-Out Tape (8") ○ 712-09.33 Modify Existing Overhead Signs
TDOT Standard Drawings	• T-WZ-12 thru T-WZ-15 • T-WZ-16 • T-WZ-18 • T-WZ-19 • T-WZ-21 • T-WZ-32 • T-WZ-36 • MM-PM-1
TDOT Specifications	• 712.02, Item B • 712.05 • 712.06
TDOT QPL	• QPL.01.001 - Temporary Tape, Removable (Type I) • QPL.01.003 - Blackout Tape (Type III) • QPL.44.003 - Temporary Portable Rumble Strips • 918.08.009 - Pave Mark Preform Plastic Type 1,60 Mils • 918.08.010 - Preformed Thermoplastic • 918.23.035 - Thermoplastic (Pave Marking Materials)

5.2.4.1 Guidance by Roadway Type

Design Teams should use temporary pavement markings on the intermediate layers of pavement open to traffic; these temporary markings should adhere to permanent pavement marking standards if they use reflective tape or reflectorized paint.

If the permanent marking material is thermoplastic, the contractor may elect to mark the final layer of pavement with reflectorized paint to permanent pavement marking standards and wait until the paving operation is complete before the permanent markings are installed. In this case, the temporary markings for the final layer will not be measured and paid for directly, but the costs are to be included in the price bid for the permanent markings.

Additional guidance for temporary pavement markings on various roadways is shown below.

All Interstate and Expressways (Duration of Marking >1 month):

- **On Non-Transition Sections:**
  - **Lane lines:** Use 8″ painted white skip lines and white raised pavement markers on 40′ spacing.
  - **Left edge lines (yellow):** Use 8″ painted solid yellow lines and yellow raised pavement markers on 20′ spacing.
  - **Right edge lines (white):** Allow as equals:
    Use 8″ solid white wet-reflective temporary tape.
    Use 8″ painted solid white lines with an approved white barrier rail delineator on top of barrier rail on 20′ spacing, or
    Use 8″ painted solid white lines only or with white flexible delineators at the outside edge of shoulder on 20′ spacing when no barrier rail is present.
- **On Transition Sections**
  - **Lane lines:** Use 8″ painted solid white lines and white raised pavement markers on 20′ spacing.
  - **Left edge lines (yellow):** Use 8″ painted solid yellow lines and yellow raised pavement markers on 20′ spacing.
  - **Right edge lines (white):** Allow as equals:
    Use 8″ solid white wet-reflective temporary tape
    Use 8″ painted solid white lines with an approved white barrier rail delineator on top of barrier rail on 20′ spacing, or
    Use 8″ painted solid white lines only or with white flexible delineators at the outside edge of shoulder on 20′ spacing when no barrier rail is present.

State Routes with 4 or more lanes (unlit during construction):

- **Lane Lines:** Use white-painted skip lines, 2″ wider than prescribed permanent lines, and raised pavement markers on 80′ spacing.
- **Edge and center lines**: Use solid lines (yellow or white, as appropriate) 2″ wider than prescribed permanent lines. Raised pavement markers (yellow or white, as appropriate) may be specified for use on a case-by-case basis, as determined at the Construction Field Review. Raised pavement markers should not be used on the right edge line. When raised pavement markers are used for the left edge line, spacing shall be 20 feet.

All Other State Routes:

- **All Lines**: Use 4″ marking lines. Centerline yellow raised pavement markers may be considered on a case-by-case basis. Discuss need at Construction Field Review.

Additional notes for temporary pavement markings are shown below.

- Raised pavement markers are to be placed in a single row, not staggered, under all applications.
- Specific recommendations should be discussed at the Construction Field Review.

- Missing raised pavement markers shall be replaced:
    - at least monthly
    - at the instruction of the engineer
- All raised pavement markers shall be removed before placement of the final pavement surface. The cost of removal shall be included in the price bid for raised pavement markers.

5.2.4.2 Use of Removeable Pavement Markings

For roadway surfaces that are to remain in place and undisturbed, removable Pavement Marking Line (per linear foot), shall be used as temporary marking for directional or separation of traffic during the traffic control phases of construction.

For roadway surfaces that are to be paved, cold planed, or otherwise removed, Painted Pavement Marking (4” Line, per linear mile), shall be used as temporary marking for directional or separation of traffic during the traffic control phases of construction.

Many Contractors use a 4” line as a guide for tracing the permanent stripe on the roadway. This allows for a cleaner line to be placed permanently.

5.2.5 Temporary Pavement Markers

<table>
<tr><th colspan="2">Description</th></tr>
<tr><td>Temporary markings are those pavement markers or devices that are placed within work zones to provide road users with a clearly defined path of travel through the work zone when the permanent markings are either removed or obliterated during the work activities.
Raised pavement markers may be substituted for markings of other types in temporary traffic control zones.
Warning signs, channelizing devices, and delineation shall be used to indicate required road user paths in work zones where it is not possible to provide a clear path by pavement markers.</td><td>
Source: TDOT</td></tr>
<tr><th colspan="2">Purpose</th></tr>
<tr><td colspan="2">Temporary markings provide guidance for traffic passing through a work zone where the normal traffic path has been disrupted by construction staging.
Temporary markings enhance and delineate runs of temporary concrete barrier and temporary on-site diversions.</td></tr>
<tr><th colspan="2">Typical Applications</th></tr>
<tr><td colspan="2">Temporary raised pavement markers should be considered for use through construction projects on major facilities and locations where the lane visibility is a potential issue. The use of temporary raised pavement markers should be addressed at the Construction Field Review on projects involving major facilities.
Can be used with daytime and nighttime operations.
Can signal road reconstruction while it is open to traffic, such as overlays or surface treatments or where lanes are temporarily shifted on pavement that is to remain in place.
Can signal surface detours, or temporary roadways, or other changed or new travel lane alignments.
Designers should ensure that the appropriate 716 series of pay items are included in the construction plans for temporary raised pavement markers.</td></tr>
<tr><th colspan="2">Implementation Notes</th></tr>
<tr><td colspan="2">Temporary raised pavement markers should be placed on lane lines for lane shifts on divided highways and freeways and 2-lane two-way diversion (run-arounds), as shown on the T-WZ-series Standard Drawings.
If used, the color and pattern of the raised pavement markers shall simulate the color and pattern of the markings for which they substitute. If temporary raised pavement markers are used to substitute for broken line segments, a group of at least three retroreflective markers shall be equally spaced at no greater than N/8. The value of N for a broken or dotted line shall equal the length of one line segment plus one gap.
If temporary raised pavement markers are used to substitute for solid lines, the markers shall be equally spaced at no greater than N/4, with retroreflective or internally illuminated units at a spacing no greater than N/2. The value of N referenced for solid lines shall equal the N for the broken or dotted lines that might be adjacent to or might extend the solid lines.</td></tr>
<tr><th colspan="2">Additional Resources</th></tr>
<tr><td>MUTCD Reference</td><td>Section 6F.79</td></tr>
<tr><td>Pay Item</td><td>716-01.05 Temporary Raised Pavement Marker
716-01.06 Temporary Raised Pavement Marker, White
716-01.07 Temporary Raised Pavement Marker, Yellow</td></tr>
<tr><td>TDOT Standard Drawings</td><td>Not applicable (N/A)</td></tr>
<tr><td>TDOT Specifications</td><td>712-02, Item B Raised Reflective Pavement Marker</td></tr>
<tr><td>TDOT QPL</td><td>918.26.041 - Raised Reflective Pavement Markers
918.26.042 - Bituminous Pavement Marker Adhesive</td></tr>
</table>

5.3 CATEGORY 2 DEVICES

Category 2 devices used in work zones consist primarily of barricades, larger channelization devices, and sign supports. **Table 5-4** summarizes the types of devices in Category 2.

Table 5-4
Category 2 Devices

Category 2
• Devices are not expected to produce significant vehicular velocity change but may otherwise be hazardous.
Types
• **Barricades** ○ Type I ○ Type II ○ Type III • **Pedestrian Channelizing Devices** ○ Pedestrian Channelizer Using a Barrier ○ Railing System Showing a Detectable Edge ○ Sidewalk Barricade • **Water-Filled Barrier** • **Temporary Signs** • **Advisory Speed Signs** • **Special Signs** • **Additional Temporary Sign Details** ○ Sign Sheeting ○ Sign Flags and Sign Flag Boards ○ Sign Supports • *Perforated Steel Square Tube Posts* • *Temporary Sign Support* • *Portable Sign Support* • *Concrete Barrier Sign Support* • *Existing Sign Support*

5.3.1 Barricades

Type III Barricades (see next table) are primarily used in TDOT practice.

Type I and II Barricades

- Type I and II barricades are portable or fixed devices with one/two rails with alternating orange and white, angled, retroreflective stripes.
- Stripes should slope downward in both directions from center when right and left turns are provided; stripes should slope downwards toward the center when no turns are intended
- Warning lights may be used to increase attention to the barricade and associated signage, such as a ROAD CLOSED sign. Two types of warning lights, Type A and Type C.
- Channelizing devices shall be used if the temporary traffic control zone will be installed for more than 12 hours or if it is left unattended.


Source: TDOT * Warning lights (optional)

Purpose

- Barricades help control road users by closing/partially closing, restricting or delineating all or a portion of the right-of-way.
- Barricades delineate PCMS, sequential arrow boards, or temporary portable traffic signal trailers.

See Section 5.2.1 for additional information on Flexible Drums.

Typical Applications

- TDOT typically only uses Type III barricades (see next page for information).
- Type I barricades may be used on conventional roads or urban streets.
- Type II barricades may be used on high-speed roadways, but TDOT typically only uses Type III barricades.
- Type I and II barricades may be used for sidewalk closures.
- Use in areas where road flow is maintained throughout.
- Use in daytime and nighttime conditions.
- **Barricades and Drums:** Flexible drums shall be used in lieu of Type II barricades due to better performance in terms of durability and target value.

Implementation Notes

- Device should not interfere with pedestrian circulation routes more than 4” from support and between 27” and 80” from surface.
- Provide ballasting (sandbags) to prevent overturning or displacement. For Type I barricades, the support may include other unstriped horizontal rails necessary to provide stability.
- Use a minimum of 270 square inches of retroreflective area facing road users.
- Install signs on device if required; provide adequate visibility of device should be provided from both directions.
- Use alternating 4” wide orange and white retroreflective stripes sloping downwards at an angle of 45 degrees in direction of passage of road users.

Additional Resources

MUTCD Reference	• Section 6F.68
Pay Item	• 712-07.01 Temporary Barricades (Type I) • 712-07.02 Temporary Barricades (Type II) • 712-05.01 Warning Lights (Type A) • 712-05.03 Warning Lights (Type C)
TDOT Standard Drawings	• N/A
TDOT Specifications	• 712.09
TDOT QPL	• QPL.34.019 - Miscellaneous Roadside Hardware • QPL.45.028 - Other Lightweight TCDs

Type III Barricades are primarily used in TDOT practice.

Type III Barricades

- Type III barricades are portable or fixed device having one/two rails with alternating orange and white, angled, retroreflective stripes.
- Stripes should slope downward in both directions from center when right and left turns are provided; stripes should slope downwards toward the center when no turns are intended.
- Warning lights may be used to increase attention to the barricade and associated signage, such as a ROAD CLOSED sign. See Pay Items below for two types of warning lights, Type A and Type C.

Type III
* Warning lights (optional)

Purpose

- Type III barricades control road users by closing/partially closing, restricting or delineating all or a portion of the right-of-way.
- Type III barricades delineate portable changeable message sign (PCMS), sequential arrow boards, or temporary portable traffic signal trailers.

Typical Applications

- Type III barricades should be used on freeways, expressways and other high-speed roadways
- Use with daytime and nighttime conditions.

Implementation Notes

- Device should not interfere with pedestrian circulation routes more than 4” from support and between 27” and 80” from surface.
- Provide ballasting (sandbags) to prevent overturning or displacement.
- Use a minimum of 270 square inches of retroreflective area facing road users.
- Install signs on device if required; provide adequate visibility of device and sign with flashers. Signs mounted should not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails.
- Alternate 6” wide orange and white retroreflective stripes sloping downwards at an angle of 45 degrees in direction of passage of road users.
- Place at regular intervals in a closed lane and in advance of and at point of road closures.
- Place across roadway or curb to curb.

Additional Resources

MUTCD Reference	• Section 6F.68
Pay Item	• 712-07.03 Temporary Barricades (Type III) • 712-07.04 Directional Indicator Barricade • 712-05.01 Warning Lights (Type A) • 712-05.03 Warning Lights (Type C)
TDOT Standard Drawings	• T-WZ-19 • T-WZ-36 • T-WZ-55 • T-S-18
TDOT Specifications	• 712.09
TDOT QPL	• QPL.34.019 - Miscellaneous Roadside Hardware • QPL.45.028 - Other Lightweight TCDs

See Chapter 4 for more information on the application of PCDs.

5.3.2 Pedestrian Channelizing Devices (PCD)

Description

- A PCD is a longitudinal, continuous barrier with detectable edge.
- PCDs must be ADA-compliant and meet Americans with Disability Act (ADA) and Public Right-of Way Accessibility Guidelines (PROWAG) specifications.
- Channelizers and railing systems are typically orange and white striped and several feet high.


Source: TDOT

Purpose

- PCDs delineate the pedestrian walkway and indicate pedestrian facility closures.
- Barricades shall be used to close the entire width of the walkway surface.
- A walkway surface shall be firm, stable, and slip resistant.

Typical Applications

- PCDs can signal pedestrian detours or diversions as well as sidewalk closures.
- This device may also be used as a bicycle channelizing device to provide separation and guidance for bicycles from active work areas. This device is not intended to separate bicycle traffic from motor vehicle traffic as bicycle traffic may need to enter into or cross vehicular traffic to execute a turn or other movement.

Implementation Notes

- Detectable edges for long canes shall be continuous and 6 in. min high above the walkway surface and have color or markings contrasting with the walkway surface.
- Use longitudinal channelizing devices for pedestrians shall be 32 in. high or greater.
- When hand guidance is required, the top rail or top surface shall: be in a vertical plane perpendicular to the walkway above the detectable edge, be continuous at a height of 34 to 38 in. above the walkway surface and be supported with minimal interference to the pedestrian's hands or fingers.
- When both sides of a temporary pedestrian bypass require channelizing devices, then the devices should be a similar type (railing system, barricade, or fencing system), excluding when a barrier (such as concrete barrier) is used to protect pedestrians from an open traffic lane.

Additional Resources

MUTCD Reference	• Section 6F.74 • Section 6F.85
Pay Item	• 604-44.10 Temporary Covered Pedestrian Greenway • 707-07.02 Chain-Link Pedestrian Bridge Cage • 707-08.03 Pedestrian Gate • 707-11.01 Pedestrian Construction Barrier Fence
TDOT Standard Drawings	• T-WZ-55
TDOT Specifications	• 712.02, Item D • 712.04, Item F
TDOT QPL	• QPL.34.018 - Water Filled Plastic Channelizing Device • QPL.34.019 - Miscellaneous Roadside Hardware • QPL.37.001 - ADA Detectable Warning Truncated Domes • QPL.45.009 - Pedestrian Channelizers (< 100lbs.)

5.3.3 Water-Filled Barrier

Water-Filled Barriers

Source: TDOT

- A water-filled barriers is filled with water to make it immovable.
- These can be stacked or interlocked, thus allowing to create a continuous line of traffic drums to block access to work zones in areas of 45 mph or less.
- See information provided in “Temporary Traffic Barriers.”

Purpose

- See information provided in “Temporary Traffic Barriers.”

Typical Applications

- See information provided in “Temporary Traffic Barriers.”

Implementation Notes

- These devices can be easily moved when not filled and have good turning radius for deployment and do not require end treatments as it is integrated into an existing system *(24).*
- See information provided in “Temporary Traffic Barriers.”

Additional Resources

MUTCD Reference	• Section 6F.85, 6F.88, 6F.70

Pay Item	• 712-01 Traffic Control
	  ○ 712-01.02 Lane Closure
	  ○ 712-01.03 Lane Closure (Night Work)
	  ○ 712-01.04 Traffic Control Supervisor
	  ○ 712-01.05 Flagman
	  ○ 712-01.50 Maintenance Of Traffic
	  ○ 712-01.51 Portable Barrier Rail Delineator (Double)
	  ○ 712-01.52 thru 712-01.56 Maintenance Of Traffic
	  ○ 712-01.60 Maintenance Of Traffic (Henley Street Tunnels)
	• 712-02.02 Interconnected Portable Barrier Rail
	• 712-04 series
	  ○ 712-04.01 Flexible Drums (Channelizing)
	  ○ 712-04.10 Temporary Flexible Tubular Delineator
	  ○ 712-04.50 Barrier Rail Delineator

TDOT Standard Drawings	• T-WZ-11 THRU T-WZ-16 • T-WZ-18 • T-WZ-19 • T-WZ-21 • T-WZ-32 thru T-WZ-34 • T-WZ-36 • T-WZ-40 THRU T-WZ-42 • T-WZ-61 • T-WZ-PBR1 • T-WZ-PBR2
TDOT Specifications	• 712.04, Item F
TDOT QPL	• QPL.34.018 - Water Filled Plastic Channelizing Device

5.3.4 Temporary Signs

Temporary traffic control signs communicate general and specific information to roadway users within the work zone area. Signs may include words and/or symbols and are organized into three categories:

- Regulatory
- Warning
- Guide

The *MUTCD* Parts 6F.2 through 6F.59 provide additional details about temporary traffic control signing *(1).*

Detour signs shall be used only when traffic is rerouted onto another road; they shall not be used for diversions (runarounds), lane shifts, etc. on the road under construction. A ROAD WORK NEXT XX MILES sign shall be used on road work more than 1 mile in length and shall be rounded to the next mile up (example: 5.4 miles in road work shall be shown as 6 miles on the ROAD WORK NEXT XX MILES sign).

Description

Source: TDOT

- Temporary signs convey regulatory, guidance, and warning messages.
- Colors typically include orange for work zones, though non-work zones signs can be used or remain in-place so long as they are still relevant and accurate.
- Standard orange flags or flashing warning lights may be used in conjunction with signs.

Purpose

- These signs convey regulatory, guidance, and warning messages.

Typical Applications

- Use anytime and nighttime conditions.
- Use to signal changes to alignment, lane configuration, speeds, pavement conditions, and more.

Implementation Notes

- Appropriate signing must be visible and legible during construction activities, and updated, covered or removed, as activities change.
- All signs used at night shall be either retroreflective with a material that has a smooth, sealed outer surface or illuminated to show the same shape and similar color both day and night.
- Temporary signs can be moved about within the work zone, as needed; or, installed in fixed locations for the duration of the project.
- When the design of a sign is not provided in the MUTCD, FHWA Standard Highway Signs manual, or TDOT Supplement to the Standard Highway Signs Book, a separate design will be needed and must be included in the contract plans.

Additional Resources

MUTCD Reference	• Section 6F.02, Table 6F-1
Pay Item	• 712-06 Signs (Construction) • 713-16.41 Relocate Sign
TDOT Standard Drawings	• T-WZ-34 • T-WZ-50 THRU T-WZ-54 • T-WZ-60
TDOT Specifications	• 712.04, Item D
TDOT QPL	• QPL.10.001 - Roll Up Signs • QPL.34.019 - Miscellaneous Roadside Hardware

5.3.5 Advisory Speed Signs

Description

- Advisory speed signs indicate the recommended safe speed to navigate through a work zone ahead; these speeds are lower than any in-place regulatory speed limit.
- Use in combination with a warning sign only.
- Signs should be installed below the appropriate warning; signs may be omitted if posted speed is 40 mph or less.
- Signs are 24” x 24” in size when used with a sign that is 36” x 36” or larger.
- When used with orange temporary traffic control zone signs, this sign should have a black legend and border on an orange background.
-

Source: MUTCD, W13-1P

Purpose

- Notify road users to lower speeds below regulatory speeds to travel through work zone safely.

Typical Applications

- Freeways, expressways, and other roadways.
- Daytime and nighttime conditions.
- Extreme weather conditions.

Implementation Notes

- If used in combination with a Dynamic Speed Display (DSD) (also known as "YOUR SPEED") sign is used, the advisory speed plaque and appropriate warning sign should be located near the DSD sign but may be up to a maximum of 100 feet ahead if found necessary.
- Signs should not be mounted until the recommended speed is determined by the highway agency, except in case of emergencies.
- Signs should not be placed near a regulatory speed sign.
- Remove signs when workers are not present.

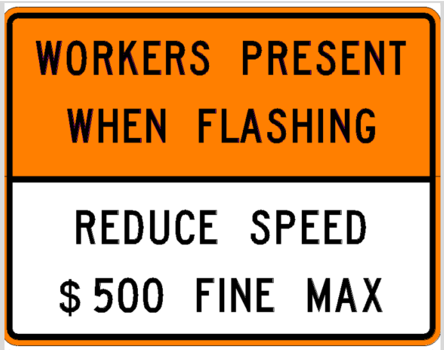
Additional Resources

MUTCD Reference	• Section 6F.52 • Table 6F-1
Pay Item	• 712-06.16 Signs (Construction) (Reduced Speed Warning)
TDOT Standard Drawings	• T-WZ-34 • T-WZ-50 THRU T-WZ-54 • T-WZ-60
TDOT Specifications	• 712-02, A, F
TDOT QPL	• N/A

5.3.6 Special Signs

Description

- Special warning signs should comply with the general requirements of color, shape, and alphabet size and series. The sign message should be brief, legible, and clear.
- Project identification signs are typically placed in-advance of all other work zone signing, including the “ROAD WORK AHEAD” sign.
- Business access: The “BUSINESS ACCESS” sign is used to identify a private business access which may be obscured or otherwise impacted by construction.



TN-44 for use in-advance of interstate construction
Source: Tennessee Supplement to the MUTCD *(7)*

Purpose

- Provide additional information such as project identification, business access, or other information.

Typical Applications

- **Project information**: Longer duration projects (one year or more), large projects (relatively large cost or other high-profile projects), projects with multijurisdictional partnerships.
- **Business access**: More common in urban areas, used where business access or frontages are obscured by construction.

Implementation Notes

- Sign should be coordinated in relation to other adjacent signs.
- Signs should not be placed near a regulatory speed sign.
- Remove signs when workers are not present.

Additional Resources

MUTCD Reference	• Table 6F-1
Pay Item	• 712-06 Sign (Construction)
TDOT Standard Drawings	• T-WZ-34 • T-WZ-50 thru T-WZ-54 • T-WZ-60
TDOT Specifications	• 712-02, A, F
TDOT QPL	• QPL10: 916.06.025 - Work Zone Sheeting (Signs)

TDOT Supplement to the Standard Highway Signs Book provides additional information. ***(7)***

5.3.7 Additional Temporary Sign Details

Sign implementation in the work zone must consider visibility through factors such as sign sheeting, flags or flag boards, and sign support types. This section describes the requirements and considerations for sign installation.

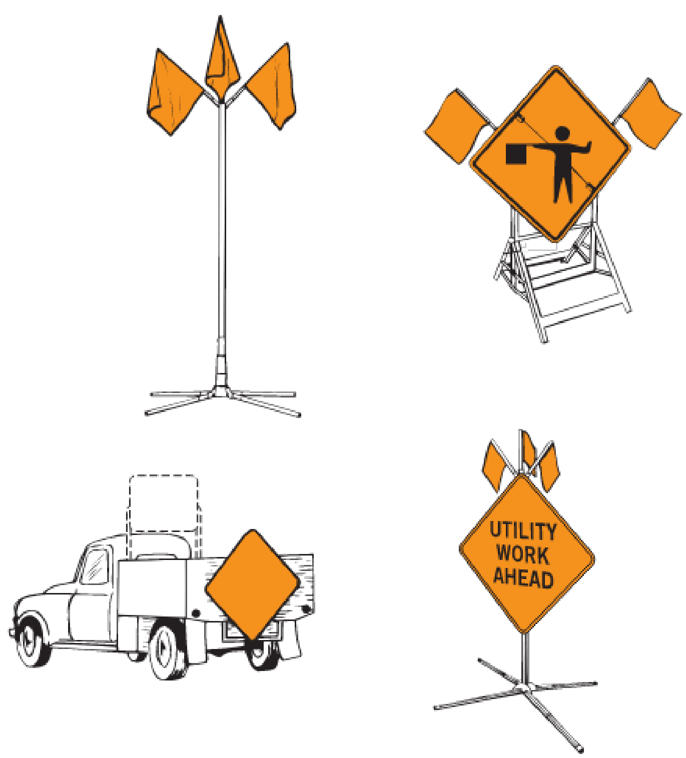
5.3.7.1 Sign Sheeting

Sign sheeting requirements ensure sign visibility, readability, retro reflectivity, and consistency in a work zone. A variety of temporary signs and sign designs may be used within a traffic control plan, and it is important to convey specific information to the users of each specific traffic control plan. Refer to TDOT *Standard Specification* 916.06 for additional information about sign sheeting *(8).*

5.3.7.2 Sign Flags and Flag Boards

Sign flags and flag boards draw increased attention to signs and other traffic control devices. Flags are typically attached to critical signs that may otherwise go unnoticed, such as temporary speed zones, critical detour signs, or other regulatory signs that may go unnoticed. When standard orange flags or flashing warning lights are used in conjunction with signs, they shall not block the sign face. See *MUTCD* Section 6F.03 for additional information about sign flags *(1).*

Figure 5-1
Sign Flags and Sign Supports *(1)*



Source: MUTCD *(1)*

5.3.7.3 Sign Supports

Sign supports include metal posts, roll-up supports, barriers, or vehicle mounts to support work zone signs. Where it has been determined that it is necessary to accommodate pedestrians with disabilities, signs shall be mounted and placed per Section 4.4 of the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).” Additional pedestrian accommodation requirements are described in the draft *Public Right-of-Way Accessibility Guidelines (PROWAG)* Section R205 *(9)*, as adopted by TDOT.

Chapter 4 provides additional information about designing for pedestrians in a work zone.

Sign supports should consider the construction activity, duration, and costs.

Refer to TDOT Specifications 916 and TDOT QPL for additional information about sign supports.

Types of sign supports are as follows:

- **Perforated/Knock-Out Steel Square Tube Posts:** Metal posts are a popular alternative due to cost, ease of installation, and the ability to reuse the posts at the conclusion of the project
- **Temporary Sign Support (TSS):** A TSS is a crashworthy metal sign support that can be used instead of in-ground metal post installations.
- **Portable Sign Support (PSS):** A PSS can be used to mount a roll-up sign for short-term or intermittent work.
- **Concrete Barrier Sign Support:** Barrier sign supports are used to install temporary signs on concrete barriers where space for a TSS or post-mounted sign is not available.
- **Existing Sign Supports:** Temporary signs may be replaced or added to existing signs installed on existing highway sign supports and structures with prior approval from the Region Traffic Engineer.
- **Vehicles:** For mobile operations, a sign may be mounted on a work vehicle, a shadow vehicle, or a trailer stationed in advance of the temporary traffic control zone or moving along with it

Additional information is available in the *MUTCD* Section 6F.03 *(1)* and TDOT Specification 916 *(8).*

5.4 CATEGORY 3 DEVICES

Category 3 devices used in work zones require more complex crash testing and are expected to cause significant velocity change or other harmful reactions to impacting vehicles. These devices primarily consist of impact attenuators, concrete barriers, guardrail systems, and others. **Table 5-5** summarizes the types of temporary devices in Category 3.

Table 5-5
Category 3 Devices

Category 3
• Category 3 devices and/or hardware are expected to cause significant velocity change or other harmful reactions to impacting vehicles.
Types
• **Temporary Traffic Barriers** o Temporary Concrete Barrier o Temporary Steel Barrier • **Additional Temporary Traffic Barrier Details** o Temporary Glare Screens/Shields o Reflective Barrier Panels o Temporary Connections and Terminals • *Bridge- to-Guardrail Connectors* • *Bridge Rail Connectors* • *Guardrail Terminals* o Anchoring o Temporary Bridge Rail • **Temporary Impact Attenuators** o Temporary Crash Cushions

5.4.1 Temporary Traffic Barriers

As noted in **Table 5-6**, there are two types of temporary traffic barriers, including:

- Temporary Concrete Barrier
- Temporary Steel Barrier

Barriers are selected based on work type and duration, and they are required based on pavement drop off. Certain types of barriers can be called out due to needed deflection due to tight work areas, but specific types are not generally part of TTC design.

The temporary concrete barrier and steel barrier have similar descriptions, purposes, and typical application information. Therefore, a summary table with information about all three barrier types is provided along with specific tables for each barrier. The similarities and differences between each barrier type should be noted.

Overview of Temporary Traffic Barriers (Concrete and Steel)
See next page for additional details on both types.

- Temporary traffic barriers are shifting portable barriers that can be used as channelizing devices.
- When using to channelize vehicular traffic, temporary traffic barrier shall be supplemented with delineation, pavement markings, or channelizing devices.

Purpose

- Prevent penetration by vehicles while minimizing injuries to vehicle occupants
- Provide positive separation between workers, bicyclists, and pedestrians from motor vehicle traffic where a temporary pedestrian pathway shares a portion of the roadway with vehicular traffic
- Separate opposing directions of vehicular traffic and protect from cross-over crashes
- Provide unbalanced flow to accommodate changes in direction of peak period traffic flows
- Clearly define entry and exit of work zone

Typical Applications

- Medians, shoulders of Interstate/State Highway Freight roads; freeway crossover; low-speed urban areas; gate approaches; roadside excavations; material storage sites; unusually hazardous traffic conditions; where existing traffic barriers and bridge railings are removed during a construction stage; where bridge deck with open holes in deck; bridge railing removed, where scaffolding or equipment with workers overhead are in place for three days or more *(10)*.
- Barrier use considerations include drop offs that will not be backfilled overnight; unprotected features (walls, piers); working and non-working equipment; interim unprotected items (stockpiles, ditches); proximity to and severity of hazards; duration of exposure; size of work area; traffic exposure to opposing traffic; contractor mobility and ingress/egress; traffic volume; work zone speed; barrier deflection distance; vertical/horizontal roadway alignment; hazard presented by barrier itself once in place; hazard presented to pedestrians and traffic during barrier placement *(10)*.
- Use with daytime and nighttime conditions.

Implementation Notes

- Design for specific application intended depending on speed ranges.
- Install end treatment (in accordance with AASHTO's Roadside Design Guide) by flaring until end is outside the acceptable clear zone by providing crashworthy end treatments or by using sand barrel array (temporary impact attenuator); truck-mounted attenuator (TMA); temporary connection between barrier run and other railing system (guardrail or bridge rail); overlapped ends with adjacent barrier run; or by burying blunt end into fill slope. This is done to reduce the impact of striking the upstream end of the device.
- Place Portable Barrier Rail on a flat pavement surface (asphalt concrete or Portland Cement Concrete) with unobstructed space for deflection in case of impact. Pin barrier segment to adjacent segment. Buffer width for steel barriers depend on manufacturer and how barrier is secured to pavement surface. See TDOT Standard Drawings and Roadway Design Guidelines for Specifications.

TDOT's drop-off policy and notes are provided in the Roadway Design Guidelines Chapter 9 Section 5. *(11)*

Portable Barrier Rail	
 Source: TDOT	• Portable Barrier Rail (32” height) is used in long-term construction work zones. Tall Portable Barrier Rail (42” height) is used primarily in locations with high truck volumes • Concrete barriers are easy to install and cheap, but the cost of transport is high due to weight restrictions, moreover, concrete barrier impacts are violent. • See additional information provided in “Temporary Traffic Barriers.”

Purpose

- See information provided in “Temporary Traffic Barriers.”

Typical Applications

- See information provided in “Temporary Traffic Barriers.”

Implementation Notes

- Mostly freestanding installation are carried out; requires a minimum buffer behind barrier to provide allowance for lateral deflection into work area and lane separation situations. Some products can have stiffener bars or can be pinned to the pavement to reduce minimum buffer. See TDOT Standard Drawings and Roadway Design Guidelines for Specifications *(11)*. In case freestanding installment is not appropriate, use stiffener bar, anchor and drop in bolt.
- Horizontal taper rates shall be 10:1 or flatter for designs where posted speeds are less than or equal to 45 mph, and 15:1 or flatter for designs where posted speeds are greater than 45 mph.
- The approach ends of the portable barrier rail shall be located outside the clear zone or be shielded with a portable energy absorbing terminal.
- See information provided in “Temporary Traffic Barriers.”

Additional Resources

MUTCD Reference	• Section 6F.85 • Section 6F.88 • Section 6F.70
Pay Item	• 712-02.60, Temporary Crash Cushion (MASH TL-3) • 712-01 Traffic Control • 712-02.02 Interconnected Portable Barrier Rail • 712-04 Series
TDOT Standard Drawings	• T-WZ-11 thru T-WZ-16 • T-WZ-18 • T-WZ-19 • T-WZ-21 • T-WZ-32 thru T-WZ-34 • T-WZ-36 • T-WZ-40 thru T-WZ-42 • T-WZ-61 • T-WZ-PBR1
TDOT Specifications	• 712.04, Item F
TDOT QPL	• 918.12.023 - Epoxy Resin Systems (Anchoring) • QPL.34.016 - Portable Pre-Cast Concrete Barriers 350 • QPL.45.029 - WZ Barriers: Portable precast concrete, free-standing • QPL.45.030 - WZ Barriers: Portable precast concrete, anchored

Temporary Steel Barriers	
 Source: TDOT	• Temporary steel barriers provide positive steel separation to segregate the work area. • Steel barriers are costlier than temporary concrete barriers, but they are durable, easy to install, and have low transportation costs due to its weight per foot; steel barriers can be closely packed *(12).* • See information provided in “Temporary Traffic Barriers.”

Purpose

- See information provided in “Temporary Traffic Barriers.”

Typical Applications

- See information provided in “Temporary Traffic Barriers.”

Implementation Notes

- These devices can be moved/installed by hand, fork lifting, using the pickup bumper wheel system, pickup towing, using a bobcat.
- Upon impact, deflection of steel barriers varies based on deflection distance, barrier product, installation and anchoring requirements.
- See information provided in “Temporary Traffic Barriers.”

Additional Resources

MUTCD Reference	• Section 6F.85 • Section 6F.88 • Section 6F.70
Pay Item	• 712-02.60, Temporary Crash Cushion (MASH TL-3) • 712-01 Traffic Control • 712-02.02 Interconnected Portable Barrier Rail • 712-04 Series
TDOT Standard Drawings	• T-WZ-11 thru T-WZ-16 • T-WZ-18 • T-WZ-19 • T-WZ-21 • T-WZ-32 thru T-WZ-34 • T-WZ-36 • T-WZ-40 thru T-WZ-42 • T-WZ-61 • T-WZ-PBR1
TDOT Specifications	• 712.04, Item F
TDOT QPL	• 918.12.023 - Epoxy Resin Systems (Anchoring) • QPL.45.031 - WZ Barriers: Steel, anchored • QPL.45.032 - WZ Barriers: Steel, freestanding

5.4.2 Additional Temporary Traffic Barrier Details

Temporary traffic barriers are more effective when combined with temporary glare screens/shields, reflective barrier panels, and temporary connections and terminals. These elements are described below.

5.4.2.1 Temporary Glare Screens/Shields

Glare screens/shields are used to prevent distraction by blocking road users' view of work zone activities. They are usually installed along the top of the barriers between a traffic lane and a work zone. These devices should not be used if barriers are placed between opposing traffic lanes or where they could restrict road user sight distance or visibility.

These devices help prevent and avoid speed changes and erratic vehicle paths within the work zone area. They also help improve vehicular traffic flow in cases where traffic volume is approaching roadway capacity by reducing headlight glare from oncoming traffic.

5.4.2.2 Reflective Barrier Panel

Retroreflective fluorescent orange or silver-white sheeting is typically installed in curvilinear sections at the beginning and end of a barrier run to assist drivers through unfamiliar alignment. This helps increase safety for drivers and construction workers in the work zone, enhances barrier visibility, and alerts drivers of barrier presence.

5.4.2.3 Temporary Connections and Terminals

These devices connect barriers and can be an alternative to impact attenuators. They include barrier-to-guardrail connectors, bridge rail connectors, and guardrail terminals. In case a barrier needs to be connected to the guardrail or railing system, barrier-to-guardrail connectors should be used. These connectors should be secured to prevent errant vehicles from damaging the joint between the two runs. If bridge rail connectors are used, rail should be attached to guardrail run to terminate bridge rail which will help protect the hazard. In case guardrail terminals are used, guardrail should be terminated by using energy-absorbing or non-energy absorbing guardrail terminals

5.4.2.4 Anchoring

Anchoring is the process of restricting lateral barrier movements or displacement by using pins, bolts, or similar objects that are dropped into holes in the toe of the barrier. The pins or bolts should not protrude beyond the face of the barrier. Refer to TDOT *Standard Drawings* and manufacturer instructions to reduce deflections.

5.4.3 Temporary Impact Attenuators/Crash Cushions

Temporary Impact Attenuators/Crash Cushions

- These devices decelerate errant vehicles to stop or redirect them upon impact under prescribed conditions.
- The two types of crash cushions are stationary crash cushions and truck mounted attenuators
- Gating attenuators are designed to allow an errant vehicle to enter a safe space (clear zone) where it can decelerate before coming into contact with a hazard. The attenuator folds away to allow the vehicle to pass safely when the vehicle comes in contact with the attenuator. A non-gating attenuator provides a smaller clear zone and does not allow the vehicle to pass when impacted.
- Crash cushions absorb energy of the vehicle upon impact and dissipate it within the system by breaking apart, if a stationary temporary crash cushion (sand barrel drum array) is used; by rapidly colliding and decelerating, if a truck mounted attenuator or gating narrow-site system is used; or by deflecting errant vehicle if a non-gating narrow-site system is used.
- Narrow site-systems are two-feet wide and can be used to replace full-size drum array attenuator in places where drum array attenuators cannot fit.

Source: TDOT

Purpose

- Mitigate effects of errant vehicles upon striking device.
- Protect drivers from exposed ends of barriers, fixed objects and shadow vehicles.

Typical Applications

- Freeways/highways, freeway crossover.
- Medians, side of road (non-gating attenuators).
- Daytime and nighttime conditions.

Implementation Notes

- Design stationary crash cushions for specific application intended.
- Inspect device periodically to check for damage. Repair or replace damaged devices to maintain use of device.
- If using narrow-site systems, attach device to standard concrete barrier. Narrow-site systems are not designed to attach to tall “F” concrete barrier as it could result to snagging hazard.

Additional Resources

MUTCD Reference	• Section 6F.86
Pay Item	• 712-02.60 Temporary Crash Cushion (MASH TL-3)
TDOT Standard Drawings	• N/A
TDOT Specifications	• 712-02.E, 712.09
TDOT QPL	• QPL.34.012 - Gating Crash Cushions • QPL.45.034 - WZ Crash Cushions: Non-gating

5.5 CATEGORY 4 DEVICES

Category 4 devices are usually trailer-mounted and should be shielded from traffic, when practical. **Table 5-6** summarizes the types of devices in Category 4.

Table 5-6
Category 4 Devices

Category 4
• Category 4 consists of portable, primarily trailer-mounted devices. • Devices must be shielded or, at a minimum, delineated. • FHWA continues to monitor in-service crash performance. • MASH encourages the design and testing of crashworthy versions. • Category 4 devices require appropriate implementation and placement practices.
Types

• **Truck Mounted Attenuator**
• **Trailer Mounted Attenuator**
• **Temporary Digital/Electrical Signs**
    o Speed Feedback Sign Assembly
    o Digital Speed Limit Sign Assembly
    o Flashing Arrow Boards
    o Portable Changeable Message Signs (PCMS)
• **Temporary Traffic Control Signals**
    o Temporary Traffic Signals
    o Portable Traffic Signals

5.5.1 Truck-Mounted Attenuator

Truck-Mounted Attenuator (TMA)

Source: TDOT

- TMAs are energy-absorbing crash cushion systems attached to rear of shadow vehicle.
- A shadow vehicle may also be equipped with flashing arrows, changeable message signs, flashing lights, etc.
- Autonomous Truck Mounted Attenuators are discussed in **Section 5.6.**

Purpose

- Lowers severity of rear-end collision with errant vehicle.
- Protects moving work areas or short-duration activities.
- Protects work vehicles and workers ahead of vehicle with TMA.
- Protects drivers from exposed ends of barriers, fixed objects and shadow vehicles.

Typical Applications

- Freeways/highways.
- High-speed roads.
- Queue protection.
- 24-hour or less short-term mobile operations.

Implementation Notes

- Design for specific application intended depending on speed ranges. Manufacturer's rating should be considered while choosing equipment. Combination of vehicle and truck-mounted attenuator rated for less than the posted speed should be considered only in case other equipment is not available.
- Place TMA in upright position when travelling to or from work site; when used attenuator should be in full down and locked position.
- Place protection vehicle with TMA in advance of workers and equipment to provide sufficient distance for run-out from impact.
- Conduct hazard assessment to determine which vehicle should be equipped with TMA
- For stationary operations, set parking brake of vehicle with TMA and direct wheels away from work site.

Additional Resources

MUTCD Reference	• Section 6F.86
Pay Item	• 705-07.11 Truck Mounted Energy Attenuator • 713-16.02 Truck Mounted Attenuator w/ Flashing Arrow board • 712-08.20 Truck Mounted Attenuator w/ Message Board
TDOT Standard Drawings	• T-WZ-15
TDOT Specifications	• 705-07.11 Truck Mounted Energy Attenuator • 713-16.02 Truck Mounted Attenuator w/ Flashing Arrow board • 712-08.20 Truck Mounted Attenuator w/ Message Board
TDOT QPL	• QPL.34.014 • QPL.45.035 - Attenuators: Truck-mounted

Autonomous Truck Mounted Attenuators are discussed in Section 5.6.

5.5.2 Trailer-Mounted Attenuator

Trailer-Mounted Attenuator

- Trailer-Mounted Attenuators are energy-absorbing crash cushion systems attached to the rear of a shadow vehicle.
- A shadow vehicle may also be equipped with flashing arrows, changeable message signs, flashing lights, etc.

Source: TDOT

Purpose

- Lowers severity of rear-end collision with errant vehicle.
- Protects moving work areas or short-duration activities.
- Protects work vehicles and workers ahead of vehicle with trailer-mounted attenuator.
- Protects drivers from exposed ends of barriers, fixed objects and shadow vehicles

Typical Applications

- Freeways/highways
- High-speed roads
- Queue protection
- 24-hour or less short-term mobile operations

Implementation Notes

- Design for specific application intended depending on speed ranges. Manufacturer's rating should be considered while choosing equipment.
- Place trailer-mounted attenuator in upright position when travelling to or from work site; when used attenuator should be in full down and locked position.
- Place protection vehicle with TMA in advance of workers and equipment to provide sufficient distance for run-out from impact.
- Conduct hazard assessment to determine which vehicle should be equipped with truck-mounted attenuator.

Additional Resources

MUTCD Reference	• Section 6F.86
Pay Item	• N/A
TDOT Standard Drawings	• T-WZ-15
TDOT Specifications	• 712.02, Item E
TDOT QPL	• QPL.34.014 • QPL.45.036 - Attenuators: Trailer-mounted

5.5.3 Temporary Digital/Electrical Signs

There are four types of temporary digital/electrical signs, including:

- Speed Feedback Sign Assembly
- Digital Speed Limit Sign Assembly
- Flashing Arrow Boards
- Portable Changeable Message Signs (PCMS)

Speed Feedback Sign Assembly

Source: Ver-Mac

Source: Ver-Mac

- This is a trailer mounted/stationary mounted solar powered driver feedback device that alerts drivers of their speed.

Purpose

- Speed feedback signs provide drivers information about their speed to encourage compliance with speed limits.

Typical Applications

- Freeway Resurfacing or other projects where work is intermittent and when variable speed limits are needed for increased safety at certain times and increased traffic flow at others.

Implementation Notes

- Mount so that the bottom of the sign is 7' above roadway.
- The LED panel shall be a minimum of 28" wide x 18" high. The display on the LED panel shall be white. The LED numbers shall have a minimum 5 wide by 7 high pixel array with a minimum height of 18". The panel shall have auto brightness/dimming capability.
- Mount 12" diameter alternately flashing (rates not less than 50 or more than 60 times per minute) beacons above and below sign assemblies, centered horizontally. Activate beacons no earlier than 30 minutes prior to workers arriving and deactivate no later than 30 minutes after workers depart.
- The device shall have operational software and wireless communications that allows for remote operation and data monitoring.

Additional Resources

MUTCD Reference	• Section 6F.61
Pay Item	• 712-08.08 Speed Feedback Sign Assembly • 712-08.07 Portable Speed Monitor Unit
TDOT Standard Drawings	• N/A
TDOT Specifications	• 712 Speed Feedback Sign • 712-08.07 Portable Speed Monitor Unit. • 712-08.08 Speed Feedback Sign Assembly
TDOT QPL	• QPL.44.002 - Speed Feedback Sign Assembly

Digital Speed Limit Sign Assembly	
 Source: Ver-Mac	• This is a trailer mounted/stationary mounted solar powered variable speed limit sign to alert drivers of regulatory speed within the work zone. • Regulatory speed limit signs have LED displays.

Purpose

- Easily change work zone speed limits between activities that necessitate the need for a lower speed limit and the ones that do not.
- Allow remote operation and data monitoring.
- Lower the speed limits during work zone activities, then return the speed limit back to the normal posted speed.

Typical Applications

- Interstates/ freeways with speed limit greater than 55 mph.
- Facilities that have significant traffic volumes and impacts.

Implementation Notes

- Place one sign within the advanced warning area on the right side of the road. Subsequent signs shall be positioned at intervals no greater than 2 miles with one placed after each entrance ramp within the work zone. Placement should not interfere with function of roadside devices such as guard rail or terminals.
- Mount such that the bottom of the sign is 7' above roadway.
- The LED panel shall be a minimum of 28" wide x 18" high. The display on the LED panel shall be white. The LED numbers shall have a minimum 5 wide by 7 high pixel array with a minimum height of 18". The panel shall have auto brightness/dimming capability.
- Mount 12" diameter alternately flashing (rates not less than 50 or more than 60 times per minute) beacons above and below sign assemblies, centered horizontally. Activate beacons no earlier than 30 minutes prior to workers arriving and deactivate no later than 30 minutes after workers depart.
- The device shall have operational software and wireless communications that allows for remote operation and data monitoring.

Additional Resources

MUTCD Reference	• Section 6F.61
Pay Item	• 712-08.09 Digital Speed Limit Sign Assembly
TDOT Standard Drawings	• N/A
TDOT Specifications	• 712 Digital Speed Limit • 712-08.09 Digital Speed Limit Sign Assembly
TDOT QPL	• QPL.44.001 – Digital Speed Limit Sign Assembly

Flashing Arrow Boards

- A flashing arrow sign is a board in non-reflective black, mounted on a vehicle, trailer or suitable support that displays directional information.
- Use in combination with appropriate signs, channelizing devices, or other devices.
- Arrow boards have three modes of selection: flashing arrow, flashing double arrow and flashing caution.
- Information for Arrow Board Types B and C is shown below. TDOT typically only uses Type C.
    - Type B:
        - Minimum Size: 60 x 30 inches
        - Minimum Legibility Distance: ¾ mile
        - Minimum Number of Elements: 13
    - Type C:
        - Minimum Size: 96 x 48 inches
        - Minimum Legibility Distance: 1 mile
        - Minimum Number of Elements: 15

TDOT only has Type B and C approved. TDOT typically only uses Type C.

Source: TDOT


Source: Ver-Mac

Purpose

- Assist in merging and controlling road users.
- Provide adequate separation from work zone operation.
- Advise approaching traffic of a lane closure.

Typical Applications

- Use on major multilane roadways.
- TDOT typically only uses Type C.
- **Type B:** intermediate-speed facilities, maintenance and mobile operations on high-speed roadways.
- **Type C:** high-speed, high volume motor vehicle traffic control projects.
- Good for situations involving heavy traffic volumes, high speeds and/or limited sight distances.
- Good for locations where road users are less likely to expect lane closures.
- Use with freeway lane closures.
- Use with daytime and nighttime conditions.

Implementation Notes

- Place on the shoulder (stationary lane closure) of the roadway at beginning of merging taper or farther from the traveled lane. If shoulder is too narrow, place in the lane being closed.
- Delineate with retroreflective devices.
- In case multiple lanes are closed, use separate arrow board for each closed lane. If first arrow is placed on shoulder, second board should be placed in first closed lane at upstream end of second merging taper. When first board is placed in first closed lane, second board should be placed in second closed at downstream end of second merging taper.
- Should be capable of at least 50% dimming from full brilliance especially for nighttime use.
- Minimum mounting height, measured vertically from the bottom of the board to the roadway below it or to the elevation of the near edge of the roadway, of an arrow board should be 7 feet, except on vehicle-mounted arrow boards, which should be as high as practical.
- Provide remote control for vehicle-mounted arrow board.

See next page for additional resources.

Additional Resources	
MUTCD Reference	• Section 6F.61
Pay Item	• 712-08.03 Arrow Board (Type C)
TDOT Standard Drawings	• T-WZ-11 THRU T-WZ-15 • T-WZ-18 • T-WZ-19 • T-WZ-21 • T-WZ-40 • T-WZ-41
TDOT Specifications	• 712.02, Item H • 712.04, Item C • 712-08.03 Arrow Board (Type C)
TDOT QPL	• QPL.29.001 - Flashing Arrow Panels/Arrow Boards • QPL45.038 - WZ/TCD: Arrow board trailers

Portable Changeable Message Signs (PCMS)

- A PCMS is a large, lighted retroreflective message display device.
- PCMSs include a message sign panel, control system, power source, and mounting and transporting equipment.
- Use is limited to three lines of eight characters per line with a minimum of 18" letter height, and a maximum of 2 pages of information displayed.
- Use to supplement conventional signs, pavement marking and lighting.
- If using as an arrow board, it shall meet all requirements of an arrow panel and shall be used solely as an arrow board.

Source: TDOT

Source: Ver-Mac

Purpose

- Advise user of unexpected situations and routing situations in advance of the work area
- Convey complex messages including situation that user will encounter, location/distance to situation, recommended driver action

Typical Applications

- Highways where advance warning and information is required. High-density urban freeways.
- High average daily traffic (ADT) facilities.
- Adverse environment conditions, daytime and nighttime conditions.
- Crash or incident management locations.
- Change in road use pattern locations or substantial changes in speed locations.
- Significant queue and delays locations.

Implementation Notes

- Mount truck-mounted/trailer PCMS a minimum of seven feet above the road when operating.
- Locate and align PCMS to provide maximum legibility and to allow time for road users to respond appropriately to message.
- Place PCMS on shoulder of road, behind a traffic barrier or further from travel lane, outside of clear zone. (If placed on shoulder of road, always accompany with Type B channelizing device).
- Locate and angle face of sign so message is legible to approaching traffic for required distance.
- Delineate truck-mounted PCMS by shoulder taper of six cones/drums for greater visibility with maximum spacing of 20 feet.
- Installation should not block pedestrian facilities.
- Cover front face of sign with protective material.
- Display visible 0.5 mile away under day and night conditions. Each display should contain a single thought. The entire display should be readable twice at the posted speed limit prior to work starting. An accurate description of the work location or the incident location is critical.
- The PCMS shall have readable up-to-date information. Any delay message should accurately reflect the traffic delay time.
    - The PCMS message shall use days of the week not calendar dates.
    - The use of abbreviations is discouraged. The entire word should be spelled out whenever space permits. If abbreviations are used, they should be easily understood and comply with MUTCD Section 1A.15.
    - Displays shall not scroll horizontally or vertically across the face of the sign.

See next page for additional resources.

Additional Resources	
MUTCD Reference	• Section 6F.60
Pay Item	• 712-08.10 Mobile Message Sign Unit with Attenuator • 713-16.01 Changeable Message Sign Unit • 713-16.04 Changeable Message Sign Unit
TDOT Standard Drawings	• T-WZ-21 • T-WZ-61
TDOT Specifications	• 712.02, Item H
TDOT QPL	• QPL.30.001 - Portable Changeable Message Signs • QPL.45.037 – Work Zone Traffic Control Device: Variable message signs

5.5.4 Temporary Traffic Control Signals

Fixed Temporary Traffic Signals

- Fixed temporary traffic signals are temporarily mounted on fixed supports.
- Only use in situations where temporary signals are preferable to other means of traffic control, such as changing the work staging or work zone size to eliminate one-way vehicular traffic movements, using flaggers to control one-way or crossing movements, using STOP or YIELD signs, and using warning devices alone.
- When temporary traffic signals are used, conflict monitors typical of traditional traffic control signal operations should be used.
- Supplement with warning and regulatory signs, pavement markings, and channelizing devices.

Source: Kittelson & Associates, Inc.

Purpose

- Use to control road user movements through temporary traffic control zones instead of a flagger.

Typical Applications

- Temporary haul road crossings.
- Temporary one-way operations along a two-way lane; two-way highway where one lane is closed; or location where alternating traffic movements are necessary.
- Temporary one-way operations on bridges, two-lane bridge replacements, reversible lanes and intersections.
- During installation of new permanent signal.
- Location where traffic needs to be controlled through an intersection being reconfigured.
- Reconstruction of an interchange ramp terminal.
- Rock fall or side slope excavation projects.
- Locations where ADT is below 3500; delay is less than 20 minutes; sight distance can be provided between stop bars at each end of the work area; signal is more economical than flagging; environmental conditions favoring use of signals over human flagger control.

Implementation Notes

- If a temporary traffic signal is located within 1/2 mile of an adjacent traffic control signal, consideration should be given to interconnected operation.
- Temporary traffic signals shall not be located within 200 feet of a grade crossing unless the temporary traffic control signal is provided with preemption or unless a uniformed officer or flagger is provided at the crossing to prevent vehicles from stopping within the crossing.
- Cycle length for temporary traffic signals should not exceed four minutes *(39).*
- In the case of signal malfunction, temporary signals typically default to flashing red mode *(39).*
- Close any intersecting roads or driveways between the temporary traffic signals, or intersecting roadway can be incorporated with addition of another signal head in case of public roadways.
- Vertically arranged 12” diameter signal lenses should be installed.
- Each traffic signal unit shall have at least two signal heads. One signal head shall be mounted on a pole with the bottom of the signal head at least a minimum of eight feet above the sidewalk or, if there is no sidewalk, above the centerline of the road. At least one vehicle signal head shall be located over the travel lane(s) with a minimum vertical clearance of 17 feet to 19 feet above the centerline pavement surface.

See next page for additional resources.

Additional Resources	
MUTCD Reference	• Section 6C.14 and Section 6F.84 • Typical Applications 12 & 14 with Notes, Section 4D.32
Pay Item	• 730-40.02 Temporary Traffic Signal System
TDOT Standard Drawings	• T-WZ-35
TDOT Specifications	• 730.28.C Item Portable Traffic Signal System. • Special Provision 730A TTC (signalization).
TDOT QPL	• See current TDOT QPL.

Portable Traffic Signals

- Portable traffic signals are portable, trailer-mounted traffic signals.
- These are ideal when a temporary signal is required for less than a month. Portable traffic signals are powered by batteries and recharged by generators or solar panels; they function well in areas where electricity is not readily available.
- These are not recommended for use where there is more than one travel lane in each direction.
- See additional information provided in “Temporary Traffic Signals.”

Source: TDOT

Purpose

- See additional information provided in “Temporary Traffic Signals”

Typical Applications

- Divided four-lane roadways, two lanes in each direction (separate set of signal heads should be provided for each additional travel lane)
- Locations where speed is less than 35 mph; for limited applications, speeds up to 55 mph may be applicable
- See additional information provided in “Temporary Traffic Signals.”

Implementation Notes

- Mount on trailers or lightweight portable supports.
- Provide wireless connectivity and install newer technology allowing multiple phases of operations.
- See additional information provided in “Temporary Traffic Signals.”

Additional Resources

MUTCD Reference	• Section 6C.14 • Section 6F.84 • Typical Applications 12 & 14 with Notes, Section 4D.32
Pay Item	• 730-40.01 Portable Traffic Signal System
TDOT Standard Drawings	• T-WZ-35
TDOT Specifications	• 730.28.C Item Portable Traffic Signal System • Special Provision 730A temporary traffic control (signalization).
TDOT QPL	• See current TDOT QPL.

TDOT is using this device on an experimental project-by-project basis.

Driveway Assistance Device (DAD)

Source: TDOT

- A DAD is a self-contained cart with a small footprint; allows for easy maneuverability.
- DADs contain a battery bank with onboard 110-volt charger, optional outriggers and solar charging system.
- Each signal is fitted with one 12" Red indication and two flashing red arrows which alert motorists that one-way access is permitted in the direction of the flashing arrow. The device will display a flashing red arrow in the direction of the traffic traveling within the work zone. The motorist can travel in the direction of the arrow, yielding to traffic traveling within work zone. A solid red indication is displayed when it is not safe for the motorist to enter.
- There is an unlimited number of devices can be wirelessly interconnected in a single work zone.

Purpose

- Addresses the need to control traffic exiting driveways that fall within one-lane two-way temporary work zones. the device alerts drivers of traffic direction before they enter a one-lane two-way road in a work zone from driveways or local streets.
- Increases safety for all (motorist and worker) while maximizing traffic flow through work zone.
- Helps reduce the likelihood of wrong way driving in work zones
- Reduces the number of workers on the road, extends guidance for drivers and helps to reduce queueing of vehicles and cycle lengths
- Minimizes risk of injury or accident

Typical Applications

- High traffic residential and commercial areas to control driveways and minor side streets.
- Utility work such as gas and sewer line repairs.
- Emergency roadwork that requires fast and easy deployment of traffic control solutions.

Implementation Notes

- This device has a user-friendly controller design and operator training takes a few minutes for basic and complex setups.
- A push button is provided which can be used for input messages that can be displayed on liquid crystal display (LCD) screens.
- Devices can be installed at each driveway for the duration of the entire project.

Additional Resources

MUTCD Reference	• 6F.01
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• See current TDOT QPL.

Automated Flagger Assistance Devices (AFAD)

Source: Ver-Mac

- An AFAD is a trailer-mounted device which includes a remotely controlled gate arm that can be raised or lowered across a single travel lane; has high visibility signage and automated flags.
- There are two types: 1) Remotely controlled stop/slow sign mounted on trailer/moving cart and 2) Remotely controlled red and yellow lens and a mechanically gated arm.

Purpose

- control one-lane, two-way traffic
- allows a flagger to be positioned out of the lane of traffic
- controls road user through temporary traffic control zones

Typical Applications

- Designers may use the following guidance for highway segments with average daily traffic (ADT) volumes and lane closure lengths within the following ranges.

Free-Flow Thresholds for Bi-Directional Work Zones (Average Daily Traffic for both directions)	
ADT	**Length of One-Lane Section**
≤5,500	1-2 miles
7,500	½ - 1 mile
9,000	Up to ½ mile
>9,000	One-lane operations not recommended

- Use where line of sight between AFAD units are maintained; pilot car is used if AFAD units are more than ¼ mile apart
- Use for short-term/intermediate activities such as bridge maintenance, haul road crossings, pavement patching
- Use during bridge maintenance, haul road crossings and pavement patching.

Implementation Notes

- Place AFADs in advance of one-lane, two-way tapers and downstream, on roadway shoulder, from the point where approaching traffic is to stop in response to the device. If AFAD in in way of traffic lane, gate arm shall not extend into opposing lane.
- Consider flaggers as substitutes for AFADs if freight mobility width requirements cannot be met due to lane encroachments of device.
- Place such that all signs are visible to approaching vehicle with advance warning signs alerting other approaching vehicles to stop.
- Remove or cover signs, when not in use, both at AFAD location and in advance.
- Mount stop/slow sign AFAD with bottom of sign a minimum of 6 feet above pavement; mount red/yellow lens AFAD such that bottom of housing is at least 7 feet above pavement.
- Retro-reflectorize gate arms on both sides with vertical alternating red and white stripes at 16” intervals measured horizontally.
- Minimum vertical aspect of gate arm and sheeting is 2” and end of arm reaches at least to center of lane being controlled when gate arm is in down position, blocking approach lane.
- Operate AFAD by trained flagger positioned well away from traffic using radio control unit; or at a central location; or by separate flaggers near each device’s location; or cable directly attached to AFAD.

See next page for additional resources.

Additional Resources	
MUTCD Reference	• Section 6E.04 • Section 6E.06 • Figure 6E-2

Pay Item	• 712-01 Traffic Control
	  ○ 712-01.02 Lane Closure
	  ○ 712-01.03 Lane Closure (Night Work)
	  ○ 712-01.04 Traffic Control Supervisor
	  ○ 712-01.05 Flagman
	  ○ 712-01.50 Maintenance Of Traffic
	  ○ 712-01.51 Portable Barrier Rail Delineator (Double)
	  ○ 712-01.52 Maintenance Of Traffic
	  ○ 712-01.53 Maintenance Of Traffic
	  ○ 712-01.54 Maintenance Of Traffic
	  ○ 712-01.55 Maintenance Of Traffic
	  ○ 712-01.56 Maintenance Of Traffic
	  ○ 712-01.60 Maintenance Of Traffic (Henley Street Tunnels)

TDOT Standard Drawings	• T-WZ-33 • T-WZ-34 • T-WZ-61
TDOT Specifications	• N/A
TDOT QPL	• See current TDOT QPL.

5.6 OTHER DEVICES AND SYSTEMS

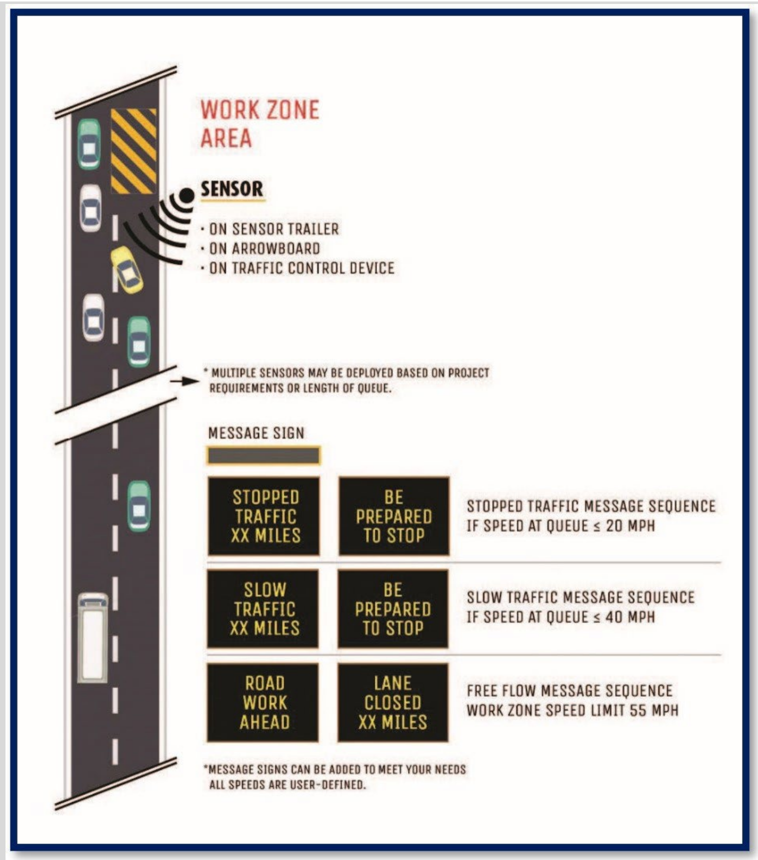
This section describes other devices that may be used in various work zone design strategies. **Section 5.6.1** includes devices and systems that TDOT currently uses, and **Section 5.6.2** includes devices TDOT does not currently use but may consider in the future.

5.6.1 Devices and Systems Currently in Use

TDOT currently uses the portable queue warning system. Flagger station lighting is sometimes used in emergency situations. Additional information on each system is described below.

The queue warning system that TDOT currently uses is further described in Chapter 6, Section 6.11.1.

Portable Queue Warning System	
• This instrumented crashworthy portable autonomous channelizing drum (40” tall, 26” diameter) communicates wirelessly to transmit data such as real-time speed and volume information. It includes the same retroreflective material as a standard traffic barrel. • Components include a construction barrel with components to facilitate aiming the device, locating its position, speed sensors, battery or other power supply, and associated electronics.	



Source: Ver-Mac

Purpose	
• Detect speed and volume of vehicles in real time. • Could be coupled with PCMS to display real time delay, back of queue, or similar information.	
Typical Applications	
• Freeways/highways.	
Implementation Notes	
• See manufacturer information for installation details. • https://www.tn.gov/content/dam/tn/tdot/construction/special-provisions/Const-712PQWS.pd	
Additional Resources	
MUTCD Reference	• N/A
Pay Item	• 712-08.14 Portable Queue Warning System
TDOT Standard Drawings	• N/A
TDOT Specifications	• SP 712 PQWS
TDOT QPL	• N/A

Flagger Station Lighting ***(Flagging at night is Not Recommended. Only to be used in Emergencies.)***
• Illumination is provided at flagger stations separate from workspace. • Provided 15-21 feet above the roadway. • Light output should be less than 2500 watts and glare-free to prevent over-lighting of flaggers. • Should provide lighting for area of at least 40 feet diameter at ground level.
Purpose
• Increase visibility of flaggers in work zone area. • Reduce speed when approaching work zone. • Increase awareness of drivers of flaggers in work zone ahead.
Typical Applications
• Low-volume roads, high speed roads. • Nighttime conditions. • Consider use of red retroreflective strip on stop sign support. See MUTCD Figure 2a-1 (e).
Implementation Notes
• Locate lighting on same side of roadway as flagger. • Locate lighting on the shoulder approximately 5-10 feet from the edge of the traveled way at a 15-degree angle away from the travel lane in advance of the flagger, without impacting the flagger's escape route. • Illuminate the flagger so that the flagger is visible, and is discernable as a flagger, from a distance of 1,000 feet.

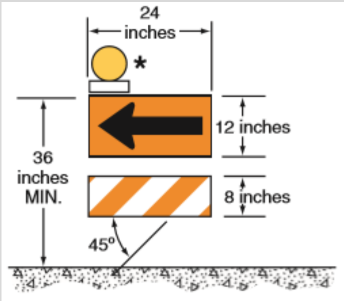
Additional Resources	
MUTCD Reference	• Section 6E.08
Pay Item	• 712-01 Traffic Control – Only used in emergency situations.
TDOT Standard Drawings	• T-WZ-33 • T-WZ-34 • T-WZ-61
TDOT Specifications	• 712.04.A
TDOT QPL	• QPL.45.040 - WZ/TCD: Work zone lights

Flagging at night is not recommended. Only used in emergency situations.

5.6.2 Devices and Systems Not Currently in Use

TDOT does not currently use the following devices and systems but may consider them in the future.

- Direction Indicator Barricade
- Mobile Barrier System
- Moveable “Zipper” Concrete Barrier
- Traveler Information Software for Web-Based Applications
- Autonomous Truck Mounted Attenuator
- Work Zone Intrusion Alarm Technology
- Sequential Lighting
- Over-height Vehicle Warning System

Direction Indicator Barricade	
• These barricades are diagonal striped, horizontally aligned, and retroreflective rail mounted with one-direction large arrow sign. • Sign should be black on an orange background and should have size of 24” x 12”. • Channelizing devices shall be used if the temporary traffic control zone will be installed for more than 12 hours or if it is left unattended.	
 * Warning lights (optional) Source: MUTCD *(1)*	 Source: ATKSafetySupply.com *(13)*

Purpose

- Direct the driver through the transition and into the intended travel lane

Typical Applications

- Use in tapers, transitions, and other areas where specific directional guidance to drivers is necessary.
- Use with daytime and nighttime conditions.

Implementation Notes

- Install in series for maximum effectiveness.
- During short duration lane closures on a multilane road, when using a combination of cones and direction indicator barriers, every third device in the merge taper and every tenth device in the tangent area should be a direction indicator barricade.
- Alternating orange and white retroreflective stripes sloping downward at an angle of 45 degrees in the direction road users are to pass.
- The stripes should be 4” wide and bottom rail should have a length of 24” and a height of 8”.

Additional Resources

MUTCD Reference	• Section 6F.69
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Mobile Barrier Systems

- Mobile barrier systems are integrated, portable, rigid-wall, semi-trailers that are used in conjunction with standard semi-tractors.
- The system serves as an extended, mobile, longitudinal barrier.
- This system is appropriate for usage on high-speed roadways that include multiple small work areas where temporary concrete barriers cannot be used due to its portability.

Source: FHWA *(14)*

Purpose

- Provide positive protection barrier and visual separation between workers, construction equipment and live traffic for small work areas (< 100 feet).
- Optimize safety and efficiency of projects.
- Reduce glare nighttime work.
- Reduce impact to adjacent lane.

Typical Applications

- Freeways/highways and other high-speed roadways.
- Bridge joint repairs.
- Pavement patching.
- Manhole adjustments.
- Overhead sign work.

Implementation Notes

- Drive system into place and occupy lane in which work is performed.
- Equip with attached truck-mounted attenuators (TMA), or a separate TMA vehicle if needed.
- Configure to incorporate storage space for additional equipment, on-board integrated power, lighting, or signage if needed.
- It is designed to remain attached to the tractor unit while in use which facilitates rapid deployment, removal, and easy repositioning while on-site.
- Adaptable for right or left side protection.

Additional Resources

MUTCD Reference	• Section 6F.86
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Movable (“Zipper”) Concrete Barrier

- This special-shaped barrier is made of multiple smaller, interlocked segments used for staging projects requiring constant ongoing moves of concrete barriers.

Source: Oregon Department of Transportation *(15)*

Purpose

- Transfer concrete lane dividers.
- Relieve traffic congestion during rush hours.

Typical Applications

- During off-peak and peak periods for opening and closing of lanes.
- Daytime and nighttime conditions.

Implementation Notes

- Attach product-specific impact attenuator to end of barrier run and move.
- Avoid specifying system less than 5 feet from a work area. Avoid specific system as being “secure” to the roadway.
- Special transfer machine is used to transfer barrier from one location to another in a single pass.
- This device has a slightly higher deflection when stuck by an errant vehicle (approximately 5 feet mid-run with unsecured ends).

Additional Resources

MUTCD Reference	• Section 6F.86
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Traveler Information Software for Web-Based Applications

- This software application analyzes traffic data and provides web-based access to other devices in the work zone.

Purpose

- Provide real-time information to the motoring public, project managers, agency traffic management centers (TMC), and public websites.

Typical Applications

- Automated queue warning.
- Travel time/alternate route messaging.
- Variable work zone speed limits.
- Truck entry warning systems.
- Weather conditions systems.

Implementation Notes

- See manufacturer information for installation and application details.

Additional Resources

MUTCD Reference	• N/A
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Autonomous Truck Mounted Attenuators

Source: Markritelines.com *(16)*

- This driverless crash cushion truck intends to reduce the damage to structures, vehicles, and motorists.
- The attenuator is mounted on the back of a truck; an autonomous truck will add an extra layer of safety since it will be behind the manned vehicle. It will be in ‘follower mode’ when paired with a lead vehicle.
- Vehicles use an aluminum honeycomb filled with air or sand to absorb or redirect impact.

Purpose

- Protect workers from errant vehicles.
- Reduce damage.

Typical Applications

- Freeways/highways.
- High-speed roads.

Implementation Notes

- See manufacture information for installation and application details.

Additional Resources

MUTCD Reference	• N/A
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Work Zone Intrusion Alarm Technology

- This safety system includes an alarm, transmitter, and receiver to alert field workers with enough time for them to escape when an errant vehicle intrudes into the work zone.
- Detection systems vary by manufacturer and include kinematic, infrared, pneumatic, microwave, and radio-based systems.
- Alert types vary by manufacturer and include audible, visual, and vibratory warnings.

Source: Static Progressive Media Group *(17)*

Purpose

- Incident reduction.
- Provides positive protection.

Typical Applications

- Low-speed roads, high-speed roads.
- Flagger protection areas.
- Work zone access points.
- Small/medium temporary work sites.

Implementation Notes

- See manufacturer information for installation and application details.

Additional Resources

MUTCD Reference	• N/A
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Sequential Lighting

- These active amber lights flash on-and-off in a sequential order; mounted on channelizing devices where tapers occur.
- The flash sequence occurs from the upstream end of the merging taper to the downstream end of the merging taper in order to identify the desired vehicle path.
- When used for warning purposes, lights in the sequence shall be flashed at a rate of not less than 55 or more than 75 times per minute.

Source: Traffic Products *(18)*

Purpose

- Increase driver awareness and recognition of merging taper.
- Helps reduce vehicle speed.
- Enhances nighttime wok zone visibility of merging tapers.

Typical Applications

- Expressways, freeways.
- Daytime and nighttime conditions.

Implementation Notes

- Each warning light in the sequence shall be flashed at a rate of not less than 55 nor more than 75 times per minute.
- Mount lights such that minimum mounting height is 30” to the bottom of the lens.
- Where plastic drums are used, there are certain situations where additional delineation provided by lighting devices may not necessary.
    - Type C (steady burn) lamps are not recommended for use with plastic drums along tangent sections following a lane closure taper or along a line of drums delineating the edge of the traveled way.
    - The use of Type C lamps is still recommended for use with drums on tapers.
    - Type C lamps on drums, including tangent sections, might be considered when climatic conditions (for example fog) dictate the need for additional delineation.
- Where portable concrete barrier rails are used, portable barrier temporary delineators are recommended in lieu of Type C lamps. These devices provide adequate delineation, while requiring less maintenance effort as compared to Type C lamps.
- The use of Type B lamps shall be limited to just those situations where a "spot" hazard is anticipated, and additional delineation of a channelizing device is considered necessary.

Additional Resources

MUTCD Reference	• Section 6F.63, 6F.83
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

Over-height Vehicle Warning System

- This warning system protects traffic and workers when temporary support structure is used during construction (such as formwork to support a permanent structure).
- An infrared sensor is used to monitor the vehicle and an audio-visual alarm will be activated when over-height vehicle is detected.

Source: Universal Signs *(19)*

Purpose

- Warn drivers of approaching over-height vehicles.
- Detect over-height vehicles moving towards bridges, tunnel entrances and overhead structures.
- Helps reduce major crashes and low clearance hazards.
- Automatic notification of incident/violation.
- Directing drivers to an alternative route.

Typical Applications

- Nighttime and daytime conditions.
- Low bridges.
- Underpasses.
- Tunnels.
- Weigh stations.
- Low clearance hazards.

Implementation Notes *(53, 55)*

- The system consists of over-height sensors, flashing LED signs, flashing LED beacon etc.
- Mount transmitter and receiver on either side of road well in advance of low structure which will form an infrared beam over the road.
- When over-height vehicle breaks infrared beam, the transmitter radio will send wireless signals to receiver which will trigger alert devices.
- Use applications to capture images of over-height vehicles and send email and text alerts to recipients.

Additional Resources

MUTCD Reference	• N/A
Pay Item	• N/A
TDOT Standard Drawings	• N/A
TDOT Specifications	• N/A
TDOT QPL	• N/A

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TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 6

WORK ZONE TRAFFIC CONTROL STRATEGIES

March 2022

TN TDOT Department of Transportation

Contents

CHAPTER 6 WORK ZONE TRAFFIC CONTROL STRATEGIES 6-1

Chapter 6

Work Zone Traffic Control Strategies

Chapter 6 describes work zone traffic control strategies that are used to safely and efficiently move roadway users through work zone areas during staged construction activities. The temporary traffic control devices used during work zone traffic control strategies are described in **Chapter 5** and are cross-referenced where appropriate in this chapter. **Chapter 6** provides guidance and information about how to apply the variety of traffic control devices presented in **Chapter 5** in a variety of contexts. Design Teams should use information from both chapters when making decisions about strategies and devices.

6.1 PURPOSE AND PRINCIPLES OF TRAFFIC CONTROL STRATEGIES

A traffic control strategy is a combination of traffic control devices that are assembled to support a particular combination of constructability needs and the experiences of each affected mode of travel and affected properties. Key principles of traffic control strategies include:

- The constructability of the strategy development process should be evaluated early in the project to verify that the strategy supports safe and effective project implementation.
- The type and number of strategies selected and implemented are often proportional to the scope and complexity of the work.
- Strategies should be selected and implemented to support the safety and mobility of all types of users, including pedestrians, bicycles, transit, motor vehicles, and trucks as well as the safety of construction workers.
- Selecting and implementing a traffic control strategy requires coordination and collaboration with other TDOT divisions, regions, and offices.
- The traffic operational, safety, and accessibility effects for each strategy should be evaluated to understand the potential impacts to each travel mode, including effects on travel time, delay, queuing, safety, and

Chapter 1 provides an overview of the TDOT project development process, including the various project stages.

accessibility. For significant projects, coordination should occur with the Traffic Operations Division and State Traffic Engineer. For regional projects, coordination can occur with the Region Traffic Engineer. Coordination may begin at the Site Review and Right-of-Way Design stages.

The most recent versions of the key references should be used to support the work zone design.

Several key references support the content in this chapter and may be consulted in conjunction with this manual. The *TDOT Work Zone Safety and Mobility Manual* *(1)* provides additional information about work zone design policies and procedures within the state. The TDOT Standard Drawings *(2)* contain standard notes and details and are referenced from the contract plans. The typical applications are from the *Manual on Uniform Traffic Control Devices (MUTCD)* *(3)* or are adapted from other documents and cover general principles and applications. This manual does not reproduce the standards, guidance, options, and support that are associated with each of these typical applications; refer to the *MUTCD* for details.

These additional resources can be accessed at the following website links:

TDOT Work Zone Safety and Mobility Manual

TDOT Standard Drawings

Manual on Uniform Traffic Control Devices (MUTCD)

The *TDOT Work Zone Field Manual for Maintenance Operations (Field Manual)* provides additional details related to short-term operations and is intended for TDOT staff only.

6.2 MAKING DECISIONS AND EVALUATING TRADEOFFS

The essence of developing an effective traffic control plan is one of identifying and evaluating tradeoffs to support informed decision-making. There are often multiple ways to approach how to construct a project, and the supporting traffic control plan needs to be compatible with and supportive of the selected construction method. As a result, a traffic control plan could be simple or complex, depending on the project type, context, complexity, and duration as well as the anticipated impacts the projects generate. Understanding the decision-making process and evaluating tradeoffs when selecting and designing work zone traffic control measures can lead to a design that meets the needs of all users and limits impacts to the roadway users and surrounding stakeholders.

A summary of typical TDOT forms that may be used during the work zone design process is described in Section 6.4.

Figure 6-1 provides a decision-making framework for selecting traffic control measures, implementing the traffic control design, and monitoring the work zone during and after construction. This framework is based on research regarding work zone decision making and outlines the need to identify performance measures and gather relevant data that may help guide the evaluation of various traffic control strategies *(4)*. This will likely include coordinating with the TDOT Traffic Operations Division (for significant projects) and/or Region Traffic Engineer (for regional projects) to get support with identifying traffic operational and safety impacts of various strategies. It will also involve coordinating with the TDOT Roadway Design Division to understand the specific needs of each user, including accessibility. The TDOT Community Relations and Communication

Division can support the Design Team with identifying and assessing stakeholder needs and outreach activities.

Identifying and evaluating the most effective traffic control strategy may also become an iterative process, where alternatives may be reevaluated, or strategies may be reconsidered based on the impacts of traffic operations, safety, temporary design layouts, schedule, constructability, and stakeholders.

Design Teams should document the decisions, input, and outcomes throughout the decision-making process to verify that decisions and goals are being carried through to the construction stages. Documentation can be completed through the Transportation Management Plan, the Work Zone Design Deviation Process (if needed), TDOT forms (**See Table 6-22**), and the Traffic Control Plans, Specifications and Special Provisions. *(5)*

Figure 6-1
Decision-Making Framework/Flowchart

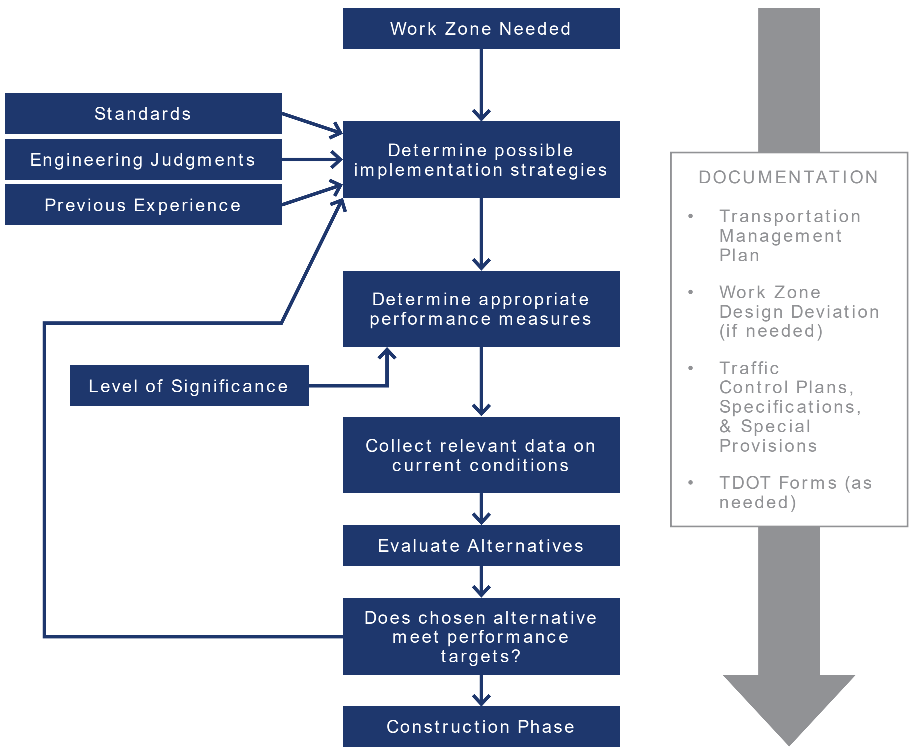


Table 6-1 provides additional information for assessing the primary stages of the decision-making framework. Key questions, potential performance measures and data needs, and considerations for evaluating, implementing, and monitoring traffic control plans are provided. The information in the table may not be relevant to every project but can be a starting point for Design Teams to assess traffic control strategies and determine the most effective strategy to meet the project's needs.

Table 6-1
Summary of Decision-Making Input

Decision-Making Input

Possible Implementation Strategies

- What are the project's purpose and primary goals (e.g., safety, capacity, multimodal connectivity)?
- What is the project's significance?
  - See **Chapters 1 and 2**.
- What is the project's type, project context, and type of operation?
  - See **Chapter 2**.
- What are the potential traffic control elements?
  - See **Section 6.5 through 6.11**.

Elements for Design

- What are the primary performance measures used to evaluate the traffic control measure?
  - Operations
    - speed, volume, capacity, delay, travel time, queues
  - Safety
    - crashes, speed, speed differential, geometry, time of work zone activity, exposure
  - User Impacts
    - accessibility, level of pedestrian and bicycle activity, transit presence, freight needs, user trip length, access to destinations, ability to maintain route
  - Construction
    - feasibility and constructability, project duration, financial costs
  - Stakeholder Impacts
    - user inconvenience, adjacent property impacts

Data Needs

- What data do you have available? What data is needed to evaluate the performance measures?
  - Traffic volumes
    - peak hour traffic volumes, daily traffic volumes, directional distribution
  - Presence of Users
    - facilities for pedestrians and bicycles
  - Transit Presence
    - routes, headway, bus stop locations
  - Freight Needs
    - type of trucks, routes, horizontal and vertical clearance needs
  - Crash History
    - total number, location, severity, type, time of day
  - Speeds
    - posted, operating, design

Table 6-1 ***(continued)***
Summary of Decision-Making Input

Evaluate Tradeoffs
• How do the work zone alternatives align with the original project purpose and goals? • What are the priorities identified in stakeholder outreach? • What are the financial constraints? • Are all users being adequately served? • What are the schedule constraints? • Document decision-making and tradeoff evaluation.
Implementation (Construction Division)
• Does the work zone implementation achieve the project purpose and goals? • Is the work zone meeting the performance targets during construction? • Has the Construction Division maintained consistent communication with stakeholders who may be affected by the implementation? • Has the outreach to the public adequately communicated to all users? • Are there any changes that may be needed to better serve users, stakeholders and achieve goals and targets?
Monitor Performance
• How can the project monitor the users' response to the work zone? • Are there any project updates or schedule changes that need to be communicated with stakeholders? • Are there any updates needed for traffic control devices based on project progression?

Identifying performance measures for a project depends on the type of project, project context, and a clear understanding of the operational, safety, and design priorities and goals for each user and adjacent stakeholders.

6.3 CONSTRUCTABILITY AND IMPACT CONSIDERATIONS

Construction projects and the associated work zone designs impact each roadway user uniquely. The impacts of both the construction itself and of the maintenance of traffic during construction are often felt beyond the roadway, extending to adjacent property owners, access driveways, connecting roadway facilities, and adjacent utilities. This section describes how to evaluate a project's constructability and feasibility as well as how to assess the impacts to each user and verify that the project's goals are achieved, stakeholders are engaged, and specific user needs are met.

6.3.1 Constructability and Feasibility

Addressing constructability and feasibility in the early stages of project development will improve project quality, minimize potential change orders during construction, and provide a buildable and biddable construction bid package. Construction projects are typically organized into a series of construction phases, often with a series of sub-phases within each phase.

A construction phase refers to the significant project sequence of events that takes place to build the project.

Construction sub-phases occur within a construction phase and refers to an activity that takes place to execute the overall construction stage.

Construction Phase: The significant project sequence of events that takes place to build the project.

Construction Sub-Phase: Occur within a construction phase and refers to an activity that takes place to execute the overall construction phase.

For Example:

- Phase 1 may include shifting traffic to the left while constructing the right side of the road.
    - Phase 1, Sub-Phase 1A, the contractor may have to construct temporary widening before shifting the traffic to the left.
    - Phase 1, Sub-Phase 1B, will allow the actual construction to the right while traffic is running along the left on the temporary widening.

  Phase 2 will shift traffic to the right on the road portion constructed. Phase 1 while completing construction on the left.

All projects (small to large, short to long, simple to complex) should consider and assess the constructability by outlining project phases and associated sub-phases, identifying project and construction constraints, and consistently communicating with the project team. This may involve early discussions, preliminary sketches, and evaluating potential phases and implementation options. The construction approach and phases directly impact the traffic control measures selected to maintain traffic and serve users during construction. As traffic control plans are developed, reviewed, updated, and refined throughout the project development stages, the constructability and feasibility should be continually evaluated to verify that the project can be constructed as planned and that the traffic control plans meet the needs of the project and users.

6.3.1.1 Connection to the Project Development Process

As described in Chapter 1 (Figure 1-1) constructability should be considered at the Preliminary Field Review Meeting during the Preliminary Design stage of the project. During the Site Review Meeting, constructability discussions continue, and general traffic control design approaches are considered. These considerations should include primary elements, such as road closures, potential detours, significant stakeholder impacts, and more. The *TDOT Roadway Design Guidelines* provide additional information about the types of questions and discussions that take place during the Site Review Meeting *(6)*. Questions related to the construction staging and traffic control design approach are outlined in the Site Review Document. The questions represent a starting point for the Design Team to begin assessing the type of information needed and the decision-making process required for ultimately determining the construction stages and work zone design.

As the draft traffic control plans are developed during the Right of Way stage of the project, constructability and the work zone measures associated with the construction phases are reviewed and evaluated to identify any adjustments. Utility coordination and identification may also influence the constructability of a project. Right-of-way impacts, including impacts to adjacent properties and businesses, may have a financial implication for the project that should also be integrated into decision making when considering construction approaches, stages, and traffic control measures.

6.3.1.2 Impact on Work Zone Design

Constructability should be considered early in the design process. The ultimate geometry of an improvement may change after considering the potential construction strategies and project constraints.

Table 6-2 provides an overview of the potential design impacts that may occur while evaluating a project's constructability and feasibility **Table 6-2**.

The ultimate geometry of an improvement may change after considering the potential construction strategies and project constraints.

Table 6-2
Constructability Impacts at Project Development Stages

Project Development Stage (Chapter 1, Figure 1-1)	Constructability Impacts on Work Zone Design
Preliminary Design	Developing conceptual construction layouts reflecting appropriate geometry and cross sections at constrained locations illustrating the relationship between construction zones and general public traffic will establish the feasibility of construction staging. The outcome of this staging exercise may impact the ultimate footprint of the improvement.
Right-of-Way Design	For construction that involved changing of elevations, this development stage will include conceptual three-dimensional modeling to confirm the staging that was evaluated during the Preliminary Design stage. This stage intends to confirm the feasibility of how the project will be constructed and establishes the ultimate footprint.
Construction (Design)	The project development stage will provide the required plans, specifications, and estimates (PS&E) for the bidding purposes based on the construction staging established and confirmed during the prior project development stage.
Construction (Field)	Monitoring the implementation of traffic control plans and evaluating the success of the traffic control measures will benefit future similar projects.

Rebuilding Interchange Project Example

Figure 6-2 and **Table 6-3 through Table 6-6** provide an example of how this may realistically occur during a project. The objective of the project was to upgrade the diamond interchange in Washington State on Interstate 5, Exit 16 with closely-spaced frontage roads to an interchange that addresses design and safety as well as meets future traffic operational needs.

Figure 6-2
Illustration Capturing Potential Design Impact

Table 6-3
Example Project – Preliminary Design Considerations

Project Development Stage - Preliminary Design

• Project challenges:
  ○ Require a new bridge that needed to be 5 to 7 feet higher than an existing bridge to address vertical deficiency along the interstate.
  ○ Maintain full interchange access during construction.
  ○ Desire to construct roundabouts with Portland cement concrete pavement at the interchange ramp terminals and an adjacent intersection.
• Design approach
  ○ Build the new bridge and ramp terminal intersections south of the existing alignment to allow the existing structure to be used by traffic during construction.
  ○ Realign frontage road to create space for interchange construction.
  ○ Minimize interaction between construction activities and the general traveling public.
• Decision making, discussions, and initial thoughts on construction staging and work zone design
  ○ Conduct preliminary three-dimensional modeling to understand how to stage the project in a way that manages the grade differentials between existing and future alignments.
  ○ The construction staging refined the ultimate footprint of the interchange improvements.

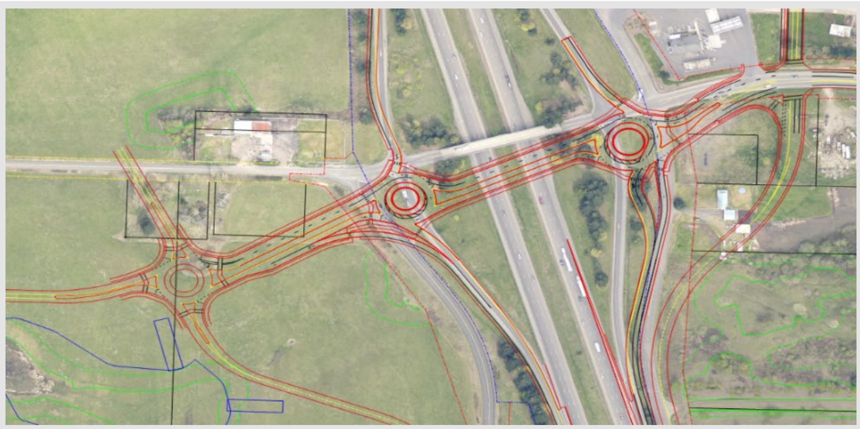
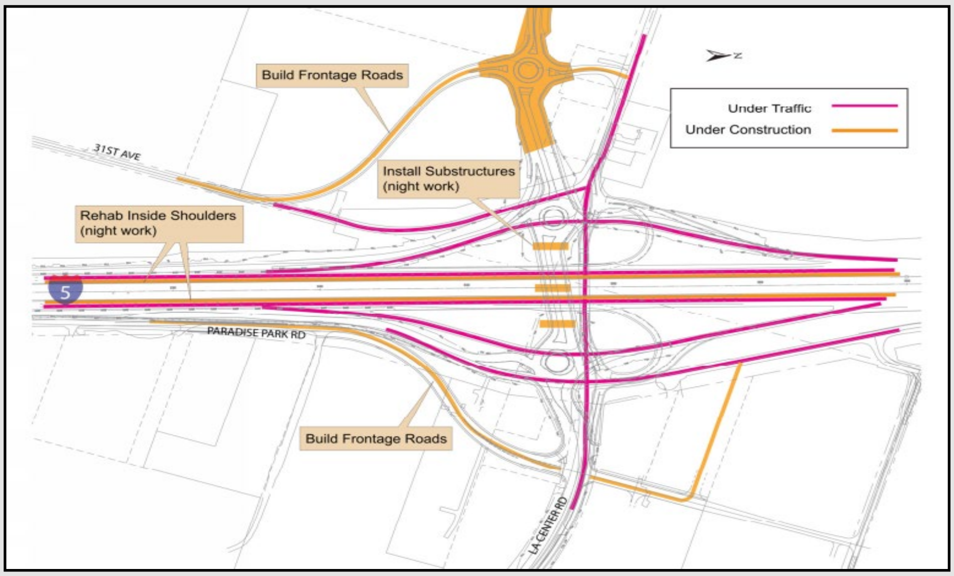

• Major construction stages:
  ○ **Phase 1:** Realign frontage roads
  ○ **Phase 2:** Construct bridge and roundabouts
  ○ **Phase 3:** Open new bridge and build tie-ins
  ○ **Phase 4:** Demolish existing bridge

Table 6-4
Example Project – Right of Way (Design)

Project Development Stage – Right of Way (Design)

• Develop strategies by considering various sub-phases within each phase to implement the identified construction phases.
• Explore various options for managing traffic to construct concrete roundabouts (Phase 2) with minimal impact to the general traveling public.
  ○ Temporarily realign on- and off-ramps while maintaining diamond interchange.
  ○ Temporarily convert diamond interchange to parclo interchange.
• Account for the timing of freeway closures for the installation of the bridge girders and when demolishing the old bridge—the interchange needs to be a diamond configuration to divert freeway traffic through ramp terminals during nighttime.
• Consider overall construction approach and explore opportunities to reduce project schedule.

Phase 1 Sub-Phase 1A - Build frontage roads and install substructures for a new bridge.



Phase 1, Sub-Phase 1B - Build temporary ramps and install new bridge girders.

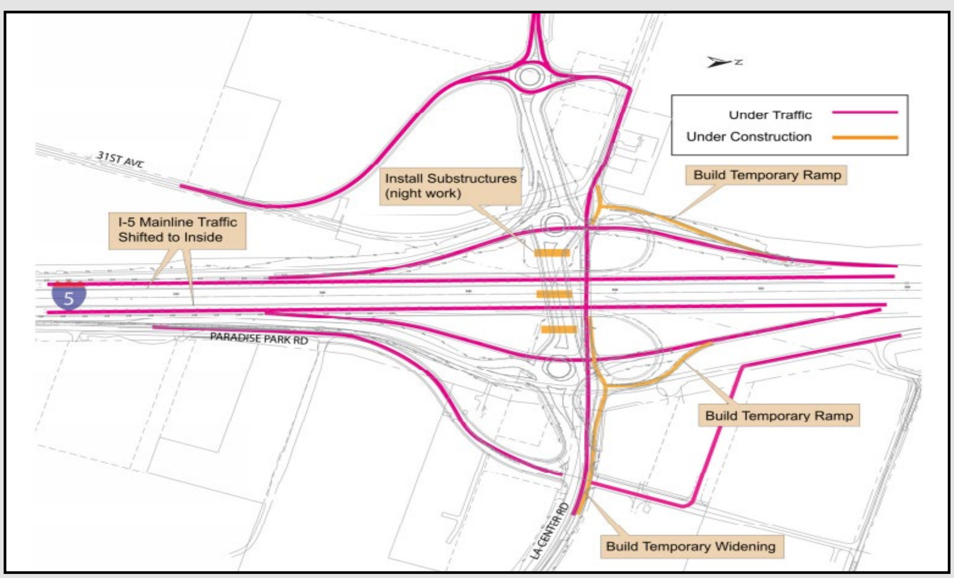
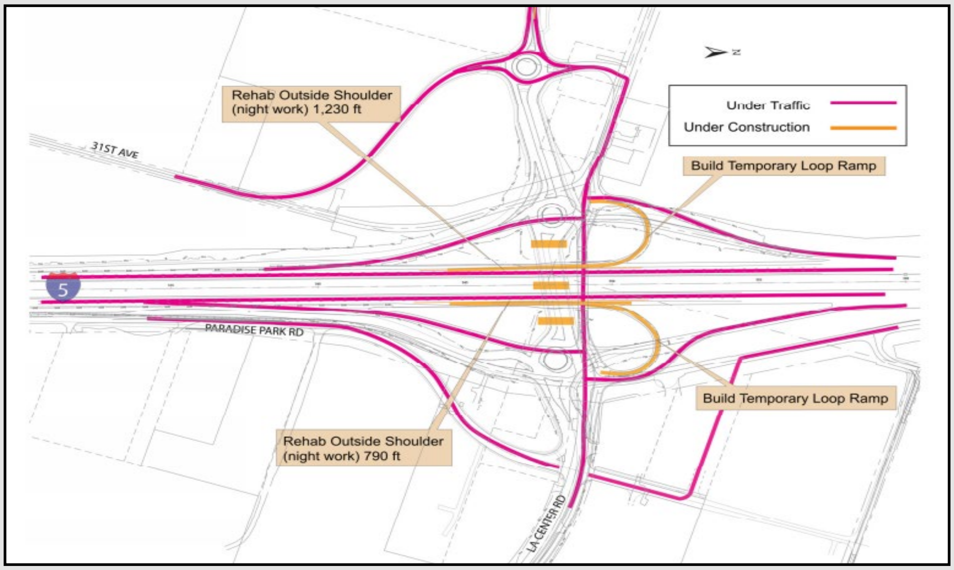


Table 6-4 *(continued)*
Example Project – Right of Way (Design)

Project Development Stage - Right-of-Way (Design)

Phase 1 Sub-Phase 1C – Shift traffic to temporary ramps and build remaining temporary ramps.



Phase 2 – Construct bridge and roundabouts.

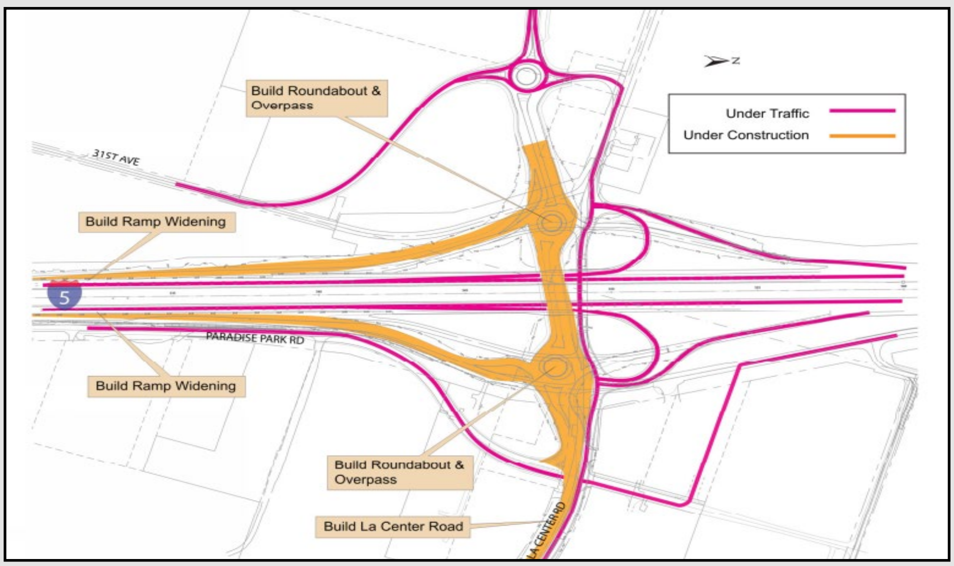
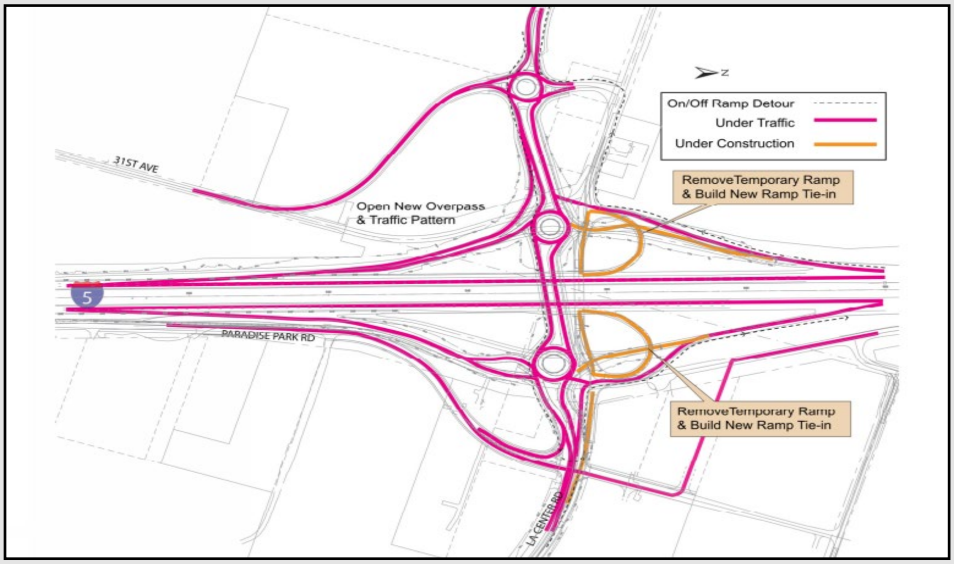


Table 6-4 ***(continued)***
Example Project – Right of Way (Design)

Project Development Stage - Right-of-Way (Design)

Phase 3 – Open new bridge and roundabouts, build tie-ins, and remove temporary ramps.



Phase 4 – Remove existing bridge and remove old/temporary roads.

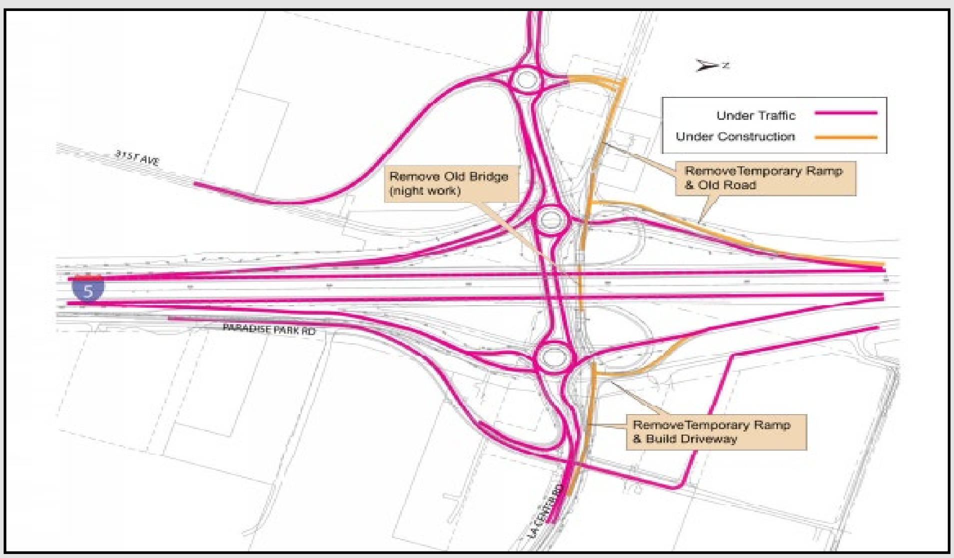


Table 6-5
Example Project – Construction (Design)

Construction (Design)
• Upon agreement of the phases and associated sub-phases, the Design Team prepared plans, specifications, and estimates (PS&E) reflecting the following: ○ advance signing ○ bicycle detour signing ○ pedestrian facilities ○ series of plans for each phase and associated sub-phase defining night and daytime activities ○ list of applicable standard traffic control plan drawings

Table 6-6
Example Project – Construction (Field)

Construction (Field)

Phase 1 Sub-Phase 1A - Build frontage roads and install substructures for a new bridge.

Phase 1 Sub-Phase 1B - Build temporary ramps and install new bridge girders.

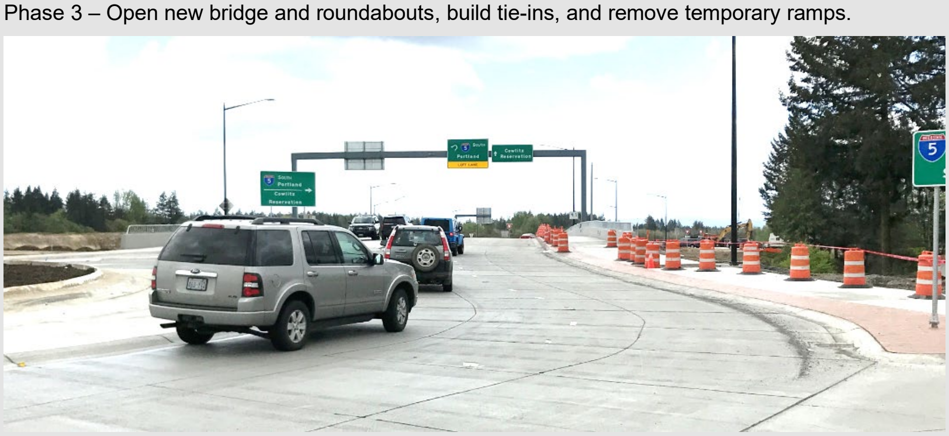
Table 6-6 *(continued)*
Example Project – Construction (Field)

Construction (Field)

Phase 1 Sub-Phase 1C – Shift traffic to temporary ramps and build remaining temporary ramps.

Phase 2 – Construct bridge and roundabouts while interchange functioned in a partial cloverleaf configuration.

Phase 3 – Open new bridge and roundabouts, build tie-ins, and remove temporary ramps.



Phase 4 – Remove existing bridge and remove old/temporary roads.

- The existing bridge was removed during night-time operations by closing the freeway and diverting lower-volume freeway traffic through ramp terminals.

6.3.1.3 Construction Phasing and Sub-Phasing

This section discusses the importance of understanding phases, sub-phases, and sequencing of the construction project, including considerations for three-dimensional elements, such as grading. Design Teams should understand how the project will potentially be built by developing a systematic approach through defining various phases and associated sub-phases, which are then captured through the project's plans, specifications, and estimate (PS&E). **Table 6-7** provides an overview of construction staging principles. **Table 6-8 through Table 6-10** provide example stages for three different project types.

Table 6-7
Construction Phasing Principles

Construction Phasing Principles
• Consider the range of potential options for maintaining traffic (full closure, partial, construct with traffic).
• Maintain current traffic conditions during construction, where feasible.
• Understand adjacent properties and stakeholder needs/input.
• Consider the potential cost savings versus short-term inconvenience.
• Consider bidding with time constraints built into the sequencing.

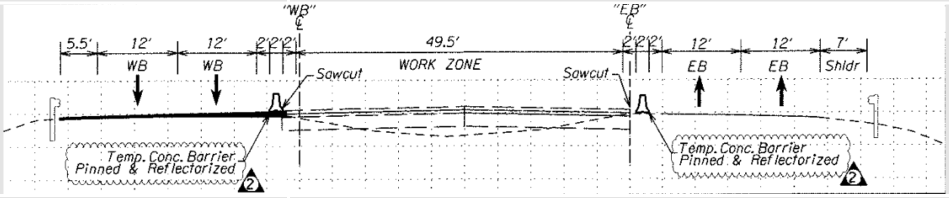
Urban Freeway Widening and Paving Project Example

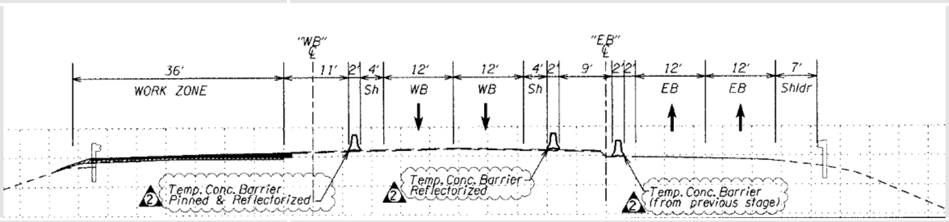
The purpose of the project was to widen US 26 in Portland, Oregon by adding one lane in each direction, from NW Cornelius Pass Road to NW 185th Avenue, making this a 6-lane cross section. In addition to the widening, the project included the replacement of the US 26 bridge structures over Rock Creek, construction of sound walls along the north side of US 26, and installation of a median barrier to prevent vehicles from crossing over the highway median.

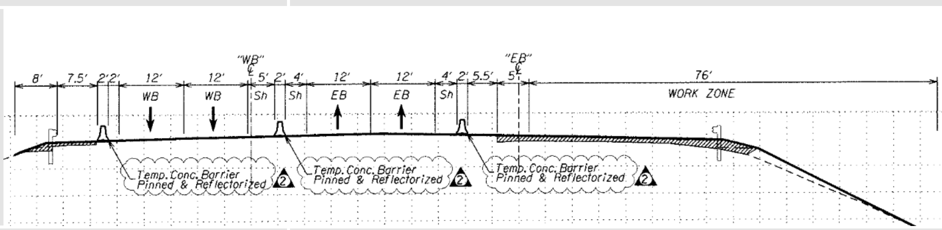
Figure 6-3
Urban Freeway Widening and Paving Example

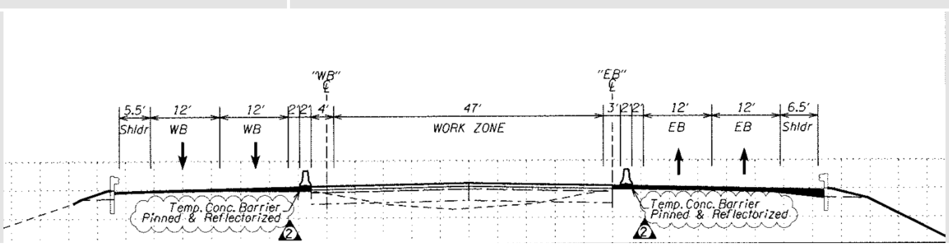
Table 6-8
Example Staging for a Freeway Paving Project

<table>
<tr><th colspan="2">Urban Freeway Widening and Paving Project Example</th></tr>
<tr><th>Construction Phase</th><th>Description of Traffic Control</th></tr>
<tr><td>Phase 1</td><td>

Widen the roadway into the median to the ultimate pavement section, excluding final wearing course in both the east- and westbound directions for the length of the proposed median crossover.
Shift traffic to the outside in both directions to accommodate temporary barrier and work zone during Phase 1.
</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td>Phase 2</td><td>

Shift westbound traffic to the median crossover and median portion of the Rock Creek bridge constructed in Phase 1. A temporary concrete barrier will be installed on both sides of westbound traffic through the median crossover area.
</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td>Phase 3</td><td>

Shift westbound traffic to a new westbound bridge and shift eastbound traffic to the median crossover and median portion of the Rock Creek bridge structure.
</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td>Phase 4</td><td>

Pavement rehabilitation will occur in the existing median shoulder, and the roadway will be widened into the median in both the east- and westbound directions for the entire project length.
Traffic will be shifted to the outside in both directions to accommodate the work zones.
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

Rural Bridge/Culvert Replacement Project Example

The improvement included widening the highway to add a new eastbound left-turn lane at the ski resort intersection and replacing two existing, 72-inch metal pipe culverts with new, 19-foot concrete box culverts at the Meadows Creek crossings of Highway 35 and Teacup Lake Road in the vicinity of Mt. Hood in Oregon. The project also included reconstructing the creek channel to improve fish passage and to address highway flooding issues. The construction phasing included one-lane, two-way operations with a temporary traffic signal to facilitate two-phase culvert construction.

Table 6-9
Example Staging for a Rural Bridge/Culvert Replacement

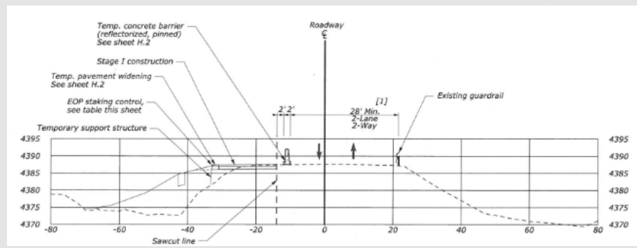
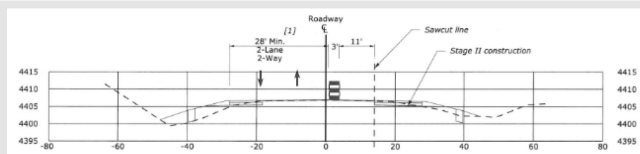
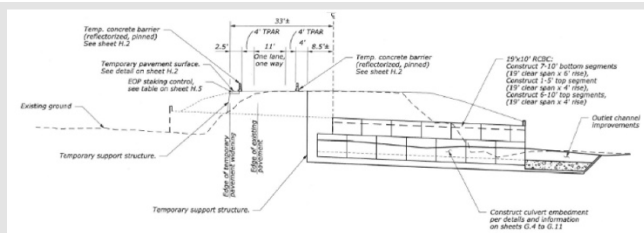
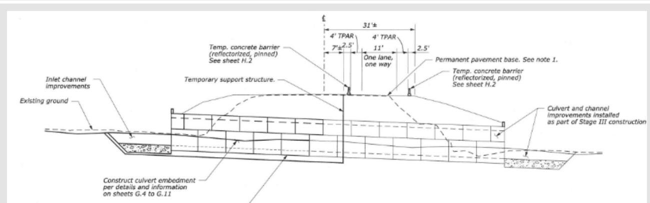
Rural Bridge/Culvert Replacement Project Example – Highway 35	
Construction Phase	**Description of Traffic Control**
Phase 1: Shift traffic to the south and construct new and temporary pavement (excluding the culvert influence area).	
Phase 2: Shift traffic to the north and construct new and temporary pavement (excluding the culvert influence area).	
Phase 3: Introduce one-lane, two-way operations with a temporary traffic signal, and shift traffic to the north; construct the southern portion of the culvert.	
Phase 3: Provide one-lane, two-way operations with a temporary traffic signal, and shift traffic to the south; construct the northern portion of the culvert.	

Figure 6-4
Rural Bridge/Culvert Replacement Example

Urban Intersection Reconstruction Project

Improvements at the existing signalized intersection in a suburban environment (Beaverton OR) include adding additional left-turn lanes on both the north and south legs on Murray Boulevard, an additional eastbound left-turn lane on Walker Road, and a northbound right-turn lane to Murray Boulevard. Improvements also include bicycle lanes and sidewalks. Fill and cut retaining walls will help minimize impacts to natural resources and adjacent properties. The bridges on Murray Boulevard and Walker Road, respectively, will be replaced to accommodate the roadway widening. The overall construction strategy for this intersection was divided into three construction sequences, with construction first along Murray Boulevard, then construction along Walker Road, and completing the intersection at the end.

Table 6-10
Example Staging for an Urban Intersection Reconstruction Project

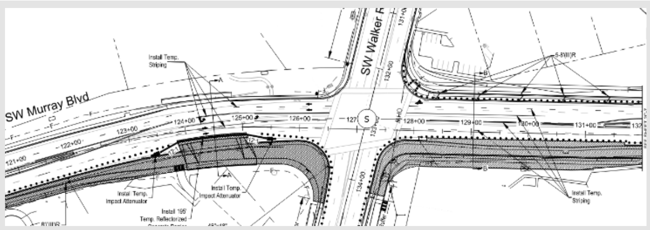
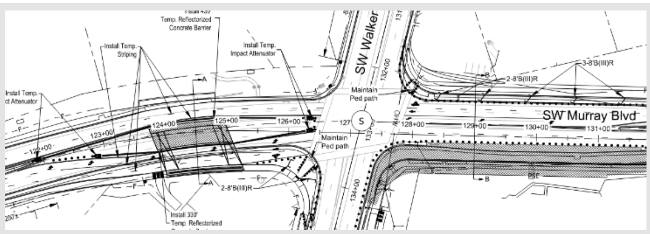
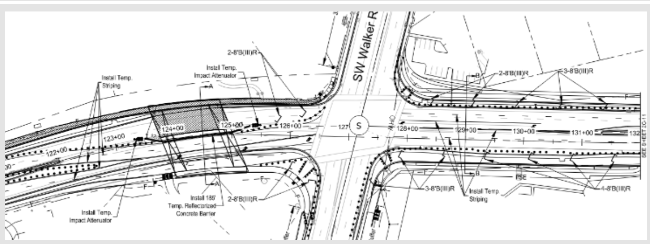
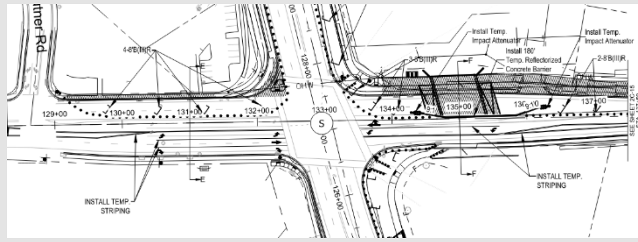
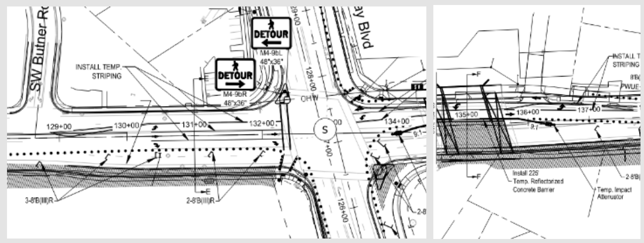
Urban Intersection Reconstruction: Along Murray Boulevard	
Construction Phase	**Description of Traffic Control**
Phase Murray (M)1: Shift traffic to the west, and widen to the east (north to the right) and construct eastern portion of new bridge	
Phase M2: Split north- and southbound traffic, continue widening to the east on far side of intersection, and construct middle portion of new bridge	
Phase M3: Shift traffic to the east, widen to the west (north to the right) and construct last and western portion of new bridge	

Table 6-10 *(continued)*
Example Staging for an Urban Intersection Reconstruction Project

Urban Intersection Reconstruction: Along Walker Rd	
Construction Phase	**Description of Traffic Control**
Phase Walker (W)1: Shift traffic to the south, widen to the north (north is up), and construct northern portion of the new bridge.	
Phase W2: Shift traffic to the north, widen to the south (north is up), and construct the southern portion of new bridge.	

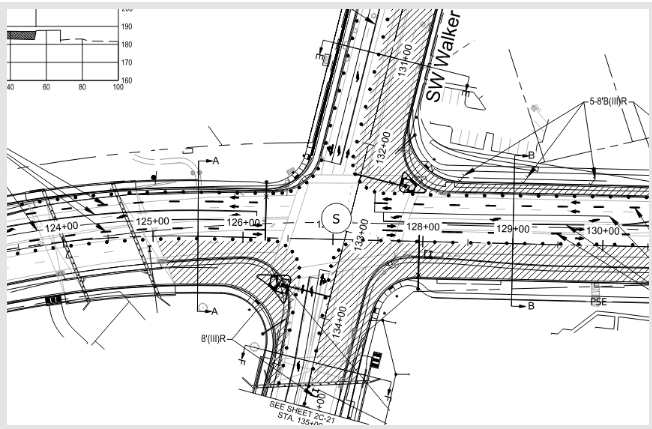
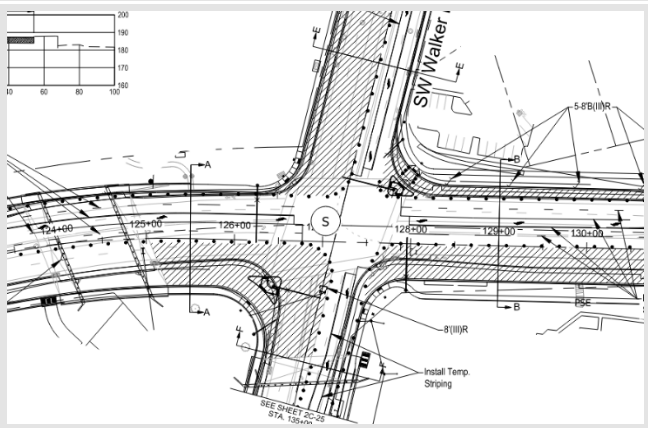
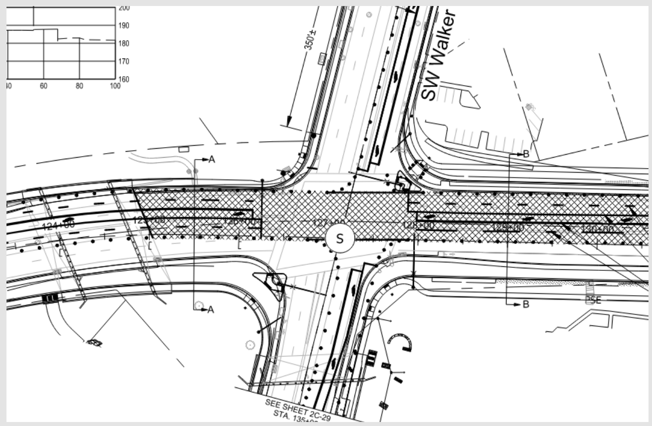
Urban Intersection Reconstruction: Intersection	
Construction Phase	**Description of Traffic Control**
Phase INTX1: Shift traffic to the north and west (north is up); complete opposite intersection corners.	
Phase INTX2: Shift traffic to the north and east (north is up); complete opposite intersection corners.	

Table 6-10 *(continued)* Example Staging for an Urban Intersection Reconstruction Project

Urban Intersection Reconstruction: Intersection	
Construction Phase	**Description of Traffic Control**
Phase INTX3: Complete intersection paving one lane at a time under flagging to raise the intersection to grade (approximately 3 feet). Nighttime construction is preferable, but due to an adjacent apartment complex, this work will need to be completed between the morning and afternoon peak hours.	

6.3.1.4 TDOT Constructability Review Process

For some selected TDOT projects, there is a separate TDOT Constructability Review Process executed by the Construction Division to assist Design Teams in assessing the constructability of projects and provide recommendations to further enhance the design quality. Projects are selected by the Construction Division during the Site Review Meeting during the Preliminary Design stage of the project, and the Construction Review takes place during the Construction (Design) stage of the project after the Traffic Control Plans have been developed and the Right-of-Way Review meeting has been held. The goal of the Constructability Review is to leverage the expertise of both the TDOT staff and outside resources in the construction industry.

Projects are selected by the Construction Division.

Construction Reviews take place during the Construction (Design) stage of the project.

Not all projects require a Constructability Review, but many can benefit. Projects that are considered for a Constructability Review include:

- projects with unusual or critical construction sequencing
- projects with critical traffic control, especially in the four major urban areas
    - Nashville
    - Knoxville
    - Chattanooga
    - Memphis
- projects where utilities may impact construction phasing and scheduled completion
- projects where retaining walls, structures, and grading are a major design component
- any project that may benefit from the experience provided by outside resources

The Constructability Review is conducted by the TDOT Constructability Review Coordinator. The Constructability Review Team consists of participants that may have a stake in the project or can provide expertise. The following is a list of potential participants:

- TDOT personnel
- Other government agencies
- Utilities
- Contractors
- Suppliers

The *TDOT Constructability Review Procedures Manual* provides additional information on this review process. *(7)*

6.3.2 Impacts to Users

Understanding and evaluating the potential impacts to users during work zone activities will help guide the Design Team in selecting a traffic control measure that meets the needs of the project and limits the inconvenience to those that typically use the roadway. This section provides an overview of the following topic areas:

- Traffic Operational and Mobility Considerations
- Detour and Diversions
- Pedestrian and Bicycle Considerations
- Driver Behavior Considerations
- Business Access Improvements and Considerations
- Utility Considerations
- Public Outreach Considerations

Some of these topics have been discussed in earlier chapters and, therefore, will primarily reference the details in other sections.

6.3.2.1 Traffic Operational and Mobility Considerations

This manual does not cover detailed Work Zone Analysis Procedures.

Chapter 2 provides information about assessing operations as part of the Transportation Management Plan.

The TDOT Traffic Operations Division and/or Region Traffic Engineer can provide support, as needed.

Design Teams should assess the level of traffic operational impacts associated with the planned work zone and construction activities and work in collaboration with the TDOT Traffic Operations Division (for significant projects) and/or Region Traffic Engineer (for regional projects) to determine the level of operational and mobility analyses if needed. Work Zone traffic operational analysis may include evaluating the following performance measures:

- Delay
- Queues
- Travel Time
- Capacity

Traffic analysis of the associated work zone impacts is completed as part of the Transportation Management Plan (TMP), as further discussed in Chapter 2. If the Design Team identifies the need for traffic operations strategies to mitigate the impacts of the work zone, this information is also included in the TMP. To assess the traffic operational impacts of the work zone, the Design Team may coordinate with the TDOT Traffic Operations Division or the Region Traffic Engineer.

Table 6-11 provides an overview of traffic operational and mobility considerations that should be assessed as part of identifying an appropriate traffic control measure.

Table 6-11
Traffic Operational and Mobility Considerations

Traffic Operational and Mobility Considerations	
Performance Measure	**Guidance**
Delay	• Traffic delays must be anticipated and addressed with appropriate work hours to reduce impacts. • The Delay Criteria Table (See **Chapter 2**) provides volume thresholds for various lane configurations for facility types. • If the delay exceeds 30 minutes, the project is considered "significant" and will require additional mitigation and documentation to address the impacts.
Queues	• The Lane Closure Decision Support System (LCDSS) provides estimated queue data for the roadway facility during the potential closure. See **Chapter 1**. • Traffic should not be allowed to back up past the advance warning signs. • Sign locations may need to be adjusted (or additional signs may need to be added) to the sequence to address backups. • The use of advance portable changeable message signs (PCMS) and other queue management techniques should be considered.
Travel Time	• Travel time is important for the traveling public, especially during the morning and afternoon commute hours. Travel time is a different form communicating delay. • Temporary changeable message signs communicating anticipated travel times will inform the traveling public of how long it may take and establish adjusted reliability and expectations based on the construction activities.
Capacity	• Removing a travel lane will reduce capacity. • Lane closures may be limited to off-peak hours to minimize delay during commute hours.

6.3.2.2 Detour and Diversions

Detours and diversions are useful components of the temporary traffic control toolbox because they help maintain the traffic around a work zone. Detours and diversions can apply to each mode of transportation: pedestrians, bicyclists, transit, cars, and trucks. Per TDOT customary practice, only TDOT facilities are typically used for designated detour routes.

Only TDOT facilities are typically used for designated detour routes.

The *MUTCD* defines a **detour** as "… a temporary rerouting of road users onto an existing highway to avoid a [temporary traffic control] zone" (*MUTCD* Section 6C.09, paragraph 01) *(3)*. Detours commonly use existing roadways that run parallel to the work zone, such as frontage roads or arterial streets parallel to a freeway. Detours increase the amount of traffic on these parallel facilities, in some cases adding significant delay and potential capacity issues at key intersections.

Similarly, the *MUTCD* defines a **diversion** as "…a temporary rerouting of road users onto a temporary highway or alignment placed around the work area" (*MUTCD* Section 6C.09, paragraph 03 *(3)*. Common types of diversions are temporary roadways, temporary bridges, or a combination of the two immediately adjacent to the work area. Diversions may have a reduced number of lanes compared to the permanent facility they are diverting; they may also operate in a one-lane, two-way reversible manner.

Table 6-12 summarizes the key distinctions between detours and diversions.

Table 6-12
General Characteristics of Detours and Diversions

Characteristic	Detour	Diversion
Facility used	Existing roadways in the transportation network that connect in a manner to bypass the work zone	Temporary roadways and/or structures within or immediately adjacent to the work zone
Typical signing needed	Detour signs showing intended route at each key junction	Temporary alignment signs
Impact area	Affects all roadways along the detour route	Typically localized to the work area

In some cases, it may be beneficial to provide a detour for selected users that may face restrictions within the work zone, rather than designating the detour for all users. These are particularly applicable to height, width, length, or weight restrictions that may be imposed by the construction activities. In addition, a detour that is significantly out-of-direction has a greater impact on pedestrians and bicyclists than it does on cars and trucks. As such, detours should be carefully weighed against the potential impact on a given mode of transportation. Depending on the nature of the work zone, it may be beneficial, for example, to divert pedestrians and bicyclists to a temporary facility near the work zone and detour some or all motor vehicles onto other facilities.

A detour is distinct from an **alternate route**, which provides additional capacity to service a primary route that may be constrained in some way. The distinction between detours and alternate routes affects the design of the temporary traffic control plan. A designated detour route must be signed using appropriate fixed temporary traffic control devices. Alternate routes, on the other hand, may or may not be designated using fixed devices. Instead, alternate routes are commonly communicated using changeable message signs, websites, and other means that can better convey the range of options and that can be modified to adapt to current conditions. This is particularly common in urban environments where multiple alternative routes may be available, each beneficial in their own way to a particular set of origins and destinations.

The TDOT Freight and Logistics Division and TDOT Permit Office can provide information about appropriate detour routes. **Table 6-13** provides guiding principles that should be used throughout the identification, evaluation, and design of detours and diversions.

Table 6-13
Detour and Diversion Guiding Principles

Detour and Diversion Guiding Principles
• Consider needs and design for all users, not just motor vehicles. o Effectively communicate advance notification for users in anticipation of the detour. o Effectively use signs, striping, and equipment in the immediate vicinity to redirect users. o Identify and manage impacts to affected users along the detour or diversion. This may involve coordinating with appropriate agencies or other groups. o Monitor and adjust detours and diversions as needed to reduce impacts and react to changing circumstances. o Only TDOT facilities are typically used for designated detour routes.

Table 6-5 and Table 6-6 provides excerpts from a TDOT detour plan.

Figure 6-5
Example Detour Map

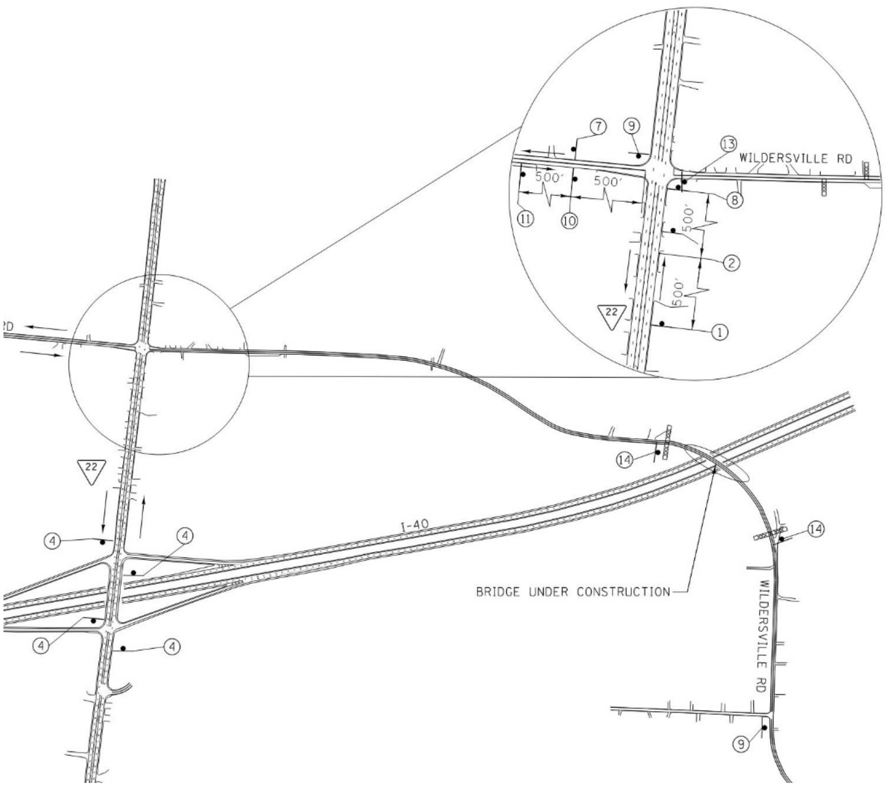
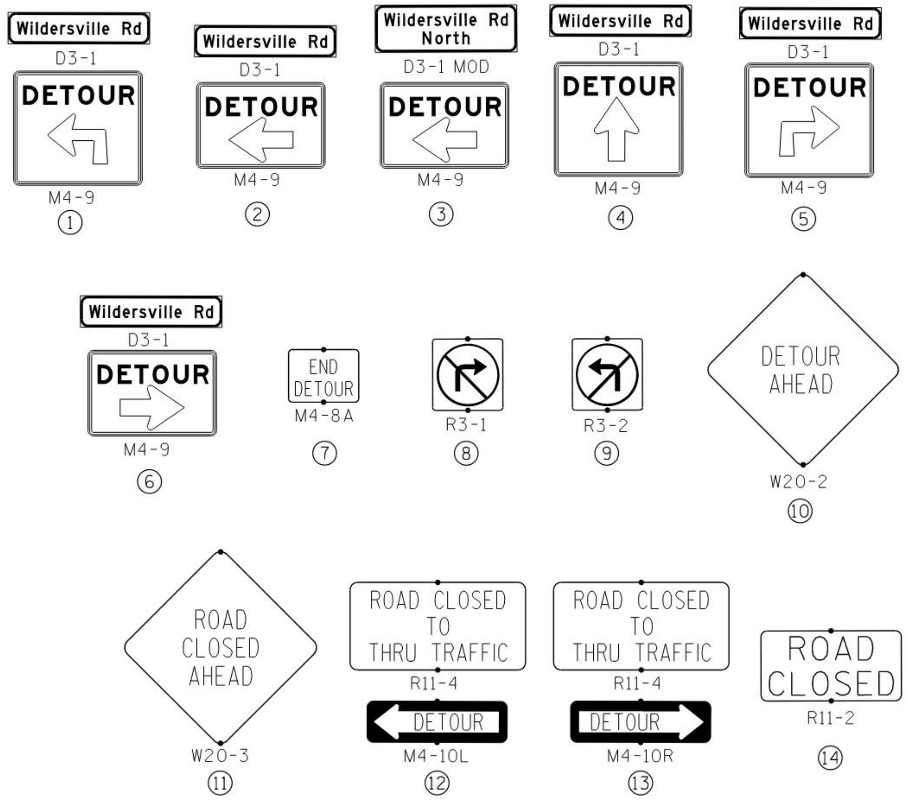


Figure 6-6
Example Detour Map Legend



Detour Design

Detours that allow for full road closures are one of the most common techniques. Benefits of full road closures include the following:

- Critical work operations with constructability or safety challenges are more easily addressed without also having on-site traffic.
- By having uninterrupted use of the entire work site, they can potentially allow the accelerated completion of a project.
- They allow construction techniques that take longer to complete, such as cast-in-place structures and concrete paving.
- They provide the safest environment for workers by removing traffic completely from the work zone.

Routes designated as detours must be able to reasonably accommodate the detoured traffic. **Table 6-14** provides an overview of design considerations.

Table 6-14
Detour Design Considerations

Detour Design Considerations

• For signalized intersections along the detour route:
  ○ Consider adjusting signal timing while the detour is in operation.
• Detours that significantly impact unsignalized intersections:
  ○ May require the use of temporary signals.
• Urban areas:
  ○ If a single roadway cannot manage the capacity of the detoured traffic, undesignated alternate routes can be offered to more evenly disperse traffic.
• Extended distance detours may inadvertently divert traffic impacting travel time and facility wear and tear on alternate routes.
• Detours must be designated using appropriate traffic control devices per *MUTCD* requirements and guidance.
  ○ Changeable message signs may be helpful in supplementing fixed signs.
• Per TDOT customary practice, only TDOT facilities are typically used for designated detour routes.
  ○ If a local jurisdiction facility is used as part of a designated detour, coordination with the local jurisdiction is required, and an intergovernmental agreement should be considered to formally establish respective roles and responsibilities.
  ○ TDOT does not control traffic signals. If signals are included in the detour route, coordination needs to occur with the local jurisdiction regarding signal timing.
• For full road or ramp closures on the Interstate highway system:
  ○ Federal Highway Administration (FHWA) requires 60-day advance notice for Interstate ramp closures lasting longer than 7 days *(6)*.
  ○ Closure of the interstate mainline may impact multiple ramps and may involve ramp closures.
• Rural Areas:
  ○ Detour routes may be very limited or may result in significant out-of-direction traffic.
  ○ Potential detour routes may not have the capacity to accommodate the detoured traffic.
  ○ Field Review discussions can help identify potential concerns with detour routes.

Additional detour information is provided in the typical applications in **Sections 6.6 through 6.10** and in the TDOT Standard Drawings *(2)*.

Diversion Design

Diversions are more localized versions of detours that remove traffic from the work area while keeping it within the general vicinity of the work zone. Examples of diversions include the following:

- lane shifts
- traffic splits or island work zones
- single-lane operation for two-way traffic using flaggers
- single-lane operation for two-way traffic using pilot cars
- single-lane operation for two-way traffic using temporary traffic signals
- median crossover, where a median paving may be required to create crossover locations

Automated Flagger Assistance Devices may be used for single-lane operations for two-way traffic.

Additional diversion information is provided in the typical applications in **Sections 6.6 through Section 6.10** and the TDOT Standard Drawings *(2)*.

Designing for Trucks and Oversized/Overweight (OSOW) Vehicles

A detour or diversion should be designed to accommodate the design vehicle. In some cases, construction constraints may require specific vehicle classes to be excluded from the work zone, such as vehicles over a certain size or weight. In these cases, the detour route should clearly identify the vehicle classes that are required to use the detour. **Table 6-15** provides design techniques for designing for trucks and OSOW vehicles.

Table 6-15
Design Techniques for Trucks and OSOW vehicles

Trucks and OSOW Design Techniques

• Establish the appropriate clear width and height for the design vehicle.
• Establish an appropriate curve radius for crossovers or turning movements, as well as superelevation where appropriate.
  ○ Smaller radii result in more off-tracking for trailers, which requires additional width.
  ○ Smaller radii produce lower vehicle speeds that must be accounted for in the traffic control device (TCD) design.
• For diversions, if lanes are separated to pass around a work zone, each route should be designed and clearly designated with the allowed dimensions.
• For speed reductions and size or weight restrictions, advance notice is essential. Techniques include, but are not limited to, rumble strips, changeable message signs, overheight vehicle detectors, and others.
• If a detour route is being used for vehicles over a certain size or weight, the detour route must be confirmed to be able to handle the detoured vehicles.
• Coordinate with the TDOT Freight and Logistics Division and TDOT Permit Office on any truck-specific diversions and detours.

Designing for Bicyclists

In many cases, a work zone requires the closure of a bicycle lane, multiuse path, or shoulder being used as a bicycle path. For the majority of TDOT projects, bicycles will continue to be served by the existing shoulder, possibly with some width reductions. In some special cases, it may be possible and appropriate for bicyclists to share a travel lane with motor vehicles based on the speed of the facility. However, through stakeholder engagement, it may be most appropriate for bicyclists to use a detour or diversion, often the same route being used for motor vehicles. As such, a temporary bicycle access route may be an integral part of the transportation management plan and traffic control plans. **Table 6-16** provides design techniques for designing for bicycles.

Table 6-16
Design Techniques for Bicycles

Bicycle Design Techniques
• Designate the diversion or detour bicycle route using traffic control devices presented in the *MUTCD*. This includes temporary signs, markings, and channelization devices. • If combining bicyclists and pedestrians into a temporary multiuse path located in the roadway, provide positive barriers between the diversion multiuse path and motor vehicles *(8).* • Avoid rumble strips within the intended path of bicyclists. These can be challenging for bicyclists to negotiate, as narrow bicycle tires can get caught in the grooves and cause the bicyclist to lose control.

Chapter 4 provides additional design guidance for pedestrians and bicycles in work zones.

Designing for Pedestrians

In many cases, a work zone requires a sidewalk closure using a multiuse path, sidewalk, or shoulder s a pedestrian path. In other cases, the work zone does not directly impact the pedestrian path but could create potential hazards, due to its proximity to the path. In either case, the pedestrians affected by the closure must be served by a detour or diversion just as any other road user. A temporary pedestrian access route should be an integral part of the transportation management plan and traffic control plans. **Table 6-17** provides design techniques for designing for pedestrians.

Table 6-17
Design Techniques for Pedestrians

Pedestrian Design Techniques
• Designate the diversion or detour walkway using traffic control devices presented in the *MUTCD*. • Provide positive barriers between a diversion walkway and motor vehicles when diverting pedestrians into the roadway *(8).* • Maintain an accessible path throughout the work zone per *MUTCD* and ADA requirements. This includes adequate width, temporary curb ramps, and detectable boundaries. • Provide signs that show which businesses are accessible along the detour or diversion route *(8).* • Provide temporary transit service for detours that are too long or out of direction.

Detour and Diversion Impact Analysis

When considering a detour or diversion, an impact analysis can quantify—or at least qualify—what effect each alternative may have on costs and benefits. Each detour or diversion alternative has costs associated with it, both in terms of costs borne by the agency and costs borne by the public. These costs should be weighed against the benefits that the detour or diversion affords to the work zone and should consider any benefits to the public, such as reduced duration of construction or limits on impacts. Because every project has different alternatives available and different potential impacts, these impact analyses are case-specific.

The following lists may help the Design Team identify the appropriate costs to consider for a given project, which may include the following:

- Construction cost of the detour or diversion, including:
    - temporary roadways
    - temporary structures
    - fixed and variable signing

    - costs of temporary treatments along the detour route to accommodate detoured vehicles, either to remove physical limitations (width, height, length, weight, etc.) or to provide additional temporary capacity
    - cost of changing temporary traffic control devices before, between, and after construction stages
    - cost of communicating traffic changes to affected property owners and the traveling public
- changes in the transportation network's operational performance or safety performance due to the increase in traffic along the detour route, including not only the detour route itself but also other facilities affected by the detour route
- impacts to properties along a designated detour route, including:
    - changes in the operational or safety performance of property access due to increased traffic along the detour route
    - increased maintenance costs along the detour route, particularly for long-term detours
- environmental impacts of detour or diversion, including:
    - water feature
    - wetland designations
    - air quality
    - noise

Changes in operational or safety performance along the detour route may require temporary mitigation, such as turning movement restrictions. An impact analysis should look at a range of feasible alternatives to determine the most appropriate mitigation.

6.3.2.3 Driver Behavior and Speed Management

Design Teams should consider driver behavior and driver expectations when designing work zones and selecting traffic control strategies. Different facility types will have different types of drivers with different types of behaviors. In addition, drivers may expect different levels of operation, performance, visual cues, and warnings in various types of project contexts. For example:

- On a freeway, drivers may expect higher speeds, wider lanes, extended sight distance, and advance warning for approaching a work zone.
- On an urban arterial, drivers may expect lower speeds, narrower lanes, access points, on-street parking, and increased presence of other roadway users (such as bicycles, pedestrians, and transit).
- On a commuter route, drivers may become so accustomed to the roadway that they do not easily recognize new roadway features and signs.

Section 6.4.2 provides information on design speed and speed zone reduction requests.

Speed management strategies must consider the land-use context, roadway type, and work zone constraints for each scenario. Geometric design elements in the work zone can often be the most effective way to manage speeds. However, modifications to the geometric design are often challenging in a temporary work zone setting. Work zones may need to rely on signage, pavement markings, and enforcement to encourage slower speeds and enforce speed limits through a work zone.

Work zone projects in rural areas should particularly focus on speed management and driver behavior considerations. Rural highways are often characterized by higher speeds, fewer turning conflicts, and minimal pedestrians *(3)*. Because crashes in high-speed rural environments often have severe consequences, additional advanced warning signs may be required to extend the warning zone in advance of the work zone.

Table 6-18 provides an overview of potential speed management techniques and treatments to encourage appropriate driver behavior through a work zone.

Table 6-18
Potential Speed Management Techniques

Category	Potential Strategy/Treatment
Signing	• portable changeable message signs (PCMSs) • fluorescent orange sheeting • advisory speed plates • innovative message signs, such as the "workers present" • arrow boards for slowing speeds before lane shifts and merges on facilities with high speeds • sign flags and flag boards to draw attention • speed feedback signs • variable speed limit signs
Pavement Markings	• reduced lane widths, potentially using tubular markers • wider longitudinal pavement markings • temporary transverse pavement markings
Enforcement	• stationary enforcement • automated speed enforcement • higher fine zones
Smart Work Zone Devices	• queue warning systems
Other Temporary Traffic Control Devices	• transverse rumble strips • flagging • flashing beacons • glare screens

Identifying and setting the appropriate speed is a contributing factor with any strategy.

Speeds should only be reduced when conditions require and the speed limit to be reset to the original (pre-construction) speed when the speed reduction is no longer needed.

6.3.2.4 Utility Considerations

All work zone design projects should identify the utility impacts and coordination needs early in the project development process. The sequence in construction staging and associated phases will likely be guided by the potential utility impacts. TDOT Standard Specifications, 105.07 Cooperation with Utilities, Railroads and Pipelines provides additional information on how to coordinate with utilities. *(5)*

Chapter 3 provides information about stakeholder outreach and public engagement.

6.3.2.5 Public Outreach Considerations

Each project has unique characteristics, and public outreach strategies should be reviewed individually based on the needs of the community stakeholders. All types of projects, large or small, can benefit from communicating with stakeholders. The TDOT Community Relations Division and TDOT Regional Community Relations Officers are equipped at supporting Design Teams in identifying and implementing the most effective approach.

Input from the Design Team and Design Manager early in the project development process supports the outreach work conducted by the TDOT Community Relations Division. The Design Team should provide necessary project information (using the Outreach Checklist (shown in Appendix B)) and begin coordination at the Preliminary Design project stage. The Design Manager and Design Team are not responsible for executing outreach activities. Based on the project information provided by the Design Team, the TDOT Community Relations Division will determine the appropriate outreach activities, lead the engagement with all stakeholders, and implement various outreach strategies.

Chapter 3 provides additional information and resources for communicating with the TDOT Community Relations Division and understanding stakeholders that may be impacted by the work zone activities.

6.3.2.6 Business Access Improvements and Considerations

Business access impacts and improvements may become important aspects of the traffic control measure selected for a project. Identifying adjacent business stakeholders and discussing access needs and requirements early in the project can help verify that the traffic control measure used for the project allows for adequate access to the surrounding businesses.

Chapter 3 provides information about stakeholder outreach and public engagement. The Design Team should work closely with the TDOT Community Relations Division and Region Traffic Engineering to obtain an understanding of the adjacent land uses and access to the various properties. Strategies for how to accommodate access during construction will be considered and discussed with the property owners.

As noted in the TDOT Standard Specifications 104.04 Maintenance of Traffic, the project should safely maintain temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, railroads, residences, garages, and farms *(5)*. The project should also provide for mowing or other vegetation removal to ensure a safe sight distance at intersections. Design Teams shall not use median crossovers on controlled access routes for construction traffic, except in areas approved by the Engineer, where traffic control devices allow for the safe movement of construction traffic.

6.4 TRAFFIC CONTROL POLICIES AND PRACTICES

This section describes key TDOT traffic control policies and practices related to selecting and implementing traffic control measures. The policies and practices must also conform to the *MUTCD (3)* as well as the American Association of State Highway Transportation Officials (AASHTO) *Roadside Design Guide (9)*. The types of policies and practices a Design Team uses helps create a consistent and streamlined solution that addresses safety and mobility needs in a work zone area.

Numerous TDOT forms can support the policies and practices used in work zone design and are associated with selecting a work zone traffic control strategy. A summary of forms that may be needed throughout various stages of the work zone design process is shown in **Table 6-19**.

Table 6-19
TDOT Forms to Support Work Zone Design

Form	*Further discussed in TDOT WZDM* Chapters
Work Zone Significance Determination Form	Chapter 1
Transportation Management Plan Form **(Including TMP cover page and supporting documentation)**	Chapter 2
Speed Reduction Request Form	Chapter 2
Outreach Checklist	Chapter 3
Work Zone Design Deviation	Chapter 6
State Highway Trooper Request Form **(Link accessed by TDOT staff only)**	Chapter 6

6.4.1 Work Zone Design Deviation Process

Designing an effective work zone requires balancing multiple constraints, including the physical constraints of the road, costs, mobility, and the safety of all users. In certain instances, specific constraints may not allow a work zone design to meet all the standard design criteria, in which case a design deviation may be considered. The work zone design deviation process verifies that all decisions have been thoughtfully and intentionally considered; it must also occur early in the planning process and provide thorough justification. To receive a design deviation, the Design Manager must complete TDOT's Work Zone Design Deviation form and request review and approval from the State Traffic Engineer and State Work Zone Engineer. The following information is required for completing TDOT's *Work Zone Design Deviation Form.* *(10)*

- proposed project and roadway details, including average daily traffic (ADT) during the construction period and posted speed limit
- identification of each of the work zone designs that do not meet minimum criteria
- a detailed explanation of geometric or other design elements that do not meet the minimum standards
- project elements that are preventing the design minimums from being met
- justification for the design deviation, including calculations, standards reference, and traffic control strategies for mitigated safety risks

The Work Zone Design Deviation form is provided at the following website *(10)*:

[Work Zone Design Deviation Form]

Appendix B provides an example of a Design Deviation form completed for a bridge project.

6.4.1.1 Implications of Stacking Minimums

In cases where design minimums are considered and design deviations may be necessary, Design Teams should limit the use of multiple minimum design dimensions, also referred to as "stacking minimums." When minimums are combined or stacked, a driver may have insufficient time to process messages and geometric features to safely navigate their vehicle. This applies to sign spacing, tapers, lane widths, and other design characteristics and details. Similarly, when minimum widths are combined, it can make interactions between different travel modes more challenging, such as when buses and bicycles arrive at the same time through the area of restricted width.

6.4.2 Design Speed and Speed Zone Reductions

Section 6.3.2 provides information about driver behavior and speed management techniques.

TDOT policy is that pre-construction posted speed shall be used as its work zone design speed.

Managing the safety and mobility of each travel mode is key to maintaining and operating safe and efficient work zones. For motor vehicles, the *MUTCD's* guidance on speed limits in work zones is to avoid reducing the speed limit as much as practical and to only do so if specified work zone conditions justify a speed limit reduction, such as in urban work zones where motorized and nonmotorized modes interact. **TDOT policy is that pre-construction posted speed shall be used as its work zone design speed**. This dictates various aspects of work zone design elements, such as placement, spacing, tapers, and curvature. The design speed should be used for the following alignments and applications unless otherwise noted:

- temporary alignment designs, such as on-site diversions or crossovers
- taper lengths for lane closures/shifts and shoulder closures
- impact attenuator selection
- temporary sign and device spacing

Reduced speed limits should be used only in the specific portions of the work zone where conditions or restrictive features are present. **Chapter 2, Section 2.5**, provides additional information about TDOT's guidance and process for making speed reduction requests.

6.4.3 Scheduling

Although the overall construction project schedules may significantly impact traffic control, work zone impacts to traffic mobility and safety may shift a traffic control schedule to operate during more limited hours. The *MUTCD* states, "Work should be scheduled in a manner that minimizes the need for lane closures or alternate routes, while still getting the work completed quickly and the lanes or roadway open to traffic as soon as possible." Design Teams must balance project elements, including scheduling to make sure the overall benefits outweigh the costs.

TDOT Standard Specifications provide scheduling considerations for state holidays, including timeframes when activities are permitted. Specifically, Special Provision 108b is prepared by the TDOT Headquarters Construction Division to specify additional details regarding the project's completion and liquidated damages. This may include specific timeframes for allowable lane closures on the roadways under construction. In addition, this special provision outlines potential penalties for any closures that extend beyond the allowable time periods *(5).*

Coordinate Special Provisions with TDOT Headquarters Construction Division regarding scheduling.

The Design Team will lay out the project sequencing, and the Contractor will be involved with scheduling.

In addition, TDOT specifications include information about creating schedules and identifying critical path items. Design Teams should:

- Define and sequence activities to meet the scope of work, phasing, accommodations for traffic, and interim/milestone/project completion dates.
- Use working days to create the schedule, beginning with the date of the Notice to Proceed.
- Verify that the schedule identifies and includes:
    - planned start and completion dates for each activity
    - duration of each activity
    - finish-to-start relationships among activities
    - interim, milestone, and project completion dates specified in the contract
    - the critical or longest path identifying the controlling activities of the work
    - activities related to the procurement of materials, equipment, and articles of special manufacture
    - activities related to the submission of working drawings, plans, and other data specified for review or approval by the construction inspector
    - activities related to department inspections and approvals
    - specified activities performed by the department
    - subcontractors, suppliers, and third parties such as utilities and railroads
- Update the schedule every month to show current progress; do so more frequently if warranted.
- Identify schedule revisions and coordinate with the Design Team to verify the schedule impacts and need for coordination and communication.

With roadways operating near, at, or even beyond capacity, the most common reason for shifting work hours away from peak periods is congestion. Any additional delays due to work zones would be detrimental to mobility and can increase the risk to workers. Working at non-typical times not only reduces congestion and delay but can also increase productivity. Typical work zone schedule exceptions to working typical weekday hours may include weekend work; work hour restrictions for peak travel hours, including holidays or special events; and nighttime work. This also may include restrictions for specific areas, including heavy tourist areas.

Nighttime work is one of the most common alternatives. However, it requires additional planning near residential areas where construction noise should be evaluated. Flagging is discouraged at night. **Table 6-20** describes traffic control plan considerations for nighttime work.

Table 6-20
Nighttime Work Considerations

Nighttime Work Zone Challenges	Considerations and Guidance
• Lower visibility creates: ○ increased vehicle incidences ○ higher safety risks to workers ○ higher costs	• Correctly place traffic control devices and signs that will optimize reflection at night. • Provide illuminating traffic control devices or signs that can easily be read at night. • Provide a well-lit work zone for drivers to maneuver and for workers (Refer to the ATSSA *Nighttime Lighting Guidelines for Work Zones*) *(11).* • Proper lighting should also be considered in conjunction with Positive Protection Barriers (see next section) for the safety of workers.

6.4.4 Positive Protection Devices

Positive protection devices can offer the highest potential for increased safety in work zone situations that place workers at increased risk from motorized traffic, such as:

- work zones that provide workers no escape from motorized traffic (tunnels, bridges, etc.)
- work zones with durations of 2 weeks or longer
- operating speeds of 45 mph or greater
- work operations that place workers close to travel lanes open to traffic
- work zones with roadside hazards, such as drop-offs or unfinished bridge decks, that will remain in place overnight or longer

Chapter 5 provides additional information on devices.

The need for longitudinal traffic barriers or other positive protection devices is to be determined on a case-by-case basis. Refer to **Chapter 5** for additional information about an array of positive protection devices. **Table 6-21** focuses on the most commonly used positive protection devices.

Table 6-21
Positive Protection Devices

Device	Purpose	Other Considerations
Temporary Concrete Barrier	For long-duration activities, where workspace is limited and either worker/traffic exposures or road user/work area hazard exposures are present regularly	• Adequate space is required for barrier deflection, or the barrier needs to be pinned to the pavement surface. • Adequate space is needed for equipment to install/move/remove the barrier. • Barrier must be placed on rigid pavement surface (AC, PCC) to remain crashworthy. • Adequate Contractor ingress/egress points are necessary at barrier ends or mid-run. • All exposed ends must be treated with some manner of impact attenuation or protection.
Temporary Steel Barrier	Similar applications to temporary concrete barrier	• To minimize the deflection of steel barrier, it must be secured to the pavement per manufacturer installation instructions • Low transportation costs. • High length/hour installation rates. • Durability. • Ease of on-site portability. • Low weight/ deadload for bridge applications
Truck-Mounted and Trailer-Mounted Impact Attenuators (TMA)	For mobile operations, short duration and stationary activities for less than three days	• TMAs require an adequate roll-ahead distance to keep the workers or workspace in front of it safe in the event the TMA is struck. • Intrusion into the workspace in front of the TMA should also be considered for high-speed work areas where the TMA spacing may be greater.

6.4.5 Flagging

Flagging at night is not recommended.

Flaggers control the flow of traffic in and around a work zone by stopping traffic, directing stopped traffic to proceed, or alerting traffic to slow down. They can stop traffic to allow construction vehicles to move in and out of the roadway, or they may be used to slow road users down immediately adjacent to active construction. Flaggers may also be used in intersections to control traffic flow in opposing directions; each flagger must only be responsible for one approach and one lane of traffic at a time.

The *Field Manual* notes that only a licensed uniformed law enforcement officer may override a fully operating traffic control signal system *(1)*. Refer to Section 6.4.8 for additional information about uniformed law enforcement guidance.

When traffic signals are set to flash red for all approaches or are turned off and replaced with temporary STOP signs, the intersection may be treated as an unsignalized intersection. A flagging operation within an unsignalized intersection may override STOP and YIELD signs in the intersection. For nighttime flagging, flaggers shall wear retroreflective pants and vests, shirts, or jackets as well as gaiters. Reflective channelizing devices shall be used, and flagger stations shall be well illuminated, except in emergencies. However, TDOT discourages flagging at night.

Automated Flagging Assistance Devices (AFADs) are remotely operated devices that help flaggers direct and control traffic without being in the vicinity of the roadway. **Chapter 5** provides additional information about this device.

Table 6-22 provides a list of typical applications for using flaggers in works zones, including assisting devices. **Figure 6-7** illustrates an example flagging situation for a TDOT project. Refer to the *Field Manual* for more information about flagging.

Table 6-22 Flagging Types and Considerations

Flagger Type	Purpose	Guidance and Considerations
Two Flaggers	Two flaggers are used to control two-way, one-lane sections of a roadway. A flagger should only be responsible for one lane of traffic at a time.	• Lines of communication must be established, and flaggers must be able to see each other or have two-way radios. • A lead flagger should be designated to coordinate activities. • Flaggers should not be used in high-speed areas, such as freeway projects.
One Flagger with AFAD	An AFAD is a remotely operated device that helps an individual flagger direct and control traffic.	• AFADs should only be considered where one lane of approaching traffic needs to be controlled • An AFAD enhances flagger safety by allowing flaggers to stay a safe distance away from the roadway. • AFAD's should be used within a ¼ mile of each other. • One flagger operating two AFADS must be able to see both devices.
Flagging with a Pilot Car	For extended work zones, a pilot car guides a platoon of road users through a two-way, one-lane work zone. Pilot car operating speeds should be limited to 25-35 mph.	• Pilot car operations should be considered for longer work areas. • Pilot cars should be considered if traffic control measures need to be implemented more than a ¼-mile away from the active work area. • Two flaggers may also be used in conjunction with a pilot car. • With extended work zones, traffic should be held for a maximum of 20 minutes at each end.
Advanced Flagger	An advanced flagger notifies road users of an upcoming situation.	• If sight distance is limited, the advance flagger should stop and inform individual road users of the reason and approximate length of delay.

Figure 6-7
Example Flagging

6.4.6 Traffic Control Within the Traveled Way

Within the traveled way, Design Teams will focus on the traffic control for travel lanes and shoulders. This will include standard practices for the following items:

- Portable Changeable Message Signs (PCMS)
- Horizontal and Vertical Design
- Rumble Strips
- Temporary Alignments

6.4.6.1 Portable Changeable Message Signs

Portable Changeable Message Signs (PCMS) are commonly used in work zones to communicate real-time information to drivers or provide additional attention to hazards that cannot otherwise be addressed through static signage. The effective and safe use of PCMS will depend on a variety of factors, including the type of situation a message describes, the geometry of a roadway, and the work zone design speed. Although the conditions of the work zone environment determine the resulting message, it is equally important to convey meaningful messages to motorists within a short period of time.

Table 6-23 provides guidance on methods to maximize the effectiveness of PCMS messaging *(12)*. Refer to the *Field Manual* for abbreviations that shall be used only on PCMSs *(1)*.

Table 6-23
PCMS Guidance

Factors	Description and Considerations	Guidance
Message Content	• The message should describe the problem, its location, and potential actions drivers can take to avoid or reduce the problem. • A unit of information is a “single answer to a single question that a driver can use to make a decision” per Section 2L.05 of the MUTCD	• Include three essential units of information: • What are the conditions and hazards ahead? • Where is the issue located? • What action should be taken?
Amount of Information	• Number of phrases (or units of information) in a message	• Maximum of four units of information
Message Length	• Number of words and phrases • Avoid generic messages. Generic messages are considered less informative and may be applied across many different scenarios, which often means they do not provide much value to drivers.	• Maximum of two phrases • Maximum of three lines (8 characters each) per phase
Character Size	• Height, width, and stroke width of characters	• Speed $\geq$ 45 mph = 18 inch height minimum • Speed <45 mph = 12 inch height minimum
Message Phrasing	• Order and arrangement of phrases	• One unit of information per line • Each phrase must be understood alone and should appear for at least 2 seconds • Entire message should be understood beginning from any phrase
Required Reading Time	• The amount of time a driver must look away to read a sign. The more times a driver must look away from the road to read the sign, the more safety is compromised.	• Drivers should be able to read the entire message twice

6.4.6.2 Horizontal and Vertical Design Policy

Work zones must provide sufficient horizontal roadway widths and vertical clearances to allow all road users to travel through a roadway safely. TDOT allows a minimum of 11-foot lanes with 2-foot shoulders. Horizontal widths less than the minimums require a Work Zone Design Deviation. Any minimums that are not met may result in oversized vehicle impacts requiring additional signing and coordination with the TDOT Freight & Logistics Division and TDOT Permitting Office. Early and consistent communication with this Division and Office will allow oversized vehicles to make adjustments to their routes or schedules.

The following design standards should apply for temporary vertical clearance measures:

- The TDOT Freight & Logistics Division and TDOT Permitting Office should be notified of any temporary vertical clearance changes such as pavement overlays or installation of falsework.
- Additional traffic control measures should be maintained to warn road users if the minimum 16 feet, 6 inches vertical clearance cannot be met. The use of PCMS may be used to display height restriction information and directions. The use of temporary low clearance signs must be included.

6.4.6.3 Rumble Strips

Rumble strips are effective ways to get a driver's attention and may impact work zones in several ways. Longitudinal rumble strips located along the shoulder or median help alert drowsy drivers or drivers leaving the roadway. However, these may confuse motorists if a temporary roadway alignment lies on top of or crosses the permanent rumble strips. This is also a critical safety issue for bicyclists who may be temporarily aligned with or shifted across a permanent rumble strip. In these cases, the rumble strips should be filled, ground, or milled during work zone operations.

Transverse rumble strips provide tactile and audible warning measures to alert drivers to unexpected changes in alignment, surfaces, or traffic control. Typically, the duration of a work zone determines which type of transverse rumble strips are used. The three different types of transverse rumble strips and applications are shown in **Table 6-24**. The TDOT Qualified Products List has additional information about rumble strips.

Table 6-24
Types of Rumble Strips

Type of Rumble Strips	Description	Guidance/Considerations
Raised Transverse Rumble Strip	Pavement marking strips used on wearing courses only	• Typically used for long durations work zone operations
Milled (Ground-in) Transverse Rumble Strips	Strips are grinded/ground into the pavement	• Typically used for long durations on base courses when a wearing course has not been paved • Not to be used on wearing course due to the damage to the pavement
Portable Transverse Rumble Strips	Rumble strips that can be temporarily placed	• Typically used for short-term or intermediate durations from 1 hour to 3 days • Portable rumble strips should be picked up at the end of each shift • Should be monitored regularly for possible shifting of devices

Source: Work Zone Safety.org *(12)*

Portable transverse rumble strips are typically used for short-term or intermediate durations.

This type of rumble strip should be picked up at the end of each shift and should be monitored regularly for possible shifting of devices.

6.4.6.4 Temporary Alignments

Temporary roadways or channelization may be necessary to divert traffic during construction phasing and should be designed based on an engineered alignment. The following design elements should be considered in developing a temporary roadway:

- The pre-construction posted speed should be used as the design speed to determine the radii for all non-freeway temporary alignments.
- Spirals may be necessary if the alignment departs from or returns to a curvilinear segment of the roadway.
- Roadway shoulder widths should match if possible; 4 feet is recommended for freeway crossover shoulder widths, and 2 feet is the minimum for temporary freeway alignments.
- Channelizing devices and pavement markings should be used where appropriate.
- Permanent geometric design criteria should be used.
- Existing signing may need to be covered with the use of new construction warning signs.

See **Chapter 6, Section 6.6 through 6.10** for more information about temporary alignments, crossovers, and on-site diversions.

6.4.7 Traffic Control Off the Traveled Way

The area off the traveled way includes design elements such as clear zones and abrupt edges and dropoffs. Specific TDOT guidance and standard practices for these design elements are provided in the following sections.

6.4.7.1 Clear Zones in the Work Zone

The work zone clear zone is the unobstructed, relatively flat area impacted by construction that extends outward from the edge of the traveled way. The width of the clear zone depends on traffic volumes, speeds, and roadside geometry. The amount of available clear zone in a work zone affects the decision to delineate or shield exposed hazards, such as portable concrete barrier ends, fixed objects, steep slopes, or dropoffs *(9)*.

When roadside space is available, the width of commonly used work zone clear zones ranges from 12 to 18 feet. When the location of construction equipment and material storage can be controlled, clear zones should be subject to greater widths, such as 30 feet. Generally, for ease of application of the clear zone in work zones, no adjustment is made for horizontal curves. **Table 6-25** provides guidance for clear zone widths for work zones *(9)*.

Table 6-25
Clear Zone Widths for Work Zones

Speed (mph)	Width (ft)[1]
60 or greater	30
45-55	20
40	15
35 or less	10

[1]Urban areas may have reduced clear zone distances.

Source: AASHTO *Roadside Design Guide (9)*

If the minimum clear zone width cannot be provided due to project and site constraints, the Design Team should consider adding a barrier located 2 feet from the travel lane with a traffic impact attenuator (TIA) on the leading end or ends.

6.4.7.2 Abrupt Edges and Drop-offs

Abrupt edges occur when a variety of highway construction activities result in varying elevations of roadway surface across a cross section. The potential hazards associated with abrupt edges depend on several factors, including depth of the dropoff, the shape of the pavement edge, distance from traveled way, vehicle speed, traffic mix, and traffic volume. Traffic control plans should provide a protection method, including using temporary barriers when necessary. Depending on the type of abrupt edge, warning signs or traffic control devices may be used to guide traffic. Abrupt edges also pose a particular risk to motorcyclists, bicyclists, and pedestrians; therefore, the adequate signing must be provided to warn these users. TDOT's dropoff policy and notes are provided in the *Roadway Design Guidelines* Chapter 9 Section 5 *(6).*

6.4.8 Uniformed Law Enforcement Support

Uniformed law enforcement may be used in the work zone to support compliance with traffic control measures and devices. They can also help reduce speeds within the work zone. The need for uniformed law enforcement is greatest on projects with high traffic speeds and volumes as well as where the work zone is expected to result in substantial disruption to or changes in normal traffic flow patterns. TDOT Standard Specifications provide additional information on uniformed law enforcement. Examples of when to include uniformed law enforcement include:

- when a new phase of traffic control must be implemented to provide brief stoppage of traffic to allow Contractors to re-align traffic control devices, erect new signs, apply new pavement markings, and/or prepare the highway for traffic
- areas where excessive speeding or crashes are common
- high-speed roadways to position law enforcement in advance of traffic queues to alert approaching motorists of stopped traffic
- in areas that require mitigating safety and congestion impacts by improving the driver behavior and alertness of the work zone

Design Teams should examine conditions on a per-project basis to determine the need for or potential benefit of uniformed law enforcement. Project factors and characteristics used to determine need may include, but are not limited to:

- project scope and duration
- anticipated traffic speeds through the work zone
- anticipated traffic volume
- vehicle mix
- type of work (as related to worker exposure and crash risks)
- distance between traffic and workers/extent of worker exposure

- escape paths available for workers to avoid a vehicle intrusion into the work space;
- time of day (e.g., night work)
- work area restrictions (including impact on worker exposure)
- consequences from/to road users resulting from roadway departure
- potential hazard to workers and road users presented by the device itself and during device placement and removal; 12)
- geometrics that may increase crash risks (e.g., poor sight distance, sharp curves)
- access to/from work space
- roadway classification
- impacts on project cost and duration

6.4.8.1 Coordination with Uniformed Law Enforcement

When enforcement is planned for a work zone project, coordination with uniformed law enforcement is essential to collectively determine the need, extent, and type of police enforcement to be used. Uniformed law enforcement personnel must be invited to pertinent project meetings to discuss how uniformed law enforcement will be used and to coordinate locations within the project for enforcement. During construction, coordination with uniformed law enforcement occurs on a weekly, if not daily basis, including finding the safest locations for placement of uniformed law enforcement within the work zone that also maintain a visual presence to the public.

While Law Enforcement presence is often desired on projects, in certain scenarios their presence is required for the work to be performed. For example, when traffic control is required within a signalized intersection while the traffic signals are in normal operation, a Law Enforcement officer is required (TCA 55-8-109). Additionally, TDOT requires LEOs during any rolling roadblock operation per the T-WZ-61 Standard Drawing.

The Designer shall not include any item for uniformed police officers in the estimated quantities for the project unless directed by the Regional Operations Office. The use of uniform law enforcement officers for traffic control will be determined by the Regional Operations Office or the Regional Safety Coordinator at the Construction Field Review.

To request a Tennessee Highway Patrol (THP) Trooper in a work zone, a Project Supervisor is required to complete the State Trooper Request Form and submit the information to the Regional Safety Coordinator or Regional Operations Engineer. This person will make the request to the THP Sergeant, who will then schedule each THP Trooper. The date, time, location, and type of work on the TDOT project must be conveyed to the Sergeant. All requests to provide the THP should be received at least 48 hours in advance of the requested time of service. It is the responsibility of the on-site TDOT Inspector to meet with the officer upon arrival to obtain information for documenting the officer's work hours and for providing the officer with information regarding the work to be performed.

When the THP is scheduled to work and the work is canceled, or the schedule is changed, the contractor is responsible for notifying the THP and the

Project Engineer at least 2 hours before the scheduled time of work. The Design Manager should immediately notify the Regional Safety Coordinator or Regional Operations Engineer.

When THP Troopers are not available, or the Regional Safety Coordinator or Regional Operations Engineer determines that the project would benefit from the use of County or Municipal Police, a Uniformed Police Officer is available through the use of the Non-Bid Item 712-08.01.

Information about payment for THP and Uniformed Police Officers is included in the TDOT Standard Specifications.

6.4.8.2 Types of Uniformed Law Enforcement

Uniformed law enforcement can increase driver awareness, provide more efficient traffic control, and prevent or mitigate incidents. The FHWA *Guidelines on Use of Law Enforcement in Work Zones (13)* outlines how to use law enforcement in work zones. Whether actively pursuing traffic violators or simply providing police presence, uniformed law enforcement typically enhances safe and effective mobility in work zones. In other instances, uniformed law enforcement may temporarily direct traffic at intersections or assist with emergency vehicle incidents. The following techniques may be used:

- Stationary enforcement is among the more commonly used strategies for the deployment of uniformed law enforcement personnel and has been shown to reduce the average freeway speeds by 5 to 7 mph within a mile downstream of an enforcement vehicle and officer *(13).* Three methods of stationary enforcement include:
    - The "pack" enforcement uses two police enforcement officers to tag team identifying traffic law violators. The first uniformed law enforcement officer identifies speeders using speed measuring devices and communicates with the downstream officer, who is then able to pursue said violator.
    - The traffic queue warning method places a uniformed law enforcement vehicle with flashing lights approximately 1/4 -mile before the work zone to gain approaching motorists' attention. Officers or vehicles positioned near the work activity may be sufficient to reduce speeds and calm traffic.
    - The traffic calming method positions officers outside their vehicles near the work zone. Instead of performing traffic control duties, officers intend to calm traffic using eye contact and hand signals. Federal regulation requires officers positioned outside of their vehicles to wear high visibility vests.
- Circulating traffic patrols continuously move through a work zone. Circulating enforcement patrols can take active enforcement roles by ticketing traffic violators, or they may take a traffic calming role by simply being a circulating presence in a work zone. This method tends to reduce the average traveling speed by 2 to 4 mph *(13).*

Tennessee law allows for semi-automated speed enforcement that uses speed enforcement technology to electronically identify vehicles violating the speed limit in work zones. This technology records information pertaining to the speeding vehicle and issues a citation through the mail.

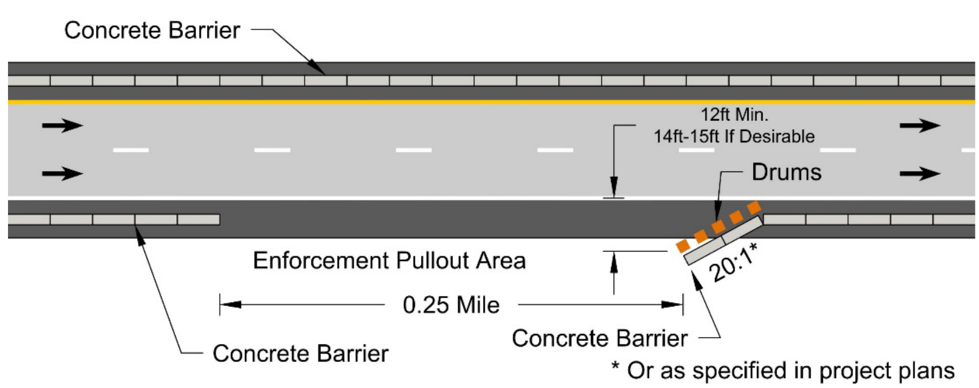
6.4.8.3 Design Consideration for Uniformed Law Enforcement

When deciding to include uniformed law enforcement in the work zone, Design Teams should consider the following:

- establishing realistic design speeds and speed limits
- limiting the length of shoulder closures
- identifying the need for enforcement pullout areas, considering the work zone components and sight distance
- determining speed management alternatives and supplements to enforcement
- conducting public awareness efforts regarding work zone enforcement
- providing motorist notification efforts regarding work zone enforcement.

Figure 6-8 illustrates an example of an adequately designed uniformed law enforcement pullout. While prioritized for law enforcement vehicles, motorists may use pullout areas if shoulder closures are greater than 3 miles long. Please note that **Figure 6-8** is provided for consideration only, and each project should be assessed for specific needs.

Figure 6-8
Law Enforcement Pullout Area



6.5 TRAFFIC CONTROL PLAN DESIGN MEASURES

Traffic control plan design measures are strategies within a staged construction activity that uses traffic control devices to optimize the safety and movement of roadway users through and around the work zone area. The type of measures and devices used depends on the type and complexity of the project. Measures may range from one or more simple devices to complex systems of devices, including work zone personnel and smart work zone devices.

MUTCD Section 6G categorizes traffic control applications by work duration, work location, work type, and highway type. MUTCD Section 6G.02 notes the following categories of work duration:

- **Long-term stationary:** work that occupies a location for more than 3 days.
- **Intermediate-term stationary:** work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more than 1 hour.
- **Short-term stationary:** daytime work that occupies a location for more than 1 hour within a single daylight period.
- **Short duration:** work that occupies a location up to 1 hour.
- **Mobile:** work that moves intermittently or continuously.

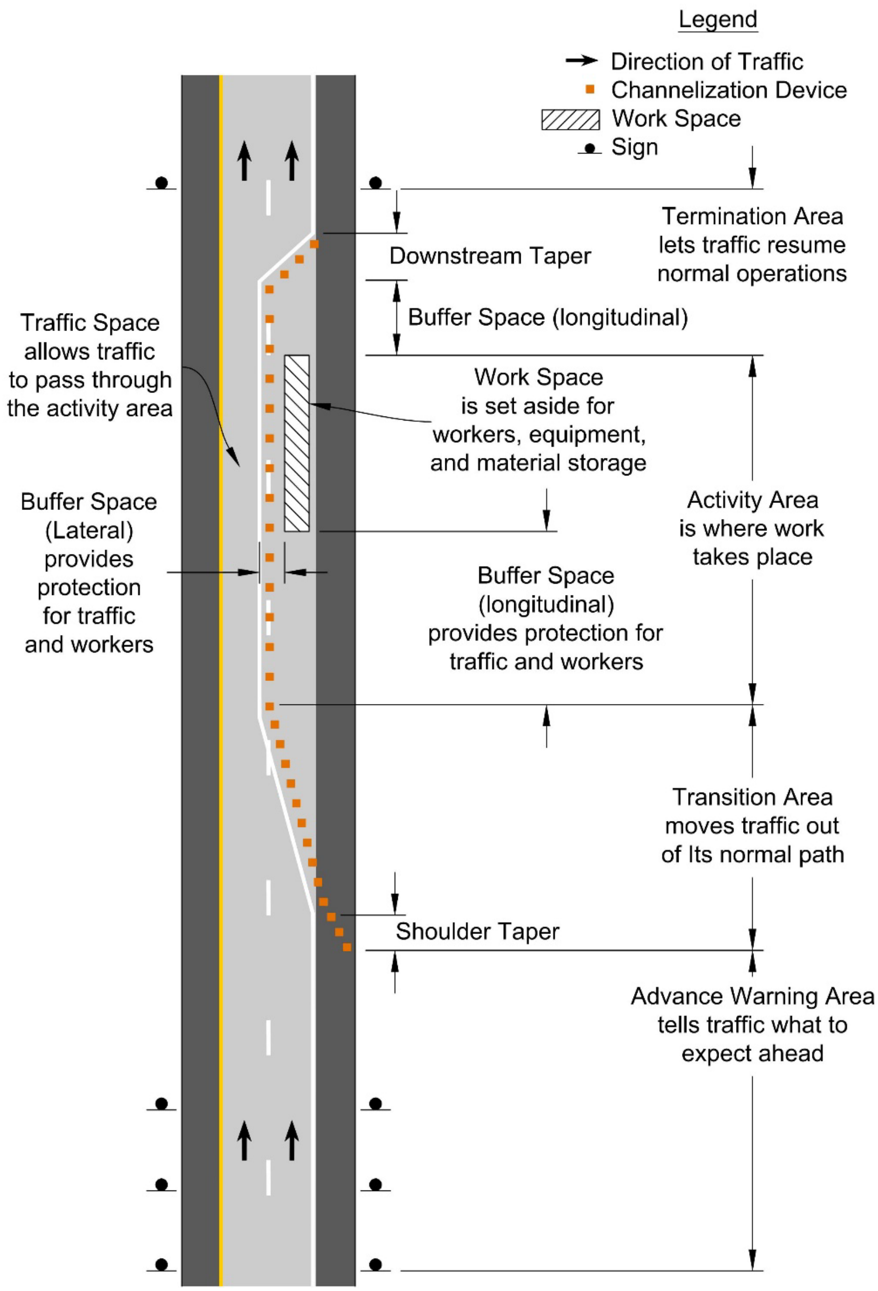
Similarly, *MUTCD* Section 6G.03 notes the following categories for the location of work:

- outside the shoulder
- on the shoulder with no encroachment
- on the shoulder with minor encroachment
- within the median.
- within the traveled way

6.5.1 Work Zone Components

The work zone can be divided into a number of zones longitudinally and laterally. When evaluating the potential traffic control measures to apply, the Design Team needs to understand each of the work zone components and types of tapers. **Chapter 2, Section 2.1.2**, provides tables and figures describing the areas within the work zone layout and cross-sectional spaces within the activity area as well as the range of tapers used in the work zone. For additional reference, **Figure 6-9** illustrates the four areas for a typical work zone design, and **Figure 6-10** illustrates the location of the tapers within a typical work zone design example.

Figure 6-9
Work Zone Areas and Components



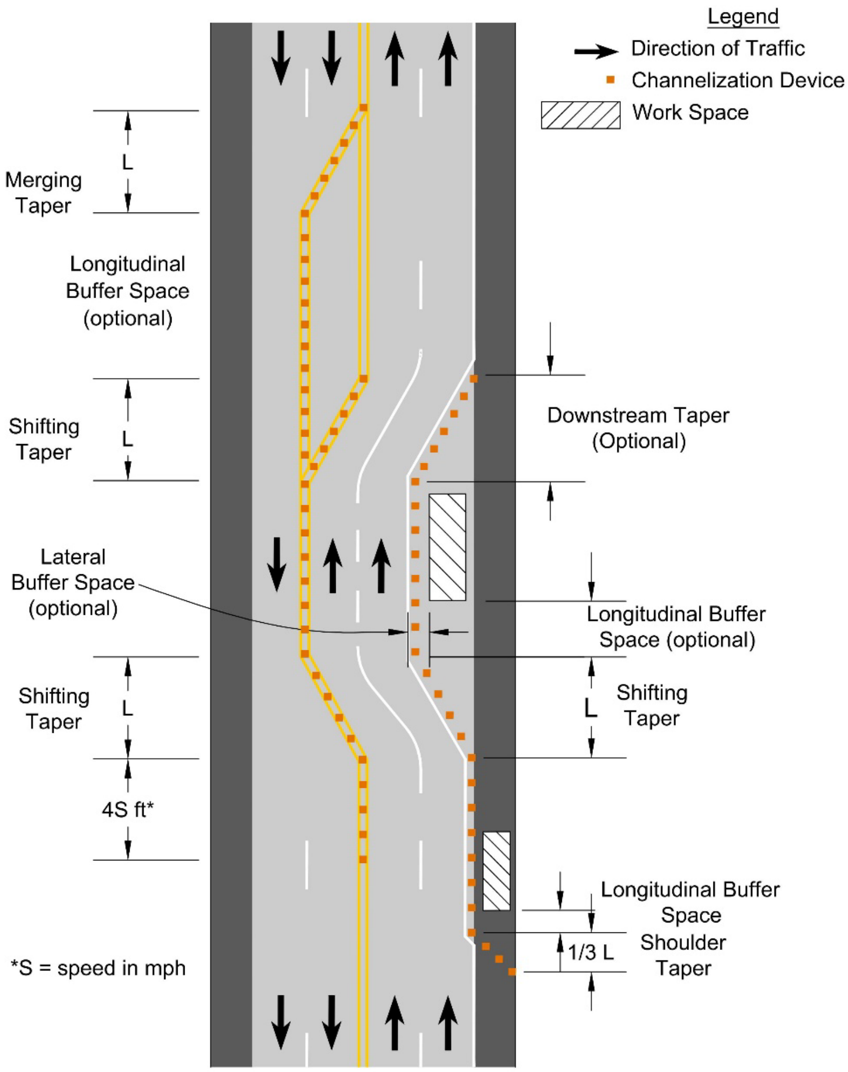


Figure 6-10
Types of Tapers

Table 6-26 through Table 6-28 provide design guidance and distances for tapers, buffers, flare rates, and lane widths.

Table 6-26
Taper Types and Formulas

Taper Types and Formulas	
Taper	**Formula**
Merging (Lane Closure)	"L"
Shifting	"L"
Shoulder Closure	"L"/3 or 1/3 "L"
Flagging (Refer to MUTCD Section 6C.08)	50' to 100'
Downstream (Termination)	Varies (Refer to MUTCD Section 6C.08)

Table 6-27
Concrete Barrier Flare Rates

Concrete Barrier Flare Rate Table	
Speed (mph) [1]	**Minimum Flare Rate**
≥ 30	8:1
35	9:1
40	10:1
45	12:1
>= 50	15:1
55	15:1
60	15:1
65	15:1
70	15:1

[1]Note: Use Pre-Construction Posted Speed to select from the tables below.

Table 6-28
Minimum Lengths

Minimum Lengths Table					
	"L" Value for Tapers (ft)				Buffer "B" (ft)
Posted Speed (mph)	W = Lane or shoulder width being closed or shifted				
	W ≤ 10	W = 12	W = 14	W = 16	
25	204	245	286	327	200
30	267	320	373	427	200
35	338	405	473	540	200
40	417	500	583	667	300
45	504	605	706	807	360
50	600	720	840	960	425
55	650	780	910	1040	495
Freeways[1]					
55	650	780	910	1040	570
60	700	840	980	1120	645
65	750	900	1050	1200	730
70	800	960	1120	1280	820

Notes:
[1]Use Posted Speed plus 10 mph to select from the tables.
For lane closures where W < 10', use "L" value for W = 10'
For shoulder closures where W < 10', use "L" value for W = 10' or calculate "L" using formula, for Speeds ≥ 45: $L = WS$, Speeds < 45: $L = S^2W/60$, S = Posted Speed + 10 mph, W = Width

6.5.2 Sign and Device Spacing

The proper spacing of temporary traffic control devices—such as signs, channelizing devices, and pavement markings—is key to allowing drivers to see, read, and react to the devices. Signs that are set too close together may confuse or overwhelm the driver, but channelizing devices that are set too far apart may not provide enough guidance to show the designated pathway or hazards to avoid.

As part of the work zone, signing conveys messages to roadway users approaching and traveling through the work zone area. Sign selection and placement significantly impact the user's ability to safely and efficiently move through the work zone as well as understand the potential navigation changes that are required. General principles for work zone signing include:

- Verify that temporary signing does not conflict with permanent signs. This may require covering or removing permanent signs during the duration of the work zone. See Specification 712.04.
- Verify existing warning or guide signs that may still be relevant during the work zone duration.
- Consult the *MUTCD* for additional signing requirements, guidance, coloring, messaging details.

Advance warning signs provide the first indication of an approaching work zone and are installed in advance of any area that would redirect road users out of their normal path. A single sign or a series of signs may be used to inform road users to take any precautions ahead of a work zone. Signs should be placed as close as possible to the active work area and should be adjusted as a project progresses and a work area moves. Installing the advance warning signs only when work is occurring helps with the effectiveness of the signs.

Table 6-29 provides preferred minimum sign spacing requirements. Specific standards may have different spacing between signs.

Table 6-29
Advance Warning Sign Spacing

Speed (mph)	Preferred Minimum Spacing* (feet)		
Non-Freeway	**A**		
20-30	100		
35-45	350		
45-55	500		
60-70	700		
Freeways	**A**	**B**	**C**
55-70 (Freeways)	1,000	1,500	2,640

A: Distance from the transition or point of restriction to the first sign.

B: Distance between the first and second signs.

C: Distance between the second and third signs. (The "first sign" is the sign in a three-sign series that is closest to the TTC zone. The "third sign" is the sign that is furthest upstream from the TTC zone.)

Reduced spacing for channelizing devices may be incorporated where additional attention is desired near business accesses, radii at intersections, or driveways. **Table 6-30** provides spacing guidance for key temporary traffic control devices. Additional device spacing information is provided in Section 6.5 and the *MUTCD*.

The following values are used for spacing of channelizing traffic control devices (TCD) including plastic drums, conical and tubular markers.

Table 6-30
Traffic Control Device Spacing

Traffic Control Device Spacing (ft)	Conditions
10	• For intersection or access radii • For Speed < 30 mph
20	• For speeds ≤ 40 mph
40	• For speeds > 40 mph (Including freeways)

6.5.3 Summary of Typical Applications

Table 6-31 shows the organization of the typical applications presented in the remainder of this chapter. These typical applications are from the *MUTCD* or have been adapted from other documents and cover general principles and applications. This manual does not reproduce all of the standards, guidance, options, and support that are associated with each of these typical applications; refer to the *MUTCD* and the *Field Manual* for details *(1, 3).*

Refer to TDOT Standard Drawings for additional details about each application. *(2)*

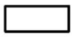
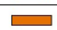
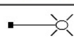
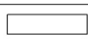
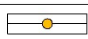
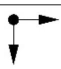
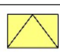
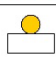
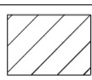
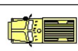
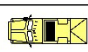
Table 6-31
Applications Summary Table

Section 6.6: Typical Applications for Urban Streets
6.6.1: Work Affecting Pedestrian and Bicycle Facilities
6.6.2: Partial and Full Street Closures
6.6.3: Work Zones at Intersections
6.7: Typical Applications for Two-Lane Highways
6.7.1: Work Outside of the Shoulder
6.7.2: Work on the Shoulder
6.7.3: Lane Closures
6.7.4: Road Closures
6.7.5: Work Zones on Low-Volume Roads
Section 6.8: Typical Applications for Multilane, Non-Access-Controlled Highways
6.8.1: Undivided Multilane Highways
6.8.2: Divided Multilane Highways
Section 6.9: Typical Applications for Freeways and Expressways
6.9.1: Rolling Roadblock
6.9.2: Work Zones Partially Extending into Direction of Travel
6.9.3: Multilane Lane Closures on a Freeway
6.9.4: Work Zones Spanning Width of Direction of Travel
6.9.5: Work on or in the Vicinity of Interchange Ramps
6.9.6: Work Involving Closure of Interchange Ramps
Section 6.10: Work in the Vicinity of an At-Grade Rail Crossing

6.5.4 Symbols on Typical Application Diagrams

Table 6-32 shows the meaning of symbols on typical application diagrams. These symbols are from Table 6H-2 of the *MUTCD* or have been adapted from other documents.

Table 6-32
Sign Legend

Symbols	Description
	Arrow board
	Arrow board support or trailer
	Crash cushion
	Channelizing device
	Direction of temporary traffic detour
	Direction of traffic
	Flagger
	High-level warning device (Flag tree)
	Longitudinal channelizing device
	Luminaire
////////	Pavement markings that should be removed for a long-term project
	Sign (shown facing left)
	Temporary barrier
	Temporary barrier with warning light
	Traffic or pedestrian signal
	Truck-mounted attenuator
	Type 3 barricade
	Warning light
	Work space
	Work vehicle
	Shadow vehicle
A, B, C Distances	Recommended Minimum Sign Spacing Based on Speed, See Table 6-29

6.6 TYPICAL APPLICATIONS FOR URBAN STREETS

Work zones on urban streets can be the most complex of all work zones due to the many travel modes being served and the close spacing of intersections and access points. Urban streets have the following key characteristics that factor into work zone design:

- **Cross Section:** The average cross section is highly variable, with one or more lanes in each direction (or in one direction, if a one-way street) and either no median, divided with two-way left-turn lanes or painted median islands, or divided with a raised median.
- **Speed:** Average travel speeds tend to be low to medium.
- **Volume:** Average motor vehicle volumes can vary widely from low to high. Pedestrian, bicycle, and transit volumes can also vary widely from low to high.
- **Access:** Access is typically dense, with both intersections and driveways at frequent and irregular intervals.

Table 6-33 shows the typical applications for urban streets, characterized by duration.

Table 6-33
Applications Summary Table for Urban Streets

Typical Applications	Duration				
	Mobile	Short Duration	Short-Term	Inter-mediate Term	Long Term
6.6.1: Work Affecting Pedestrian and Bicycle Facilities					
Sidewalk Detour or Diversion		X	X	X	X
Sidewalk Closure with Pedestrian Diversion		X	X	X	X
Sidewalk Closure with Pedestrian Detour		X	X	X	X
Crosswalk Closure with Pedestrian Detour		X	X	X	X
Temporary Bicycle Lane		X	X	X	X
Bicycle Lane in Closed Motor Vehicle Lane		X	X	X	X
Merging Bicycles and Motor Vehicles		X	X		
6.6.2: Partial and Full Street Closures					
Detour for One Travel Direction		X	X	X	X
Detour for a Closed Street		X	X	X	X
6.6.3: Work Zones at Intersections					
Lane Closure on the Near Side of an Intersection		X	X	X	X
Right-Hand Lane Closure on the Far Side of an Intersection		X	X	X	X
Left-Hand Lane Closure on the Far Side of an Intersection		X	X	X	X
Half Road Closure on the Far Side of an Intersection		X	X	X	X
Multiple Lane Closures at an Intersection		X	X	X	X
Closure in the Center of an Intersection		X	X	X	
Closure at the Side of an Intersection		X	X	X	
Closure within Single-Lane Roundabout		X	X	X	
Left-Lane Closure within Multilane Roundabout		X	X	X	
Right-Lane Closure within Multilane Roundabout		X	X	X	

6.6.1 Work Affecting Pedestrian and Bicycle Facilities

Work zones in an urban environment are likely to affect pedestrian and bicycle facilities. This can happen directly if the work area is within the traveled way of the pedestrian or bicyclist, such as work on a sidewalk or bicycle lane. However, this can also happen indirectly if the work area is within a motor vehicle travel lane, but access to that work area requires disruption to the pedestrian or bicycle travel way. In both cases, careful attention is needed to maintain a safe and usable path for pedestrians and bicyclists through or around a work area.

As a general principle, the most effective traffic control measure for pedestrians and bicyclists is one that minimizes their out-of-direction travel and minimizes their exposure to motor vehicles. Equally important, a pedestrian route that is accessible to all users must be maintained at that level to comply with the provisions and intent of the Americans with Disabilities Act.

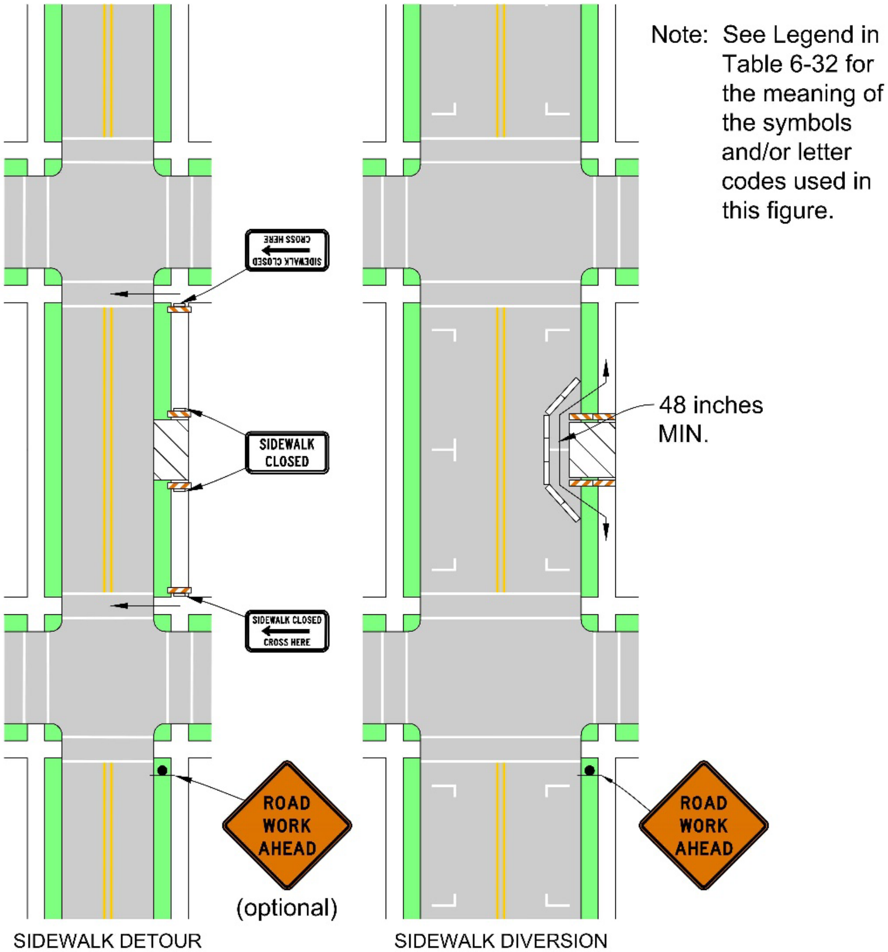
With On-Street Parking

Where on-street parking is present, a preferable treatment for pedestrians is to remove the parking adjacent to the work area and provide an accessible temporary walkway within the parking area. This can be thought of as the pedestrian equivalent to an on-site diversion, similar to that illustrated for motor vehicles on two-lane highways later in Section 6.7. This concept is illustrated on the right side of Figure 6-11 and in Figure 6-12. A key aspect of pedestrian diversion is that it needs to be accessible to all users. Ramps with acceptable slopes, detectable edges along the entire length of the diversion, and adequate width or provisions for passing are necessary to provide full use of the diversion for people with mobility or vision disabilities.

Without On-Street Parking

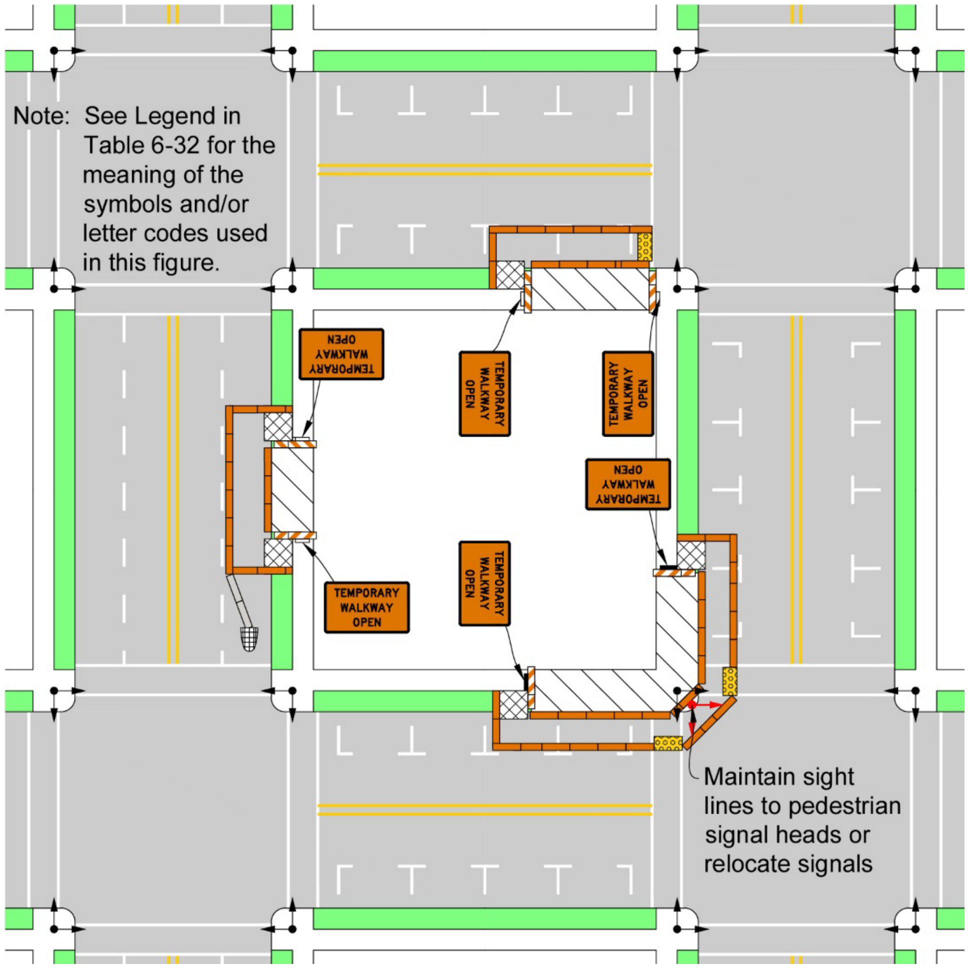
Where on-street parking is not present, it may be necessary to require pedestrians to cross the street at the nearest available crosswalk, proceed on the sidewalk opposite the work area, and then cross back. This is illustrated on the left side of Figure 6-10 for midblock closures and Figure 6-13 and Figure 6-14 for corner closures. Wherever possible, pedestrian diversion is preferred over the pedestrian detour to minimize out-of-direction travel and the number of conflicts with motor vehicles.

Figure 6-11
Sidewalk Detour or Diversion



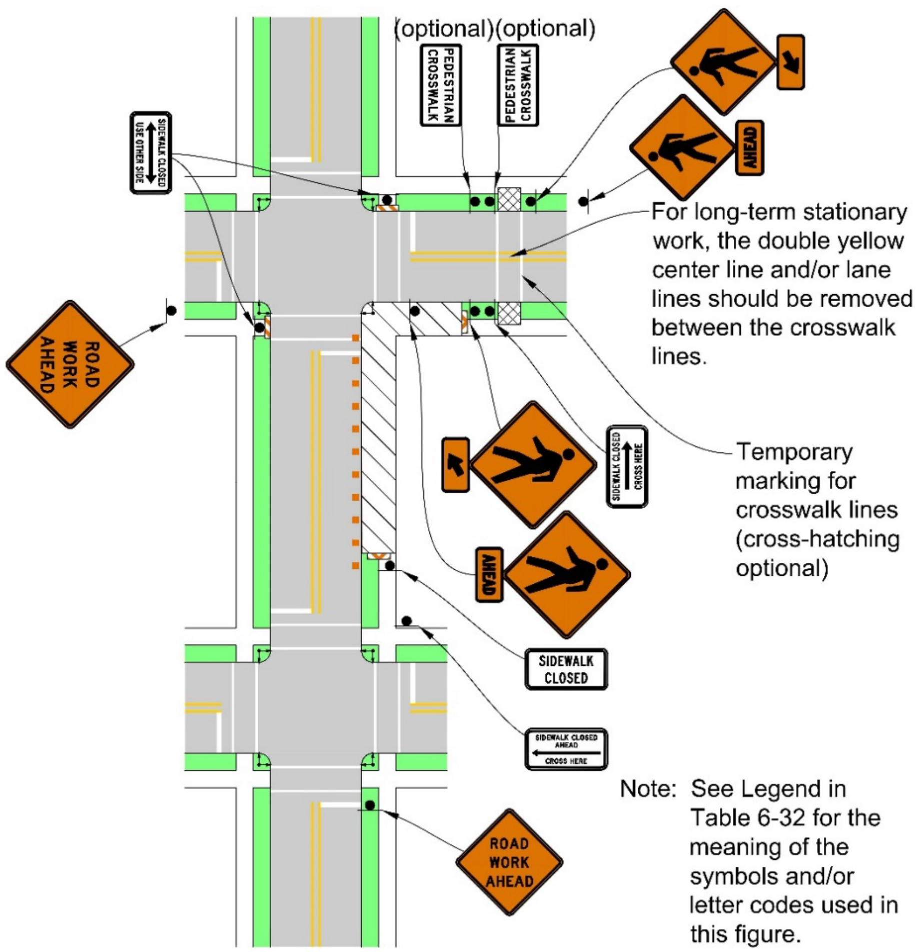
Source: MUTCD, Figure 6H-28. *(3)*

Figure 6-12
Sidewalk Closure with Pedestrian Diversion



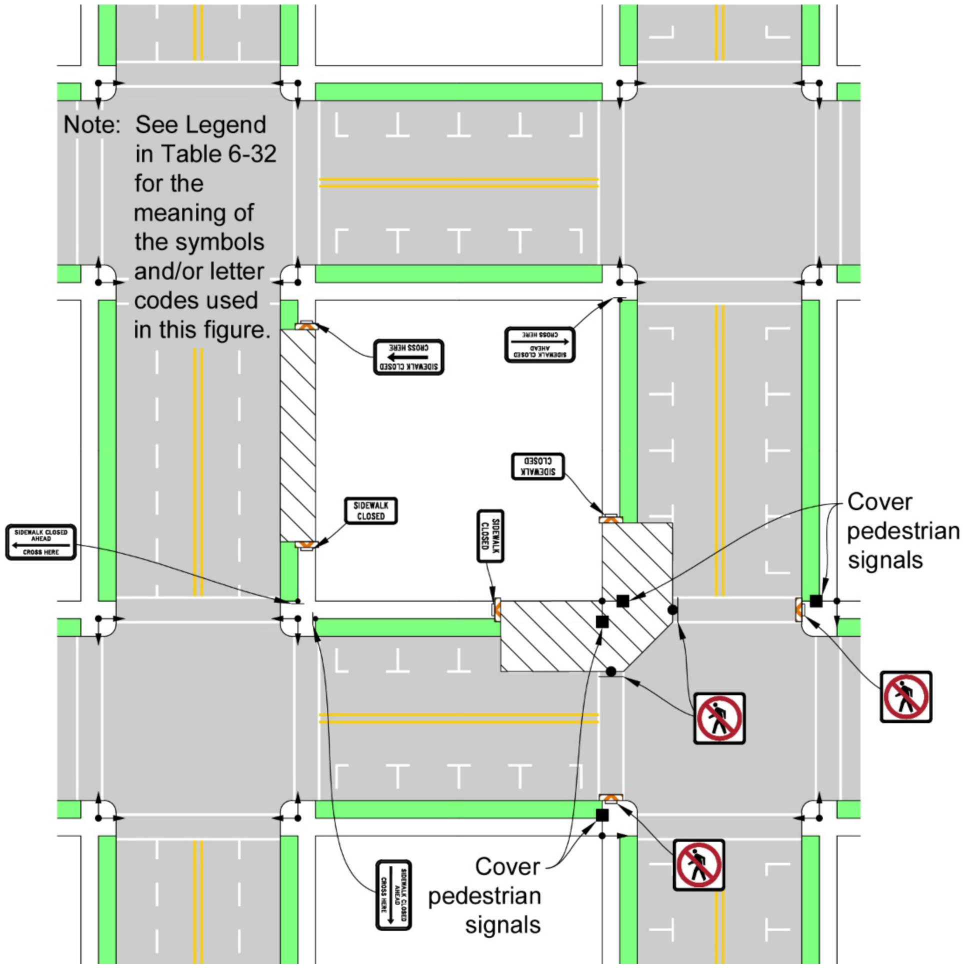
Source: City of Portland, Figure TA-S1 *(14)*

Figure 6-13
Crosswalk Closures and Pedestrian Detours



Source: *MUTCD*, Figure 6H-29 *(3)*

Figure 6-14
Sidewalk Closure with Pedestrian Detour



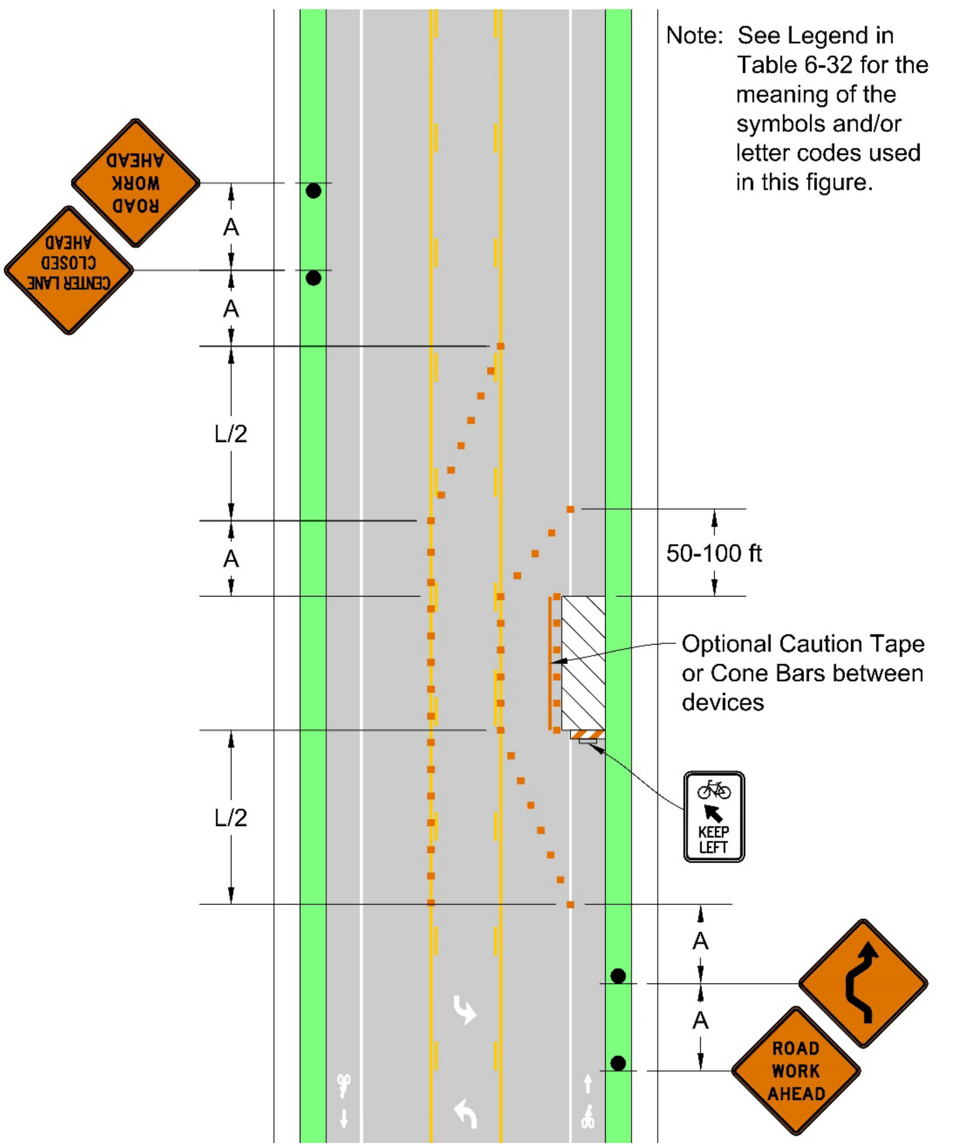
Source: City of Portland, Figure TA-S2 *(14)* Signs updated per *MUTCD (3)*

For bicyclists, it is ideal to maintain a bicycle lane wherever possible when the work area closes the existing bicycle lane. Depending on the cross section of the street, a number of options with different potential impacts on traffic operations are possible; consult with TDOT Traffic Operations when making this selection. The options include the following:

- For streets with a two-way, left-turn lane and a single through lane for motor vehicles in each direction, it is often preferable to close the two-way left-turn lane, shift the motor vehicle lane into the closed two-way left-turn lane, and shift the bicycle lane into the now-vacated motor vehicle lane. This option is most feasible where left-turning volumes are low in the vicinity of the work zone. This is illustrated in Figure 6-15.
- For streets with multiple through lanes for motor vehicles, more options are available. The two-way, left-turn lane could be closed and both motor vehicle lanes shifted, similar to the previous concept. However, it may be preferable to close one of the motor vehicle lanes and shift the bicycle lane into the closed motor vehicle lane. This option is most feasible when through motor vehicle volumes are low enough or where left-turning volumes are high enough to make the two-way, left-turn lane more essential than a motor vehicle through lane.

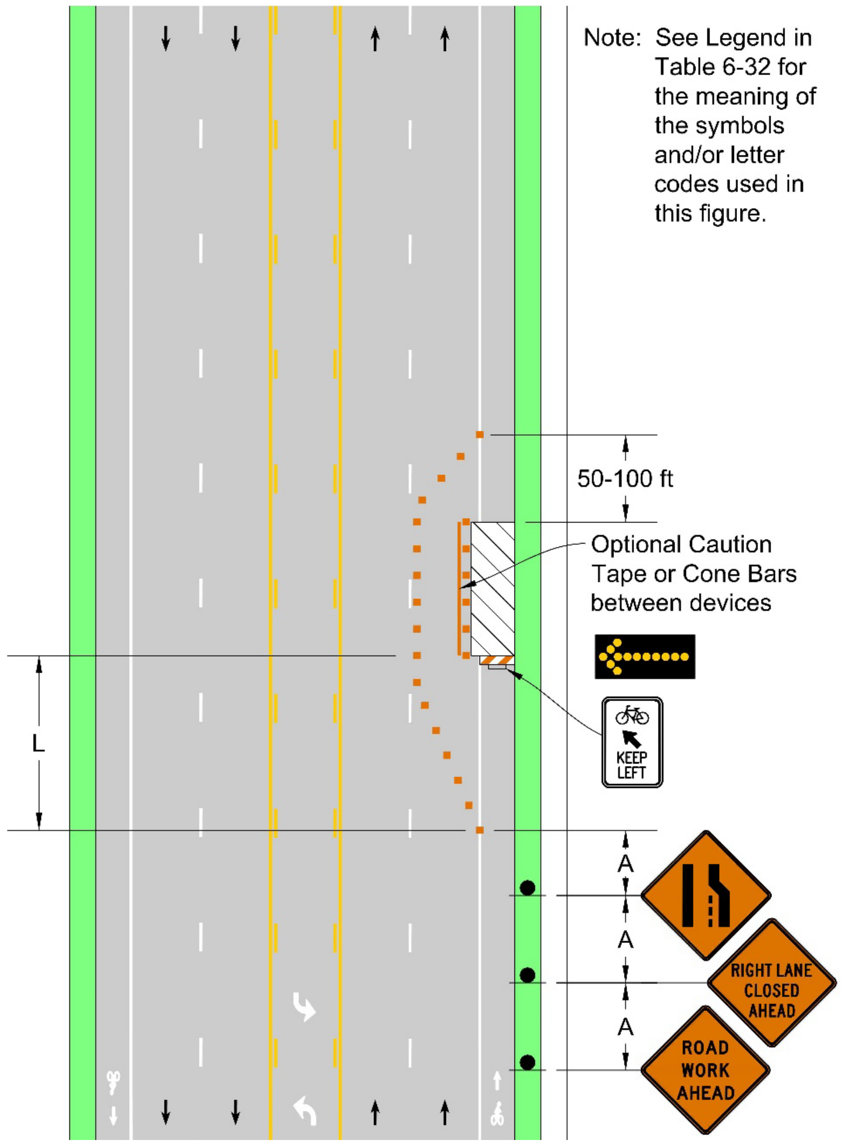
- For work zones that are wide enough to make it physically impossible to continue to separate motor vehicles and bicyclists, a shared lane may be necessary. This should be considered a last resort and should only be used when adequate provisions are in place to keep motor vehicle speeds low. **Chapter 4** provides additional guidance on bicycles in the work zone.
- In some cases, it may be preferable to divert bicyclists onto the sidewalk. This should only be done if the sidewalk width is adequate to serve both bicyclists and pedestrians or if other options are not feasible.
- In some special cases, it may be possible to close parking and divert bicyclists into the closed parking lane.

Figure 6-15
Temporary Bicycle Lane

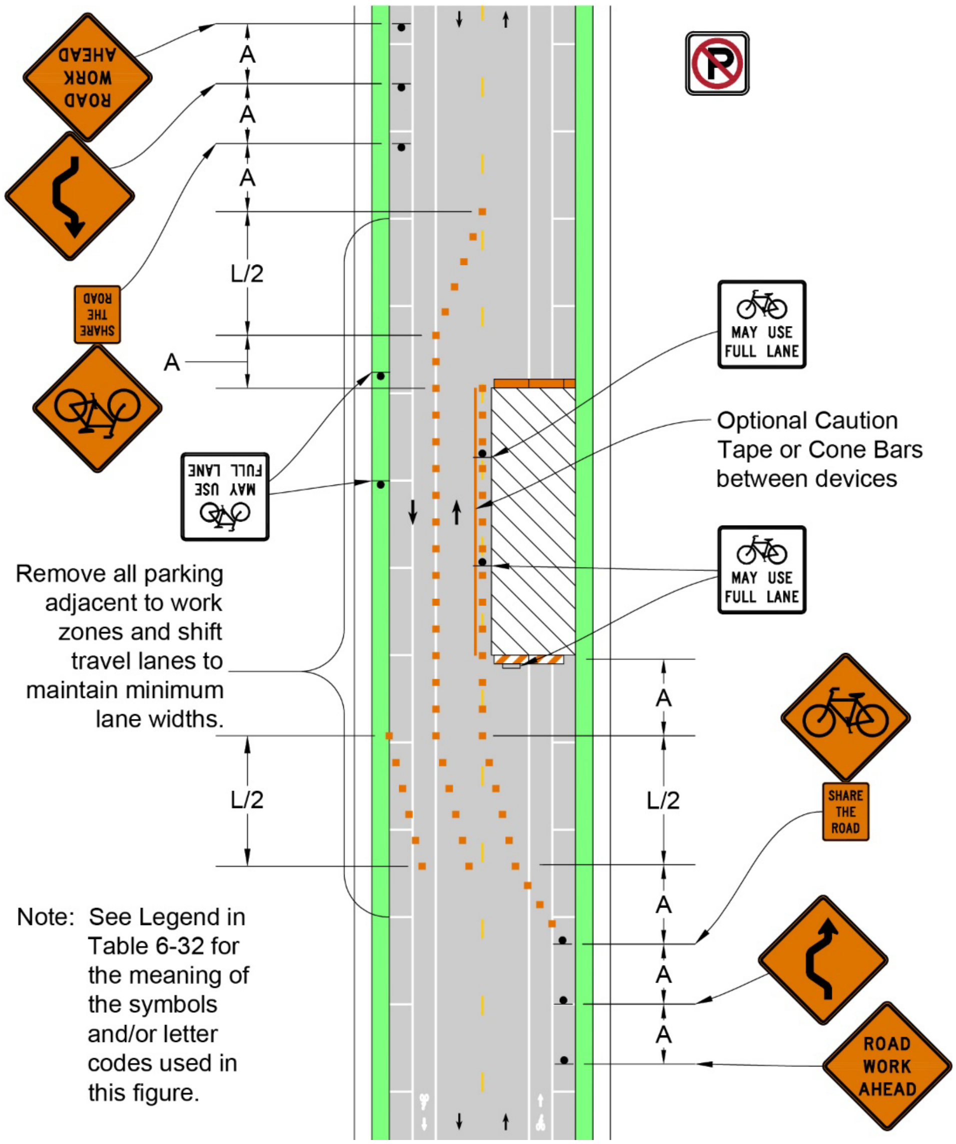


Source: City of Portland, Figure TA-B1 *(14)*

Figure 6-16
Bicycle Lane in Closed Motor Vehicle Lane



Source: City of Portland, Figure TA-B2 *(14)*



Source: City of Portland, Figure TA-B3 *(14)* Signs updated per MUTCD. *(3)*

Figure 6-17
Merging Bicycles and Motor Vehicles

6.6.2 Partial and Full Street Closures

Partial and full street closures in urban areas present a number of unique challenges, and no single typical application is likely to cover all aspects of a given project's unique circumstances.

Design Teams should consider the following general principles:

- Where options are available, divert motor vehicle traffic to facilities best able to accommodate the additional motor vehicle traffic. Detours of arterial street traffic onto residential streets should be avoided wherever possible.
- In general, it is preferable to sign a detour route along its entire length, providing signs for every key decision point or change in route.

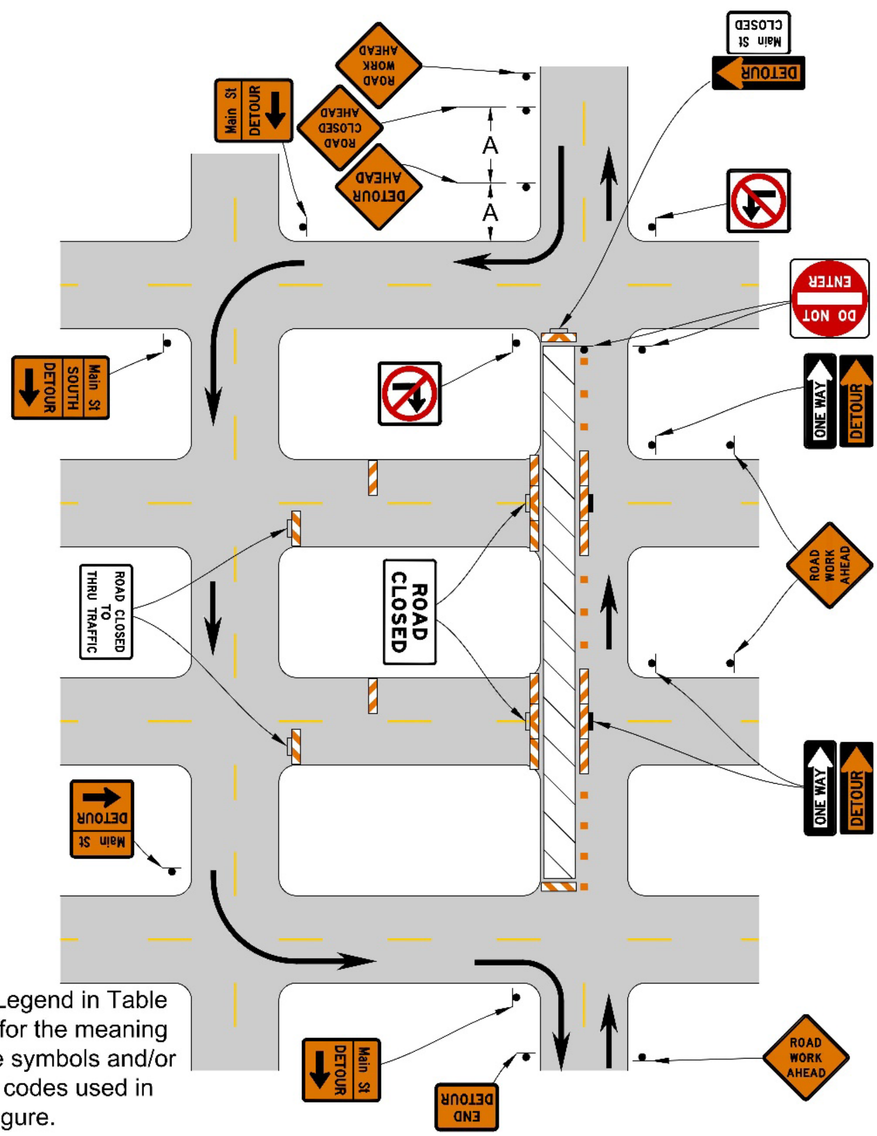
- In some urban environments where multiple alternative routes are available, it may be preferable to simply close the route and indicate USE ALTERNATE ROUTE. This is generally only feasible in areas with a high proportion of familiar road users and where other means of communication with road users are being used, such as social media, websites, and other forms of notification.

Closing a Lane for Utilities

For utility work within an urban area, it may be necessary to close a road partially or implement a full closure. Figure 6-18 shows a partial closure, where only one direction of traffic is impacted, while Figure 6-19 illustrates a full closure that triggers detours for both directions of traffic. For any detours, the strategy is to minimize out-of-direction travel.

Examples of typical applications for a detour for one travel direction (a half-street closure) and a detour of both travel directions (a full street closure) are illustrated in **Figure 6-18 and Figure 6-19**, respectively.

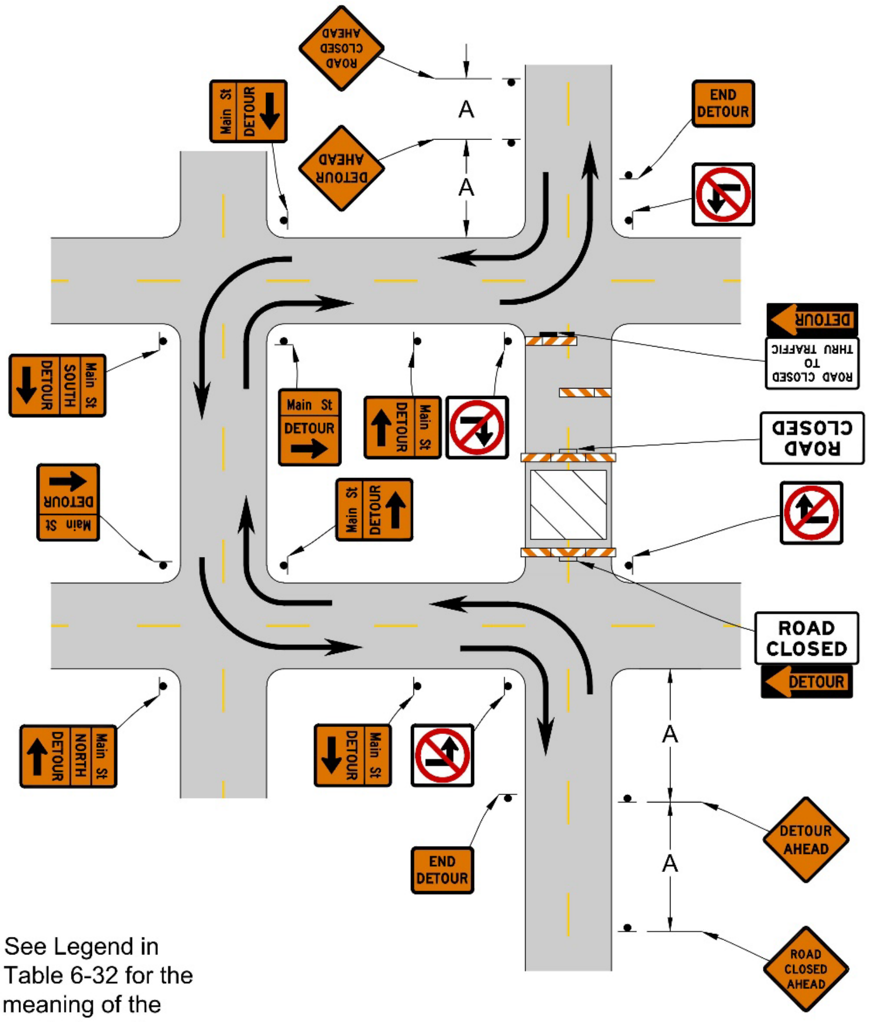
Figure 6-18
Detour for One Travel Direction



Note:
See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: *MUTCD*, Figure 6H-19 *(3)*

Figure 6-19
Detour for a Closed Street



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: *MUTCD*, Figure 6H-20 *(3)*

6.6.3 Work Zones at Intersections

No single typical application is likely to meet the unique needs of a project. Many of these options have traffic operations and safety implications; consult with TDOT Traffic Operations when making selections.

Intersections arguably represent the most challenging aspect of urban streets because they are the location where travel modes mix and cross paths. Work zones next to or with intersections represent a special challenge to providing safe and usable paths for all affected road users. In urban areas, other factors also complicate the design of traffic control device layouts, including nearby driveways, on-street parking, and transit stops. As with road segments, no single typical application is likely to meet a project's unique needs. Many of these options have traffic operations and safety implications; consult with TDOT Traffic Operations when making selections.

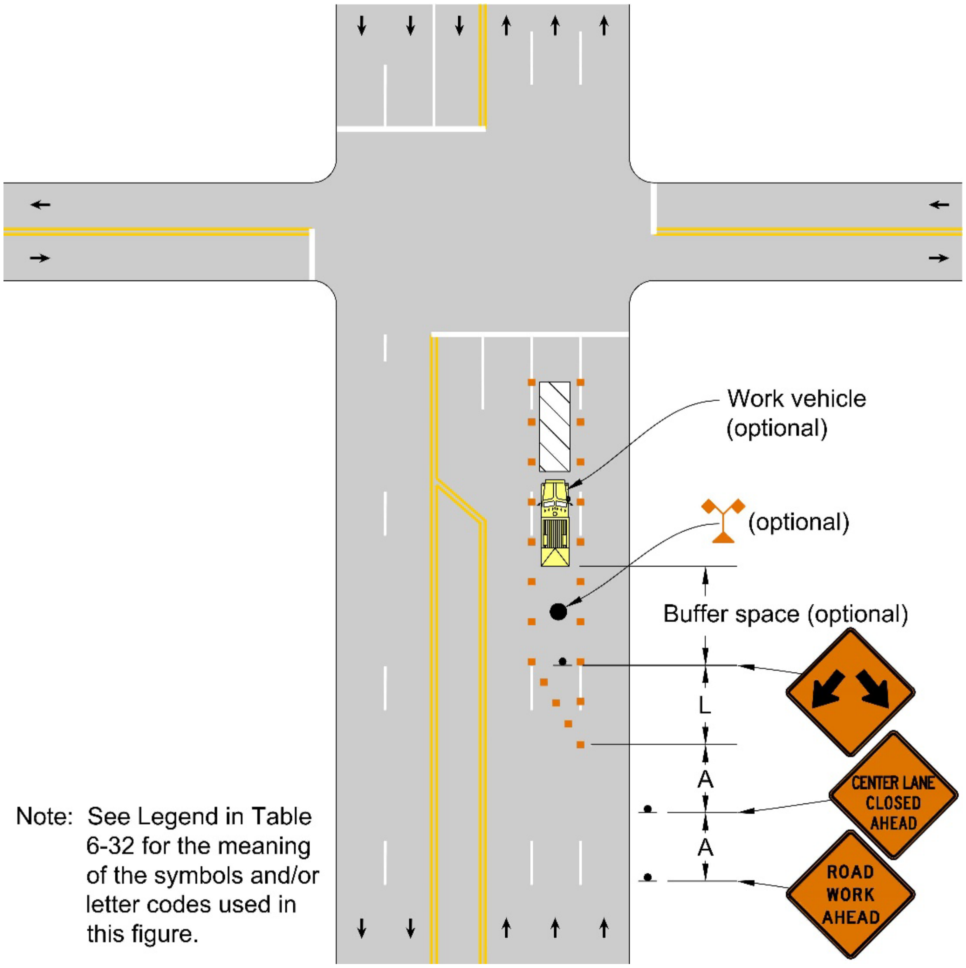
The following general principles should be used:

- Lower speed environments are safer for road users and construction workers alike. Lane closures and shift tapers are generally shorter due to lower speeds and, thus, may be more compatible with the existing roadway network.
- Adapt approach tapers and sign sequences to fit the street network and context. Intersecting streets within the approach taper sequence may create confusion unless explicitly addressed and should be incorporated into the design.
- Balance the constructability of the project with the impact on road users. In urban areas, the impacts to road users are often more significant during peak hours than off-peak hours, and careful selection of traffic control measures and times of construction can minimize these impacts. Refer to **Section 6.3** for further discussion.

Some of the more common typical applications at intersections include the following:

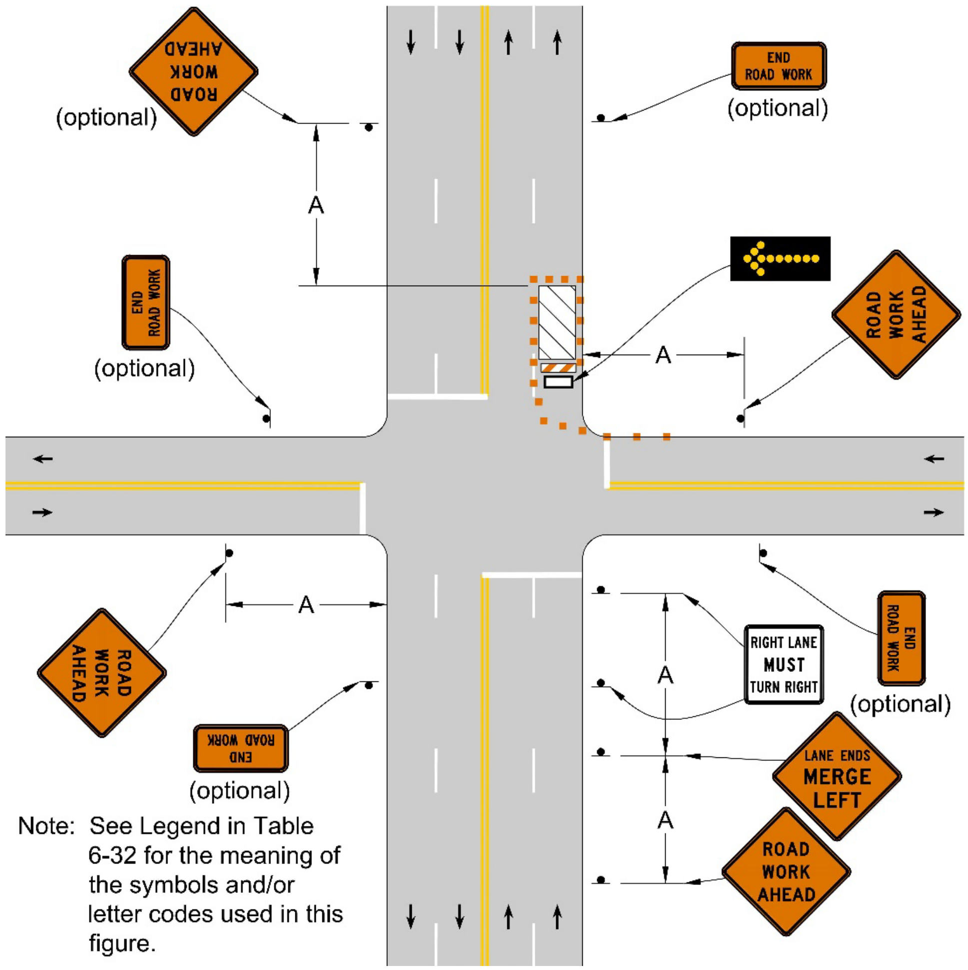
- Lane closures on the near side of the intersection. This is illustrated in **Figure 6-20**.
- Lane closures on the far side of the intersection. This is illustrated for closing the downstream right lane in **Figure 6-21,** closing the downstream left lane in **Figure 6-22**, and closing both downstream lanes in **Figure 6-23.**
- Multiple lane closures at an intersection. This is illustrated in **Figure 6-24**.
- Closures within the intersection itself. This is illustrated for work in the center of the intersection in **Figure 6-25** and work on one side of the intersection in **Figure 6-26**.
- Closure at a single-lane roundabout. This is illustrated in **Figure 6-27**.
- Left-lane closure and right-lane closure within a multilane roundabout. These are shown in **Figure 6-28 and Figure 6-29**, respectively.

Figure 6-20
Lane Closure on Near Side of Intersection



Source: *MUTCD*, Figure 6H-21 *(3)*

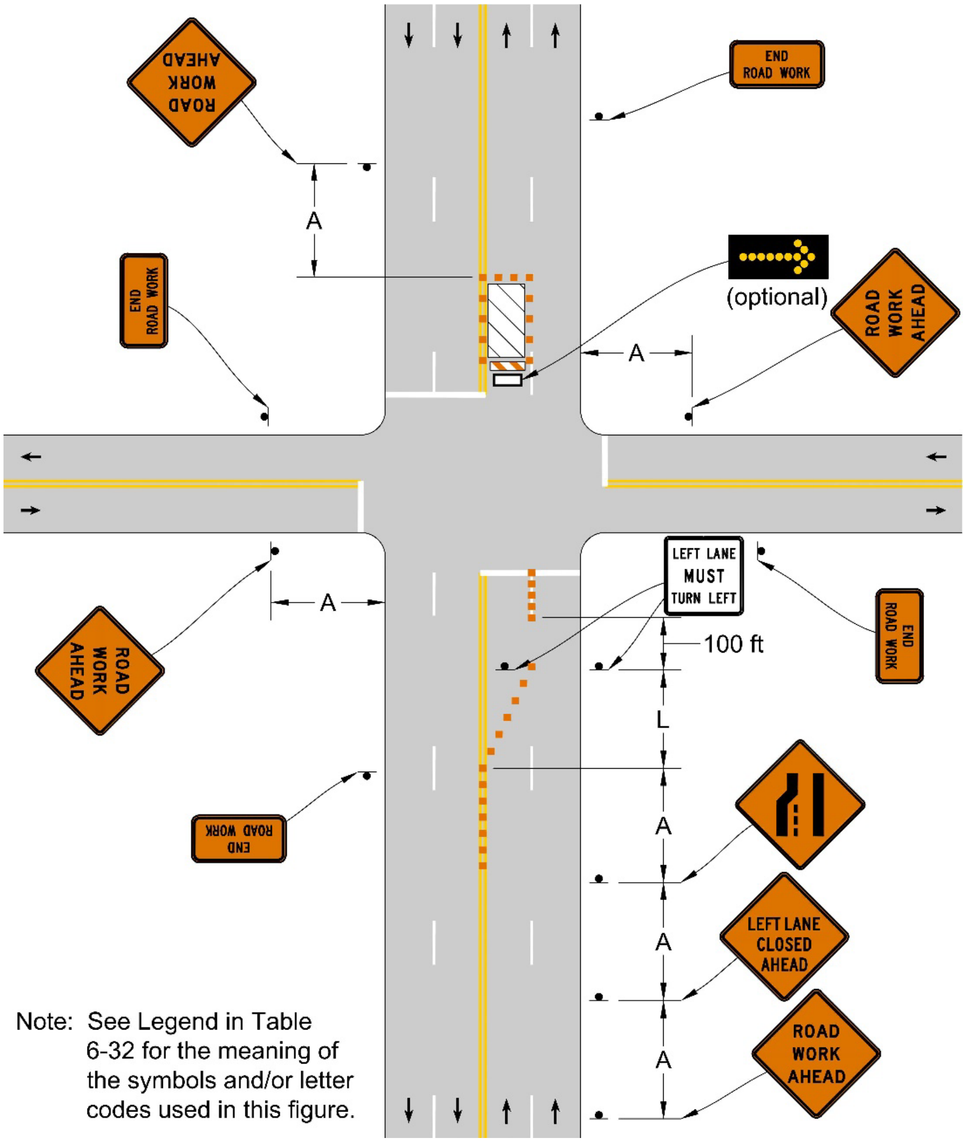
Figure 6-21
Right-Hand Lane Closure on Far Side of an Intersection



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

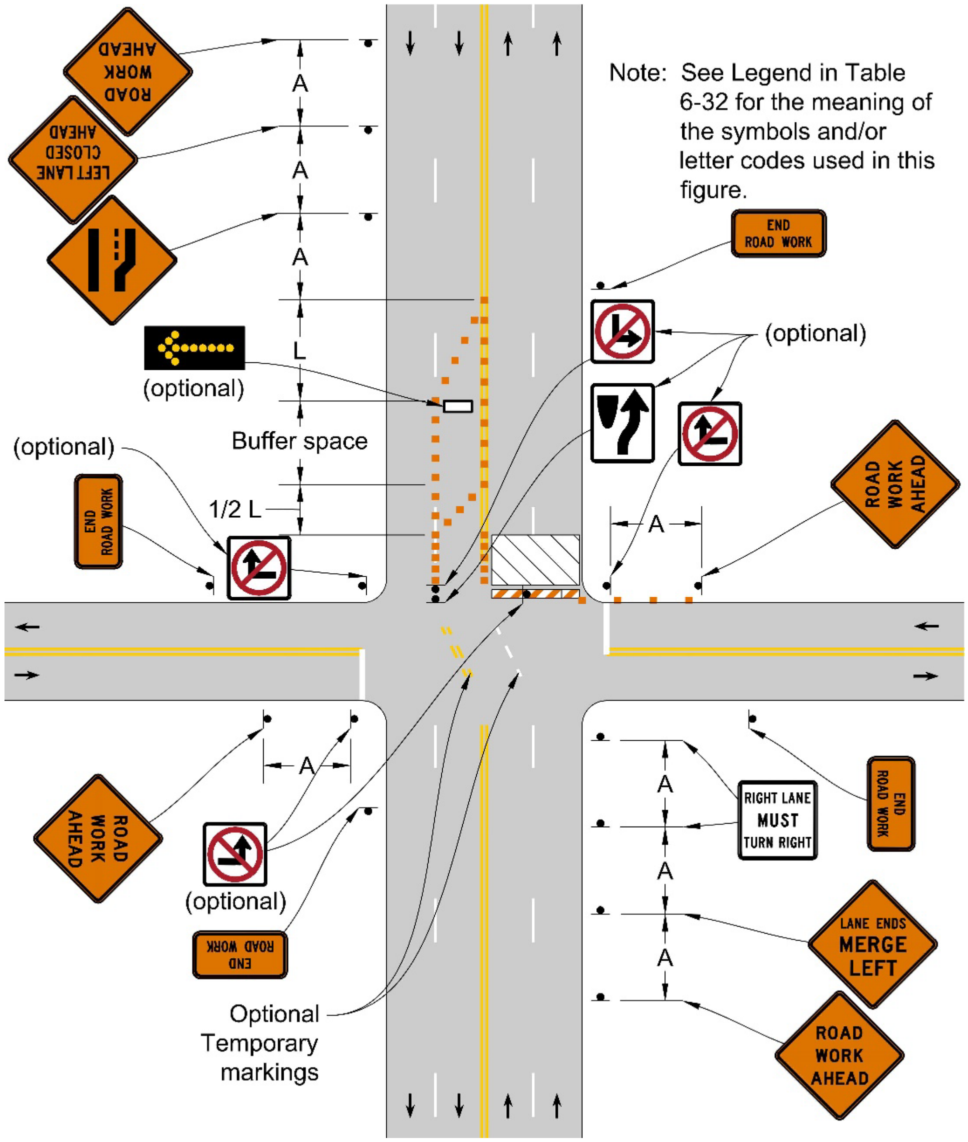
Source: *MUTCD*, Figure 6H-22 *(3)*

Figure 6-22
Left-Hand Lane Closure on the Far Side of an Intersection



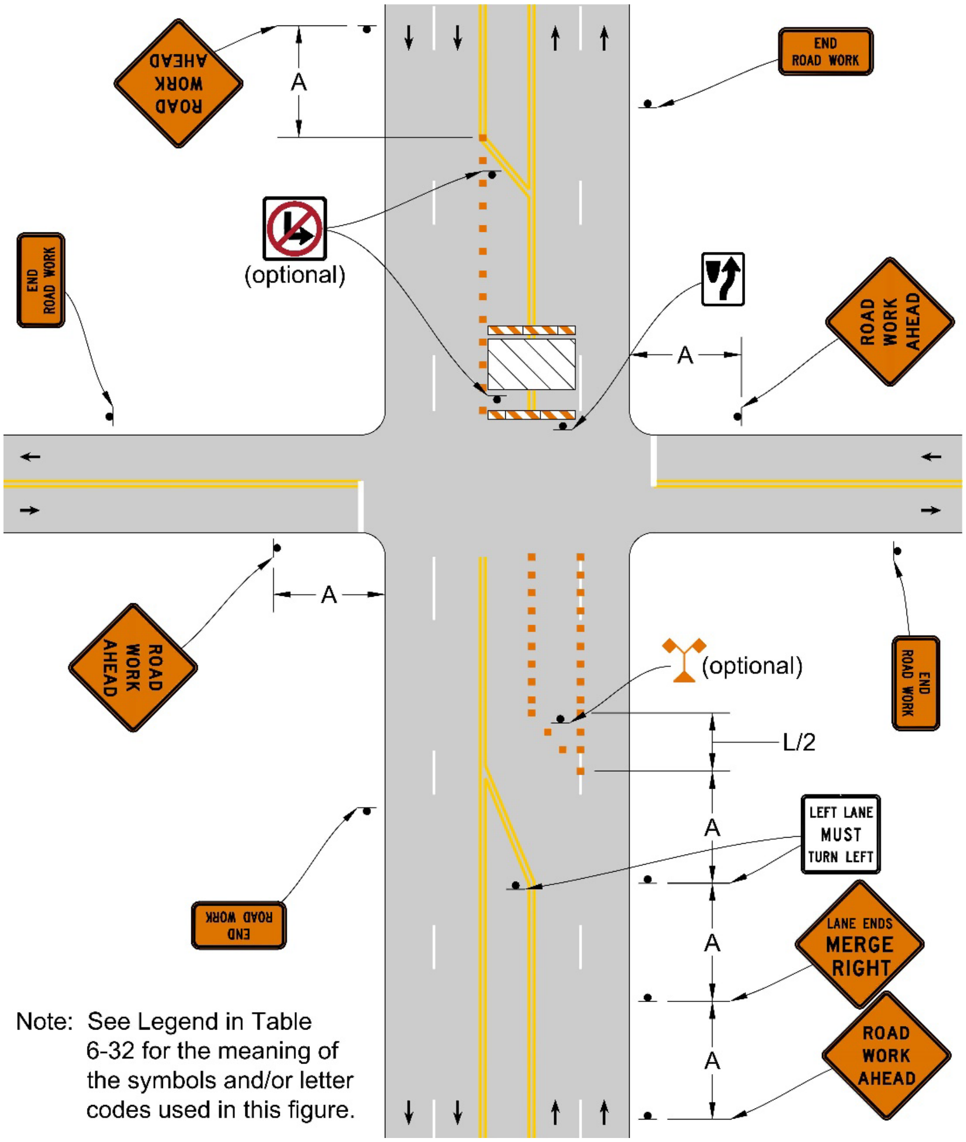
Source: *MUTCD*, Figure 6H-23 *(3)*

Figure 6-23
Half-Road Closure on the Far Side of an Intersection



Source: *MUTCD*, Figure 6H-24 *(3)*

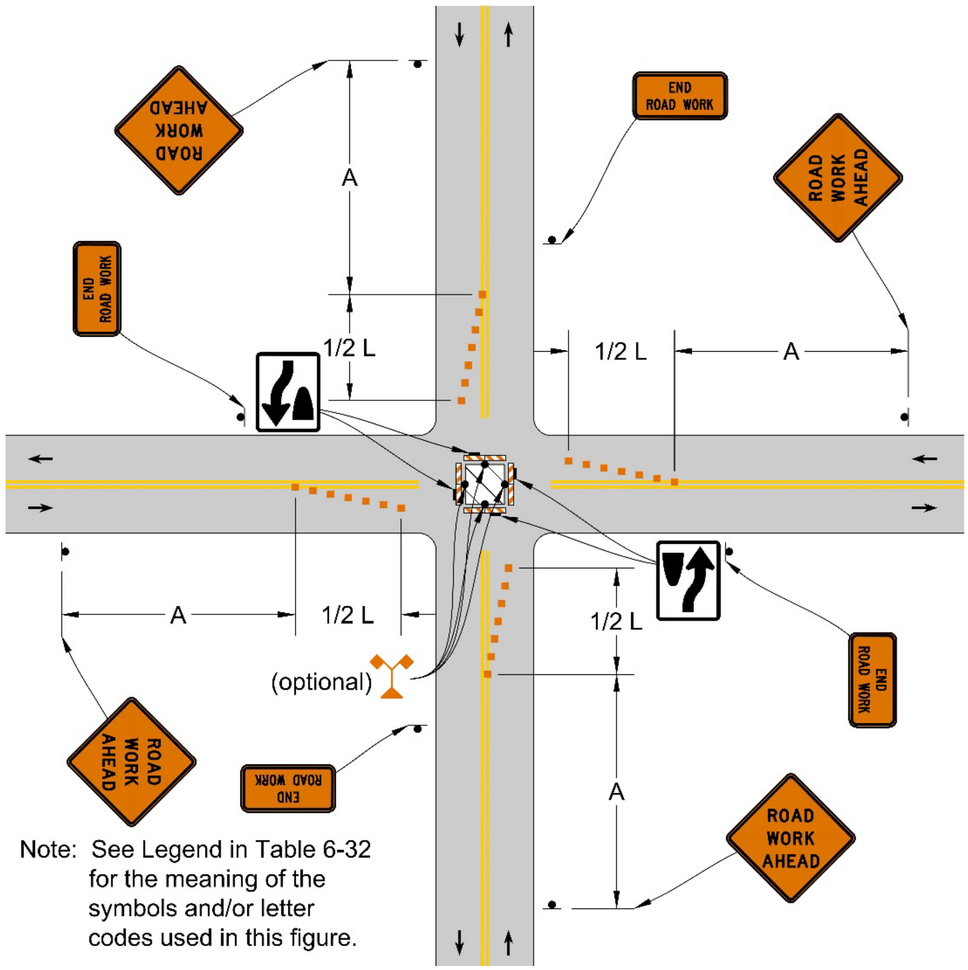
Figure 6-24
Multiple Lane Closures at an Intersection



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

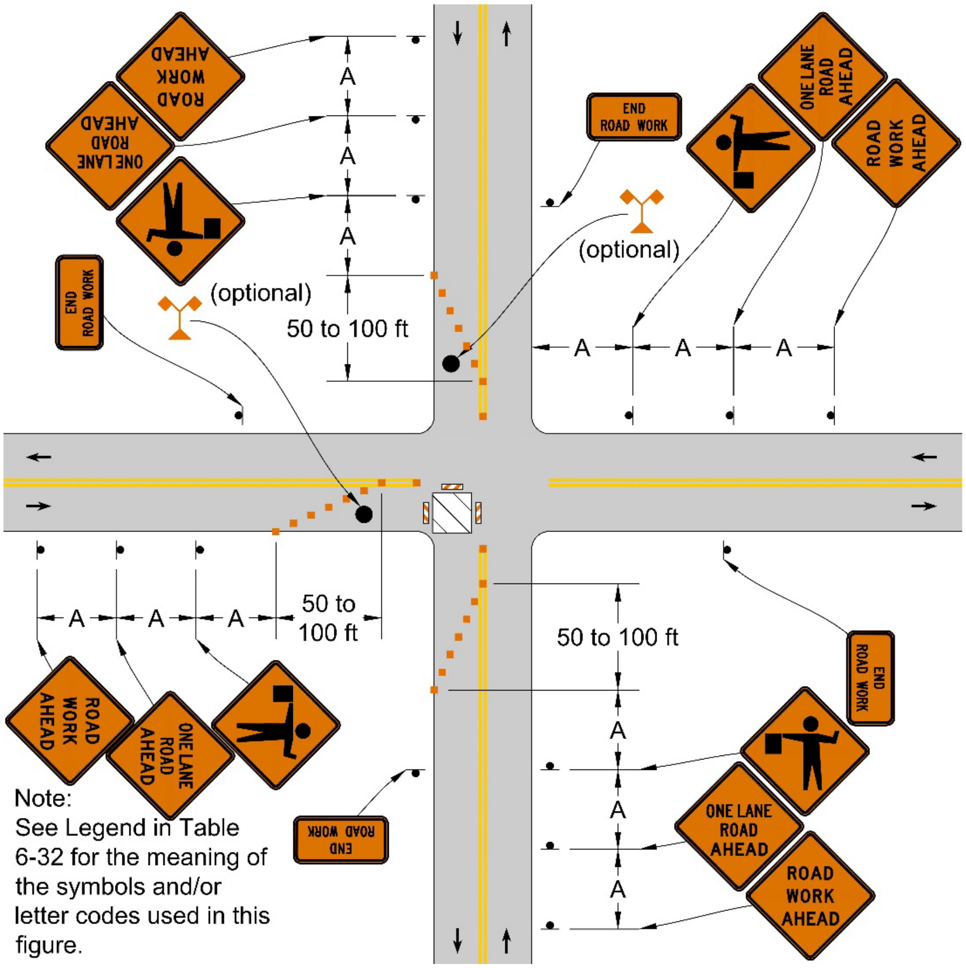
Source: *MUTCD*, Figure 6H-25 *(3)*

Figure 6-25
Closure in the Center of an Intersection



Source: *MUTCD*, Figure 6H-26 *(3)*

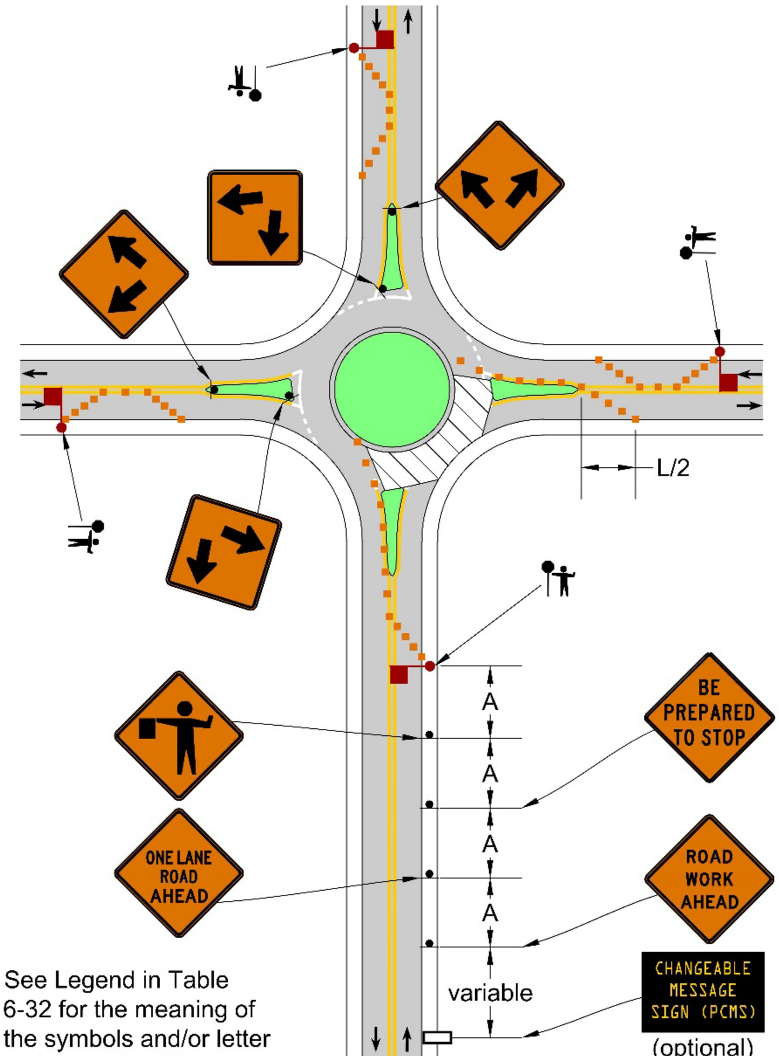
Figure 6-26
Closure at the Side of an Intersection



Source: *MUTCD*, Figure 6H-27 *(3)*

TDOT typically discourages flagging at night.

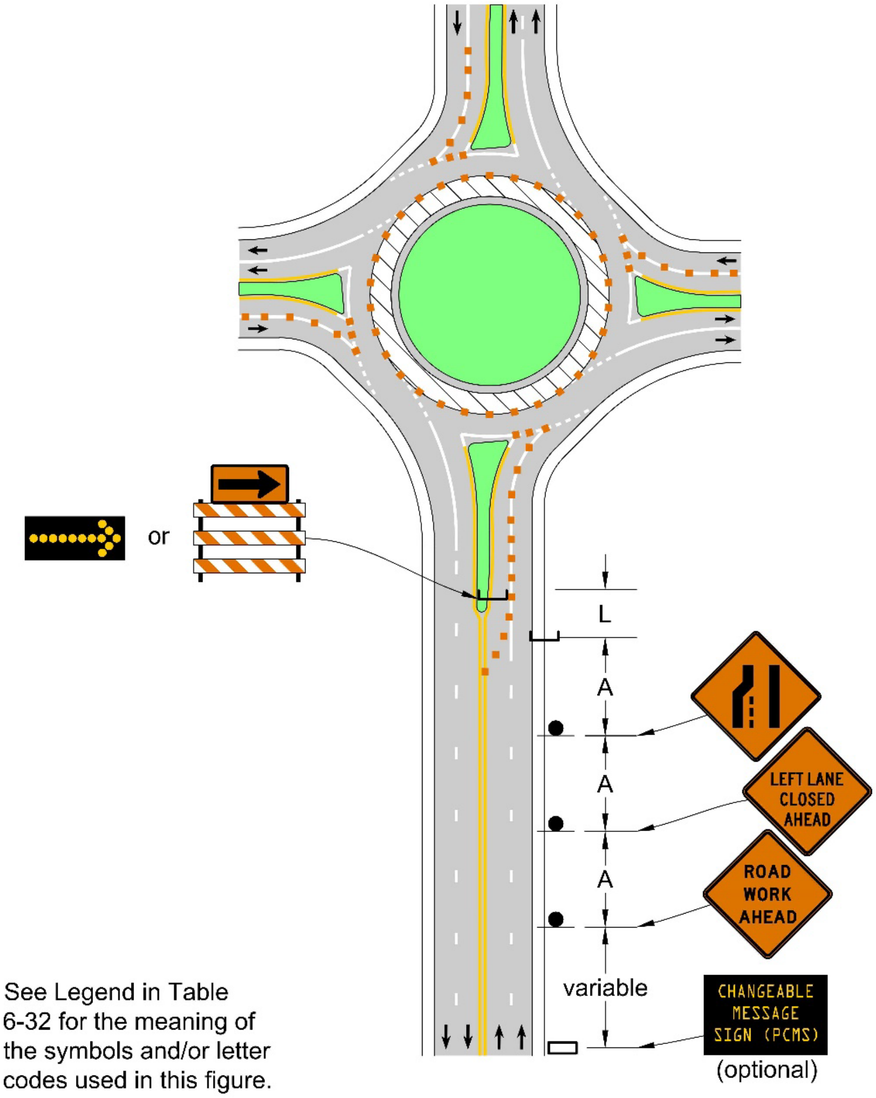
Figure 6-27
Closure within Single-Lane Roundabout



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: TDOT *Work Zone Field Manual for Maintenance Operations*, Layout 88b *(1)*

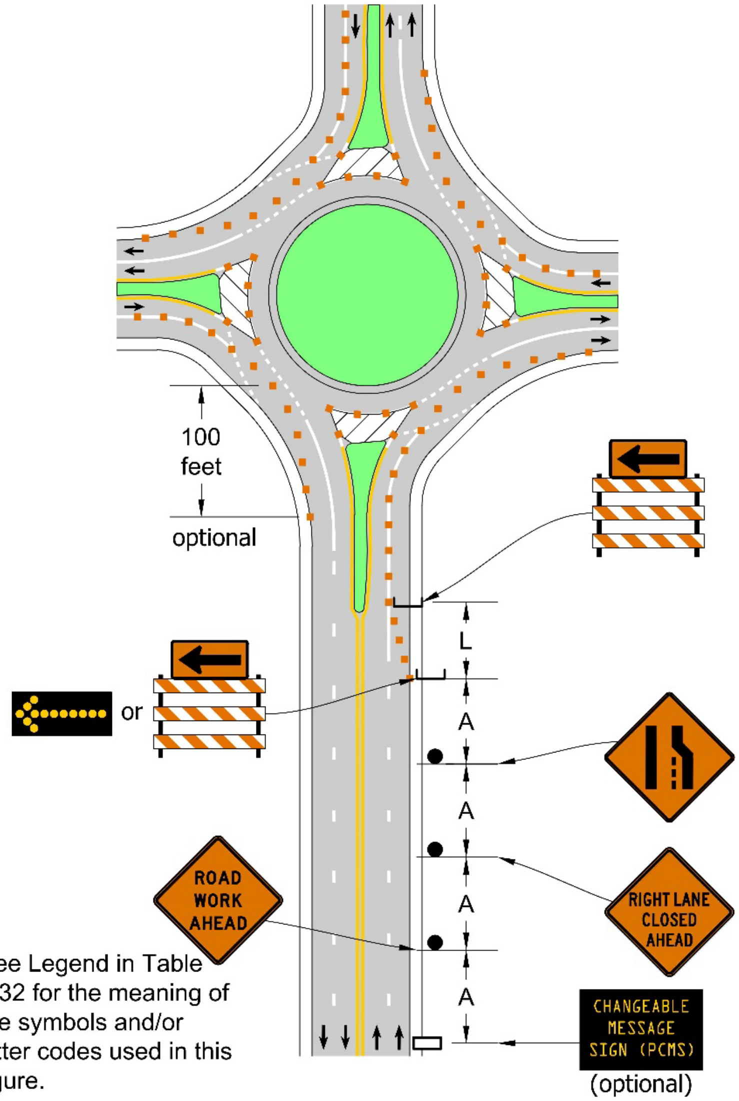
Figure 6-28
Left-Lane Closure within Multilane Roundabout



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: TDOT *Work Zone Field Manual for Maintenance Operations,* Layout 89 *(1)*

Figure 6-29
Right-Lane Closure within Multilane Roundabout



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: *TDOT Work Zone Field Manual for Maintenance Operations*, Layout 90 *(1)*

6.7 TYPICAL APPLICATIONS FOR TWO-LANE HIGHWAYS

Two-lane highways are generally rural facilities that have the following key characteristics applicable to work zone design:

- **Cross Section:** Cross sections are undivided, with one lane in each direction.
- **Speed:** Average travel speeds tend to be medium to high.
- **Volume:** Average motor vehicle volumes can vary widely from low to high. Pedestrians and bicyclists may be present but are generally low volume.
- **Access:** Access is typically less dense than in urban areas but is present and irregular.

Table 6-34 shows the typical applications for two-lane highways, characterized by duration. For work zones at intersections on two-lane highways, the techniques provided in **Section 6.6** for urban streets may also be used.

Table 6-34
Applications Summary Table for Two-Lane Highways

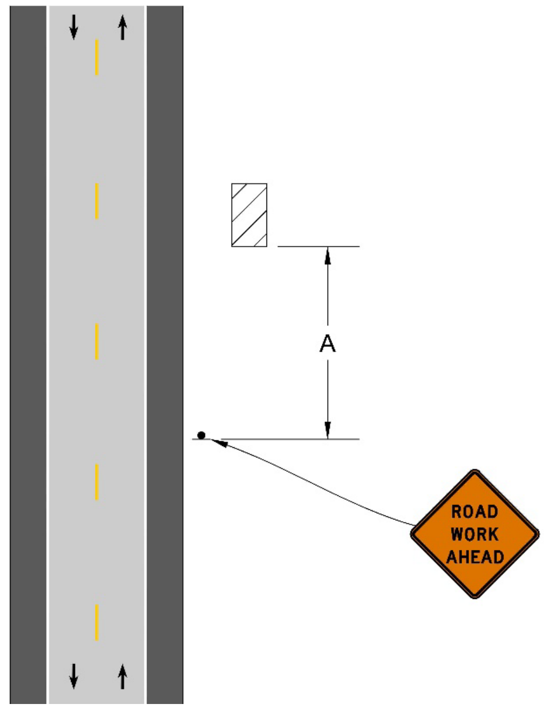
Typical Applications	Duration				
	Mobile	Short Duration	Short-Term	Intermediate-Term	Long Term
6.7.1: Work Outside of the Shoulder					
Work Beyond the Shoulder		X	X	X	X
Blasting Zone			X	X	X
6.7.2: Work on the Shoulder					
Work on the Shoulders		X	X	X	X
Short Duration or Mobility Operation on a Shoulder	X	X			
Shoulder Work with Minor Encroachment		X	X	X	X
6.7.3: Lane Closures					
Lane Closure on a Two-Lane Road Using Flaggers		X	X	X	X
Lane Closure on a Two-Lane Road Using Traffic Signals				X	X
6.7.54: Road Closures					
Roads Closed with an Off-Site Detour			X	X	X
6.7.5: Work Zones on Low-Volume Roads					
Overlapping Routes with a Detour			X	X	X
Lane Closure on a Two-Lane Road Using Flaggers		X	X	X	X
Lane Closure on a Two-Lane Road with Low Traffic Volumes		X	X	X	X
Lane Closure on a Two-Lane Road Using Traffic Control Signals				X	X
Temporary Road Closure		X			
Haul Road Crossing		X			
Work in the Center of a Road with Low Traffic Volumes		X	X	X	X
Surveying Along the Center Line of a Road with Low Traffic Volumes		X			
Mobile Operations on a Two-Lane Road	X				

6.7.1 Work Outside of the Shoulder

Traffic control measures for work outside of the shoulder are generally minimal, as shown in **Figure 6-30**. If the work involves blasting, additional traffic control measures are needed, as shown in **Figure 6-31**.

Additional Clear Zone information is described in Section 6.4.7.

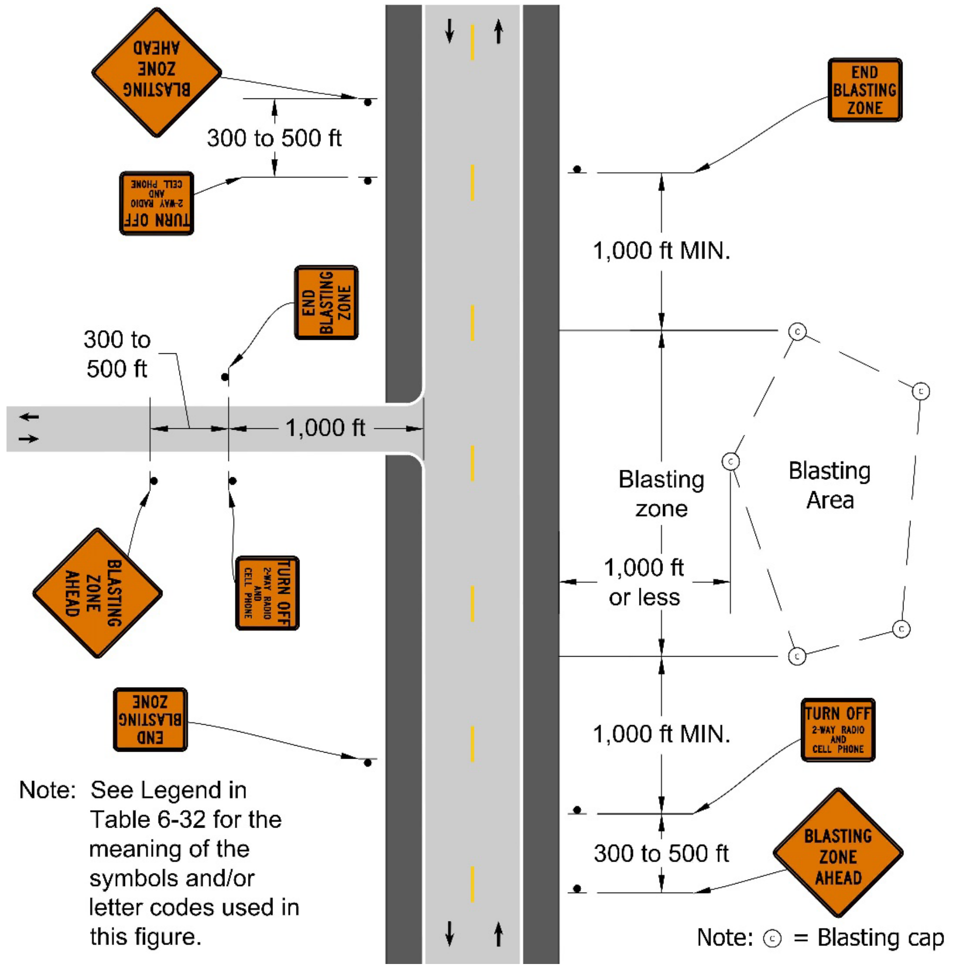
Figure 6-30
Work Beyond the Shoulder



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: *MUTCD*, Figure 6H-1 *(3)*

Figure 6-31
Blasting Zone

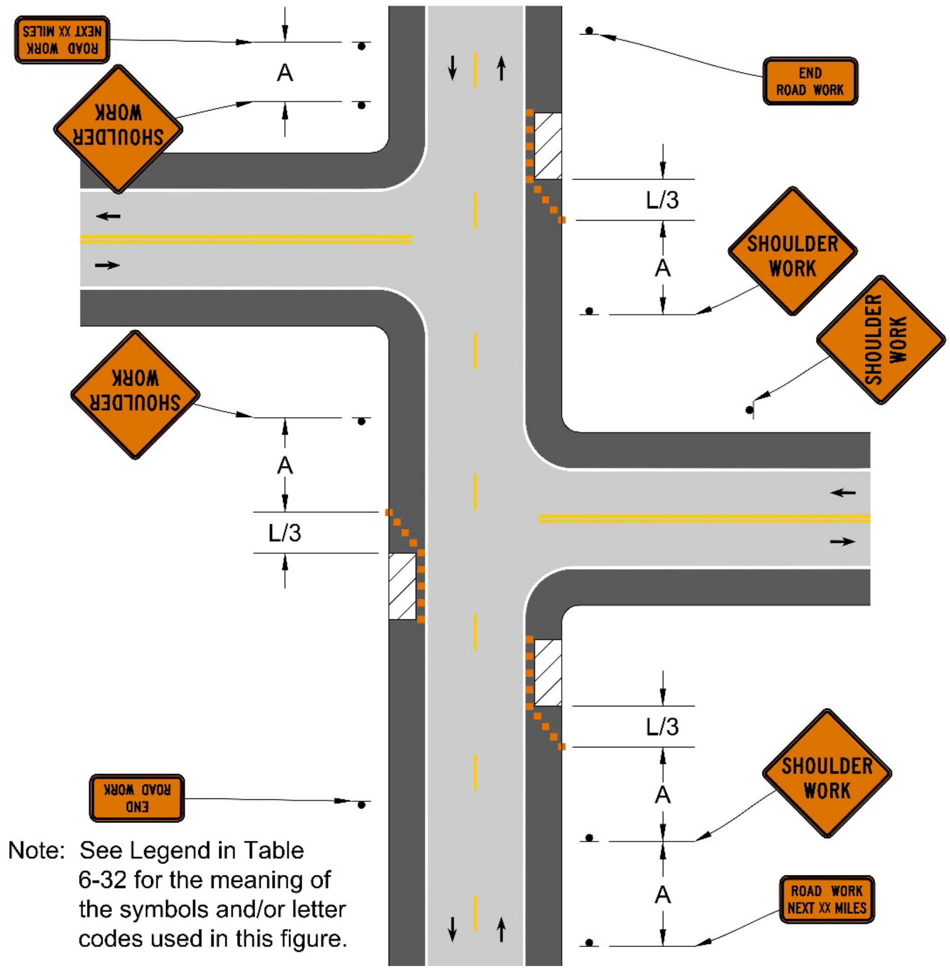


Source: *MUTCD*, Figure 6H-2 *(3)*

6.7.2 Work on the Shoulder

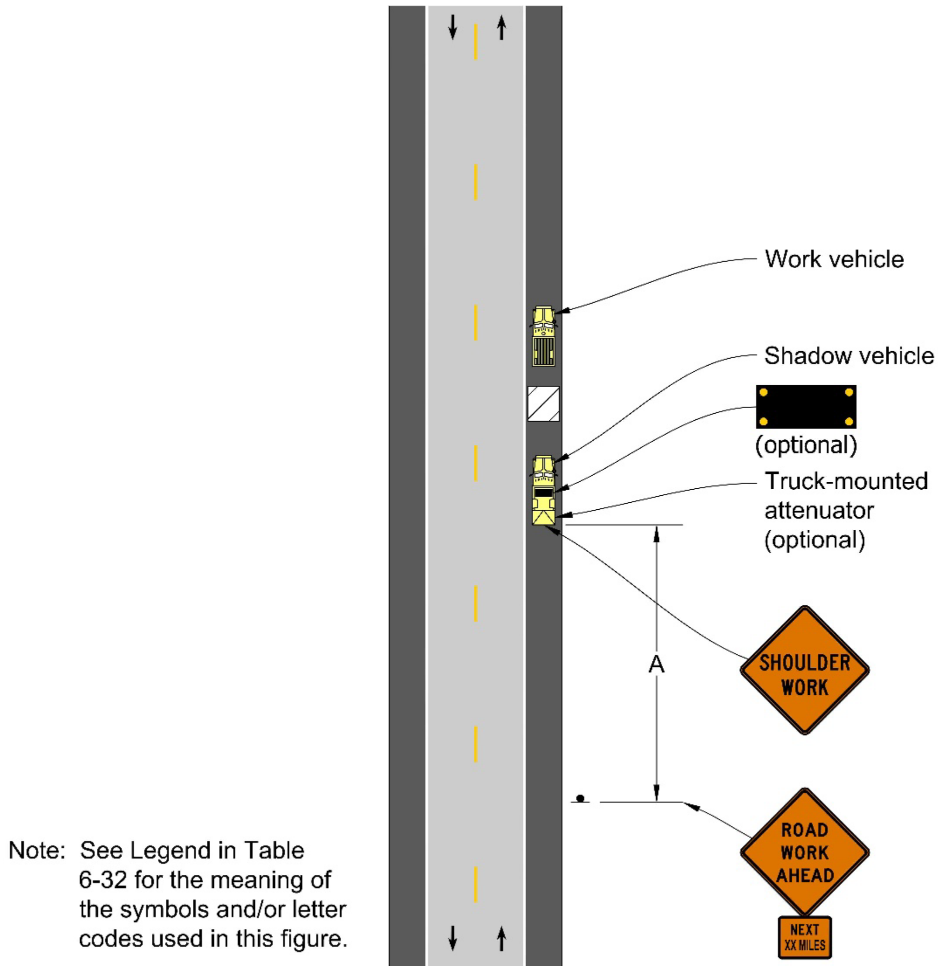
Work on the shoulder requires more traffic control devices than work off the shoulder. Typical applications for a variety of situations are illustrated in **Figure 6-32** for typical shoulder work, **Figure 6-33** for mobile operations, and **Figure 6-34** for shoulder work with minor encroachment into the travel lane. The illustration in **Figure 6-32** also shows the importance of providing a warning to intersecting roadways that are within close proximity to the work area. For shoulder closures on freeways, see **Section 6.9**.

Figure 6-32
Work on the Shoulder

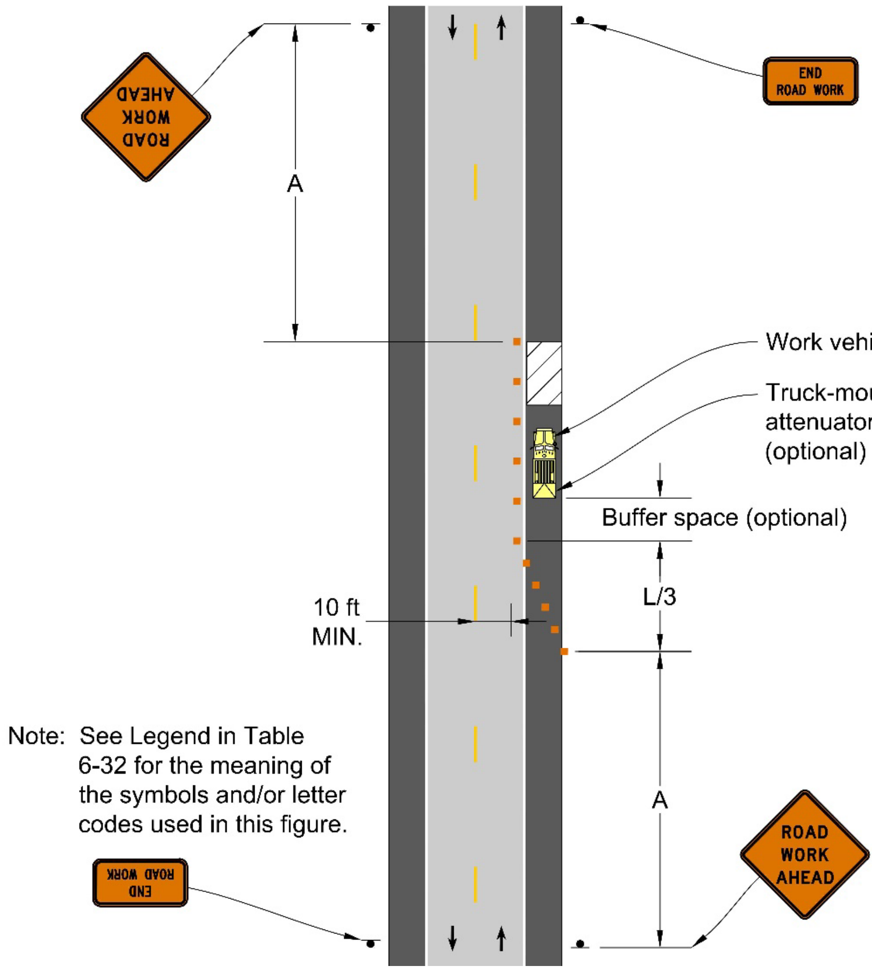


Source: *MUTCD*, Figure 6H-3 *(3)*

Figure 6-33
Short Duration or Mobile Operations on a Shoulder



Source: *MUTCD*, Figure 6H-4 *(3)*



Source: *MUTCD*, Figure 6H-6 *(3)*

Figure 6-34
Shoulder Work with Minor Encroachment

6.7.3 Lane Closures

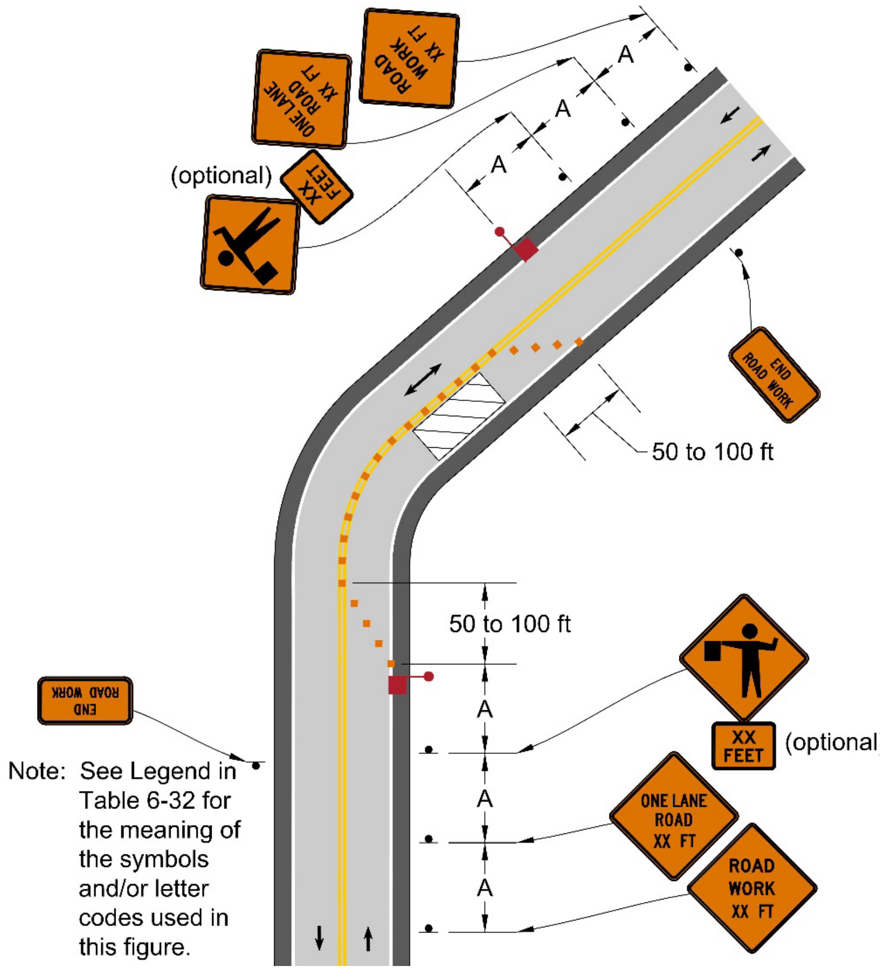
Lane closures on two-lane highways are commonly addressed by one-lane, two-way operations.

Two common types of control are used:

- Flagger operation, as shown in Figure 6-35, may be supplemented with pilot car operation if the section between flaggers is long or shifts from one side of the road to the other within the work zone.
- Temporary traffic control signals, as shown in Figure 6-36, are generally used where the control points are fixed and of sufficiently long duration to be more cost-effective, such as for bridge work or major embankment repairs; these are typically long-term work zones. Consult with TDOT Traffic Operations on signal timing parameters that are appropriate for the planned work zone.

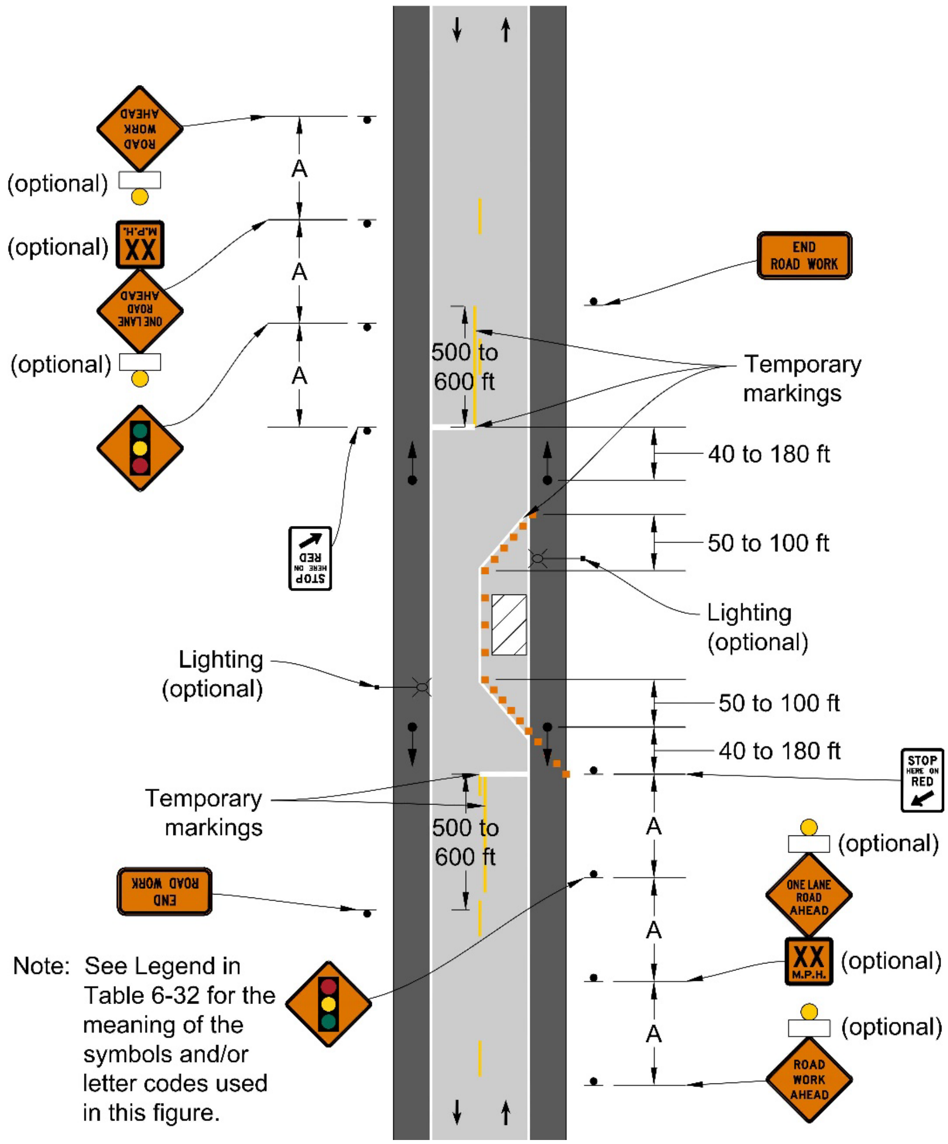
Consult with TDOT Traffic Operations about signal timing parameters that are appropriate for the planned work zone. When a project is not significant, coordinate with the Region Traffic Engineer regarding traffic operations.

Figure 6-35
Lane Closure on a Two-Lane Road Using Flaggers



Source: *MUTCD*, Figure 6H-10 *(3)*

Figure 6-36
Lane Closure on a Two-Lane Road Using Traffic Signals



Source: *MUTCD*, Figure 6H-12 *(3)*

6.7.4 Road Closures

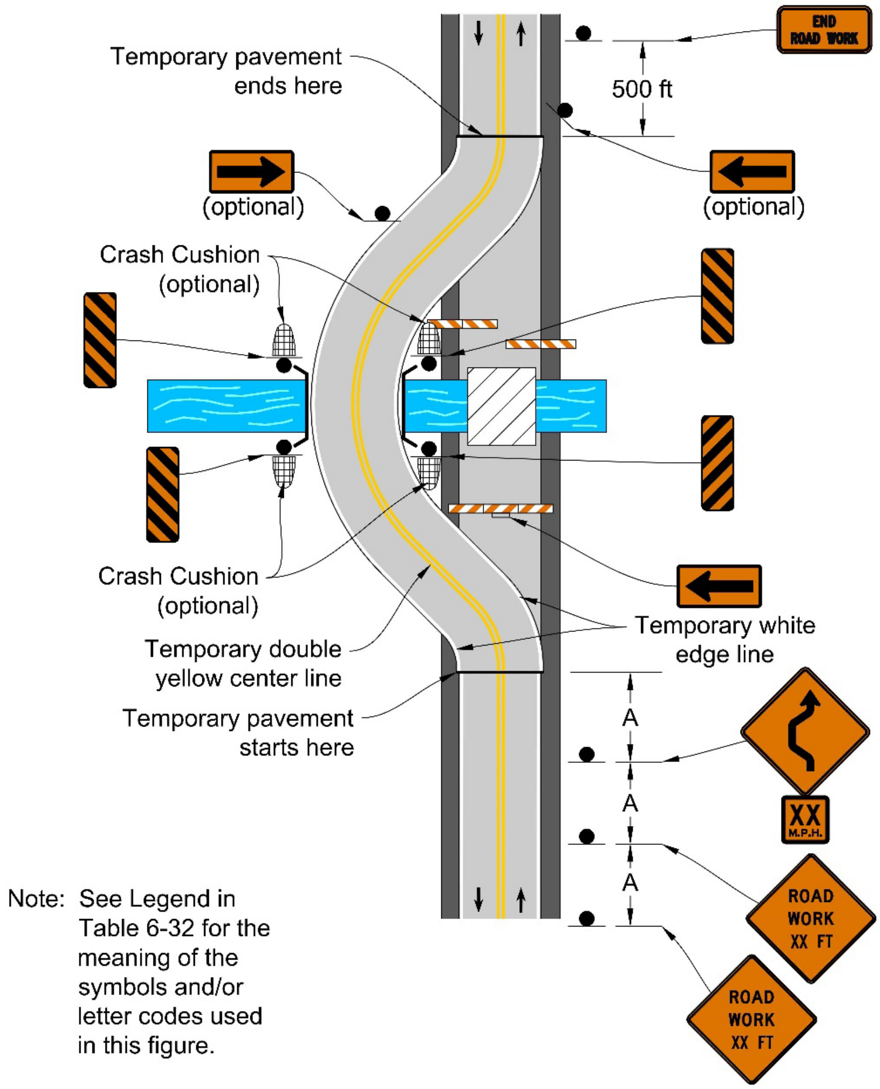
Road closures on a two-lane highway involve the complete closure of both directions of traffic. This type of traffic control measure is common for bridge construction or other activities where maintaining traffic immediately next to the work area is not desirable or possible. Compared to lane closures, road closures create more out-of-direction travel for road users. However, road closures may result in a more efficient work area, potentially shortening the duration of the project. Careful balancing of trade-offs between lane closures and road closures is needed to make the most appropriate decision for a given project. This balance between constructability and impacts to users is discussed in more detail in **Section 6.3**.

Chapter 3 provides outreach resources for communicating with stakeholders about road closures.

This balance between constructability and impacts to users is discussed in more detail in Section 6.3.

For some projects, it may be possible to close the road and provide an on-site diversion immediately adjacent to the work area. This is shown in **Figure 6-37**. The benefit of this type of operation is that all or most traffic can be accommodated on a temporary roadway without requiring detours onto other roadways. If the on-site diversion cannot be designed to serve all vehicle types (e.g., weight limits), it may be necessary to also provide detour routes as discussed below.

Figure 6-37
Road Closure with a Diversion



MUTCD, Figure 6H-7 *(3)*

For full roadway closures where on-site diversions are not possible or practical, or for roadway closures that affect one or more modes of travel (e.g., trucks), off-site detours are necessary to guide the affected road users around the road closure. The potential combinations of detour routes are site-specific and depend on both the location of the work zone and the nature of the surrounding transportation network. Further discussion of these trade-offs is provided in Section 6.3.

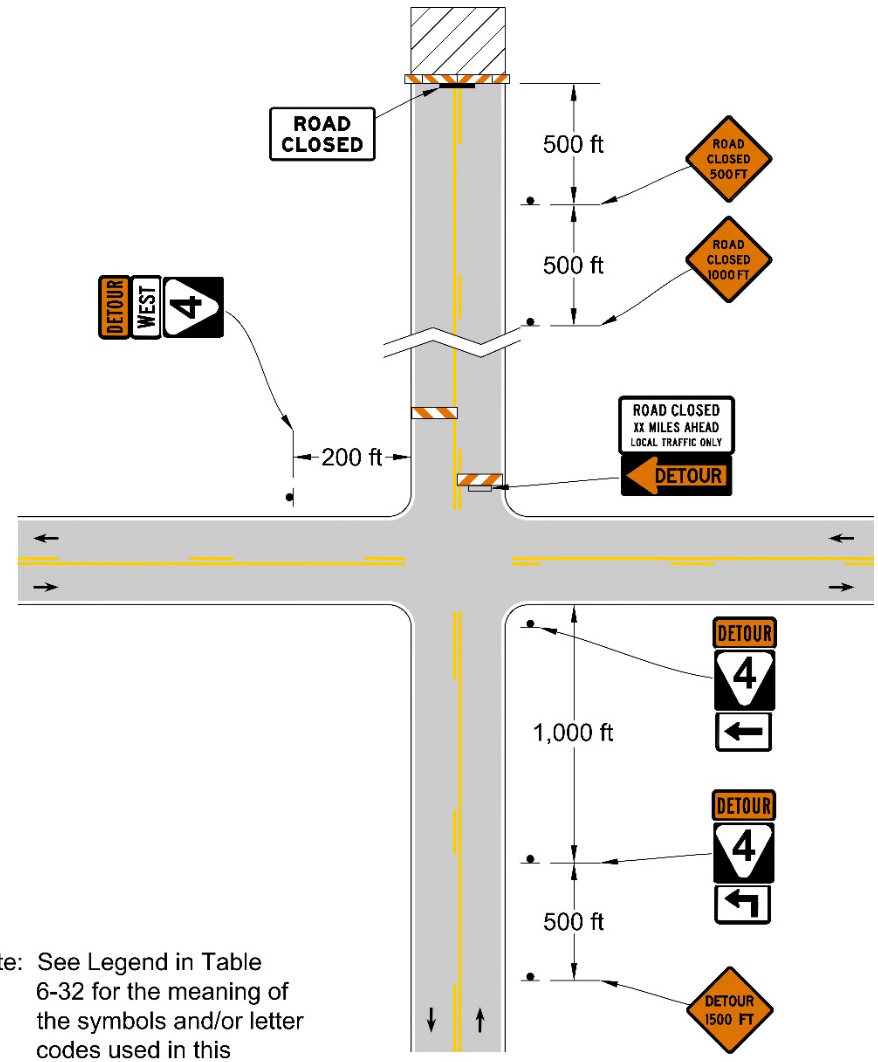
Two basic elements of a road closure with an off-site detour are illustrated in this manual: **Figure 6-38** shows the localized signing for a single route in advance of a road closure, and **Figure 6-39** shows a more complex set of signs, where two routes overlap. Key features of these detour signing plans include the following:

- The route being detoured should be signed in three places at each intersection where the detour route makes a turn:
    - in advance of the intersection so that a road user can anticipate a turn
    - at the intersection to confirm the location of the turn
    - confirmation downstream of the intersection to give the driver confidence they made the correct movement. This confirmation is also helpful at intersections where the detour is a through movement but the through alignment shifts as it passes through the intersection or where the detoured route intersects with another roadway that might be misconstrued as the detour route.
- There may be local roads or properties requiring access between the point where the detour is initiated and where the actual road closure is located. Signage to allow local traffic between these points is necessary and is illustrated in **Figure 6-38**.
- When providing advance indication of a road closure, the local context may help determine whether to sign the closure as either a certain distance ahead (e.g., XX FEET AHEAD or XX MILES AHEAD) or at or beyond a notable landmark or other feature (e.g., AT XX RIVER). Landmarks may be more helpful to unfamiliar road users, especially if there are intersecting routes nearby. Stakeholder input may help guide this decision.

Consider access to existing driveways. Work zone should be as short as possible to minimize impact.

Chapter 5 provides additional information on devices, such as the driveway assistance device (DAD).

Figure 6-38
Road Closure with an Off-Site Detour



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: *MUTCD*, Figure 6H-8 *(3)*

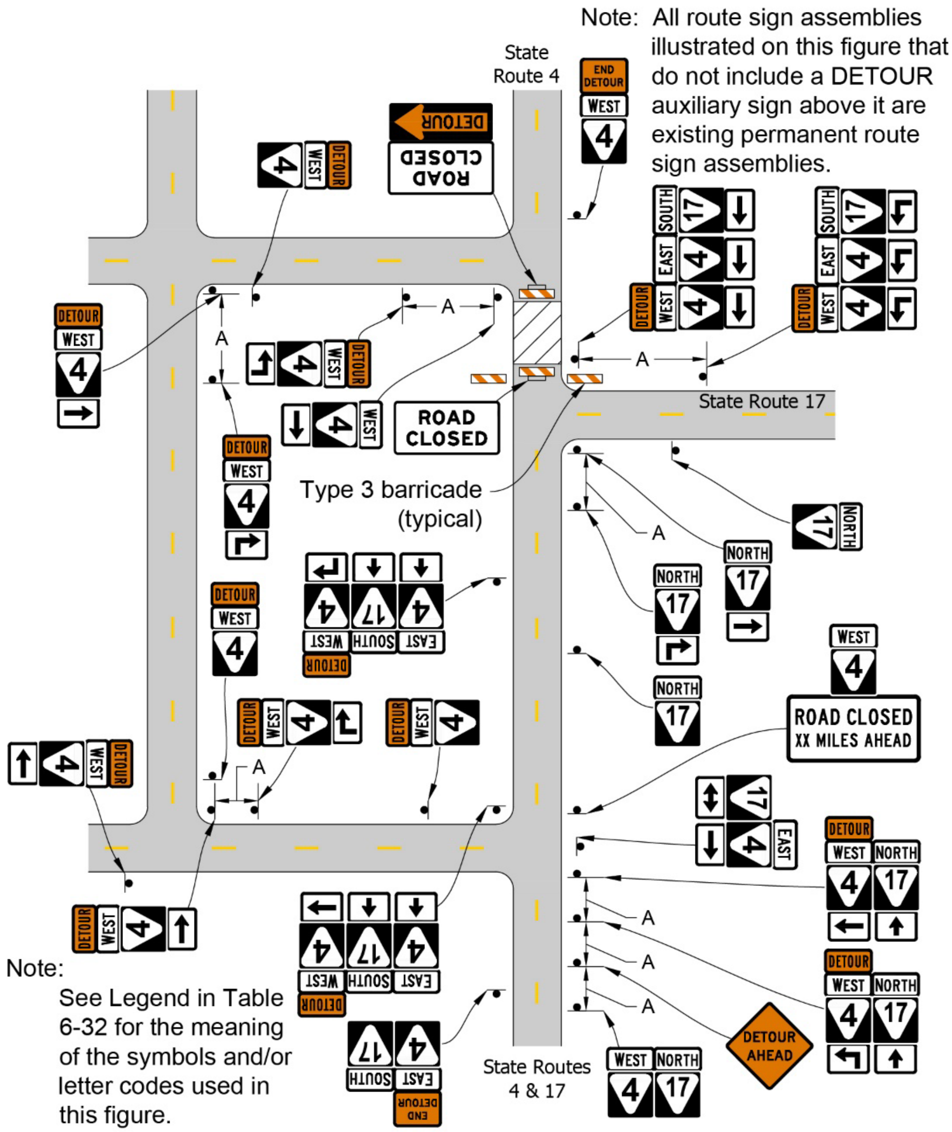


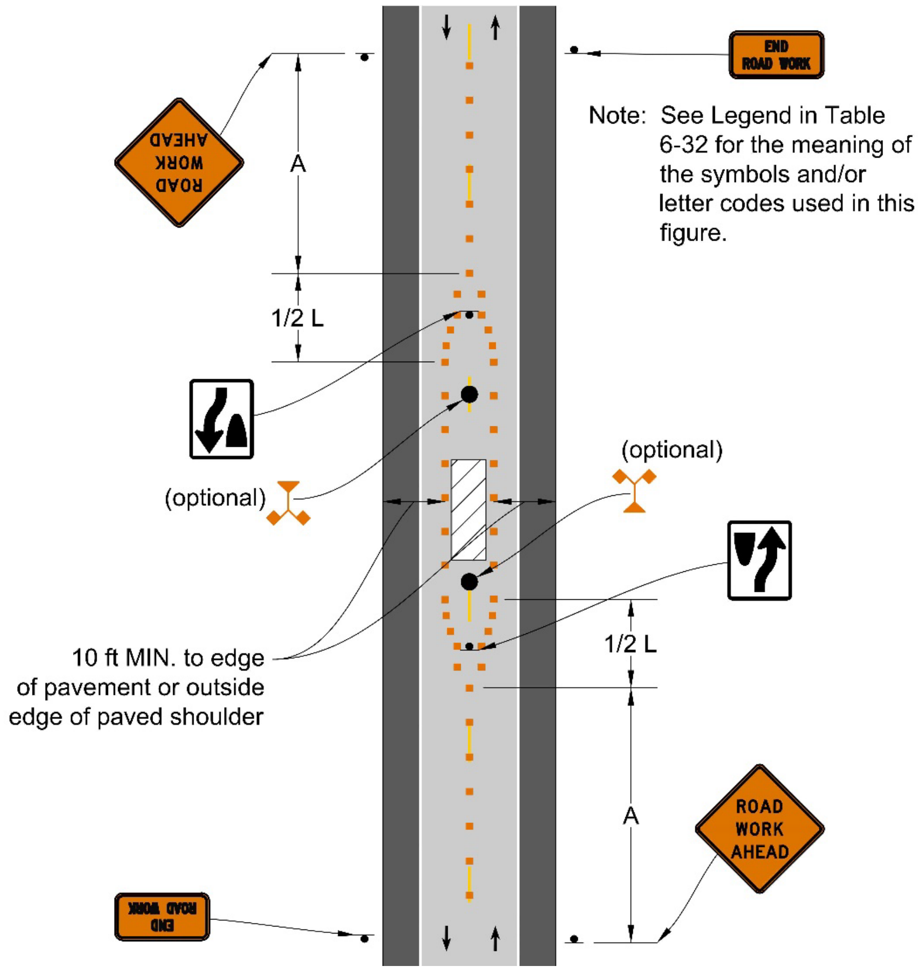
Figure 6-39 Overlapping Routes with a Detour

Source: MUTCD, Figure 6H-9 *(3)*

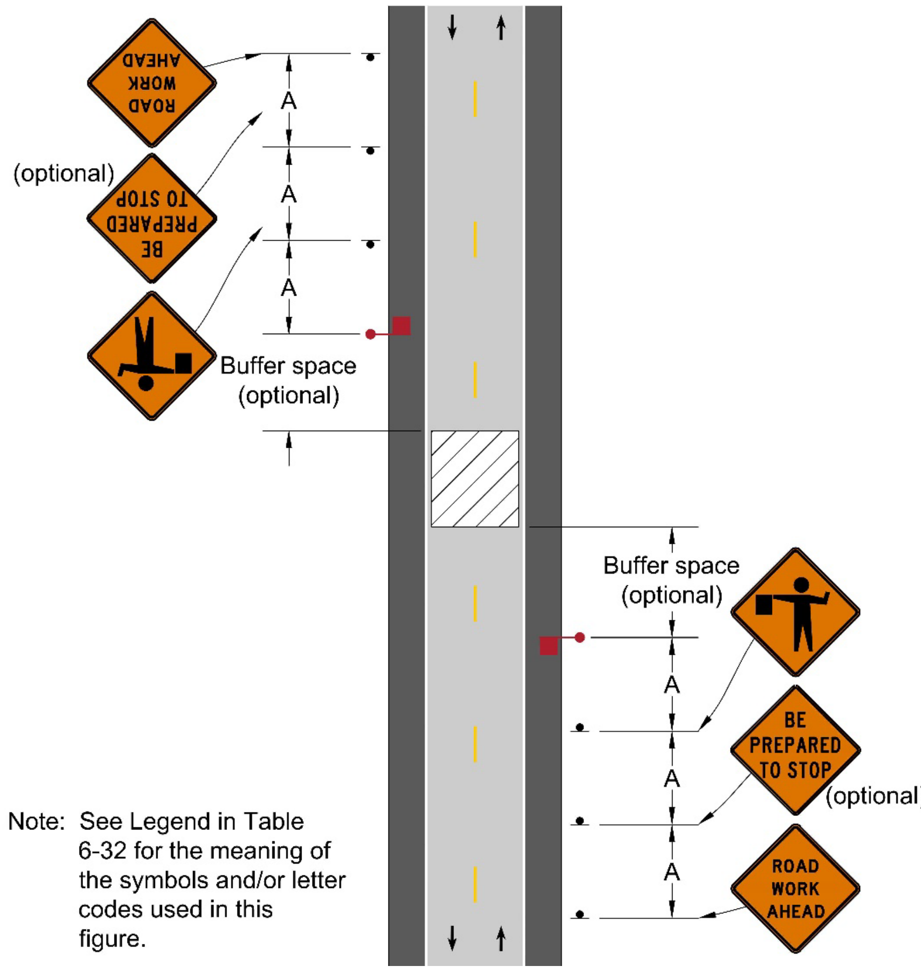
6.7.5 Work Zones on Low-Volume Roads

If traffic volumes on the two-lane highway are very low, it may be possible to use more minimal temporary traffic control techniques. The Design Team should evaluate the approaching speeds when considering these low-speed strategies and provide appropriate speed management treatments as needed. **Figure 6-40** illustrates work occurring in the center of a roadway with low volumes. **Figure 6-41** illustrates a temporary road closure.

Figure 6-40
Work in Center of Road with Low Volumes



Source: *MUTCD*, Figure 6H-15 *(3)*



Source: *MUTCD*, Figure 6H-13 *(3)*

Figure 6-41
Temporary Road Closure

6.8 TYPICAL APPLICATIONS FOR MULTILANE, NON-ACCESS-CONTROLLED HIGHWAYS

Work zones on multilane, non-access-controlled highways combine the typically rural or suburban character of two-lane highways, the multilane characteristic of freeways, and the access characteristics of urban streets. These multilane highways have the following key characteristics that factor into work zone design:

- **Cross Section:** Multilane highways may be either divided or undivided, which significantly affects temporary traffic control options.
- **Speed:** Average travel speeds tend to be medium to high.
- **Volume:** Average motor vehicle volumes can vary widely from low to high. Pedestrians and bicyclists may be present but are generally low volume.
- **Access:** Access is typically present and irregular.

Table 6-35 shows the typical applications for multilane, non-access-controlled highways, characterized by duration. For work outside of the shoulder of a multilane highway, see **Section 6.7.1** for typical applications. For work on the shoulder of a multilane highway, see **Section 6.7.2** for typical applications. For work zones at intersections on multilane highways, the techniques provided in Section 6.6 for urban streets may also be used.

Table 6-35
Applications Summary Table for Multilane, Non-Access-Controlled Highways

Typical Applications	Duration				
	Mobile	Short Duration	Short-Term	Intermediate-Term	Long Term
6.8.1: Undivided Multilane Highways					
Interior Lane Closure on a Multi-Lane Street		X	X	X	X
Lane Closure on a Street with Uneven Directional Volumes		X	X	X	X
Half Road Closure on a Multi-Lane, High-Speed Highway		X	X	X	X
6.8.2: Divided Multilane Highways					
Stationary Lane Closure on a Divided Highway		X	X	X	X
Lane Closure with a Temporary Traffic Barrier		X	X	X	X
Median Crossover on a Divided, Non-Access-Controlled Multilane Highway				X	X
Mobile Operations on a Multilane Road	X				

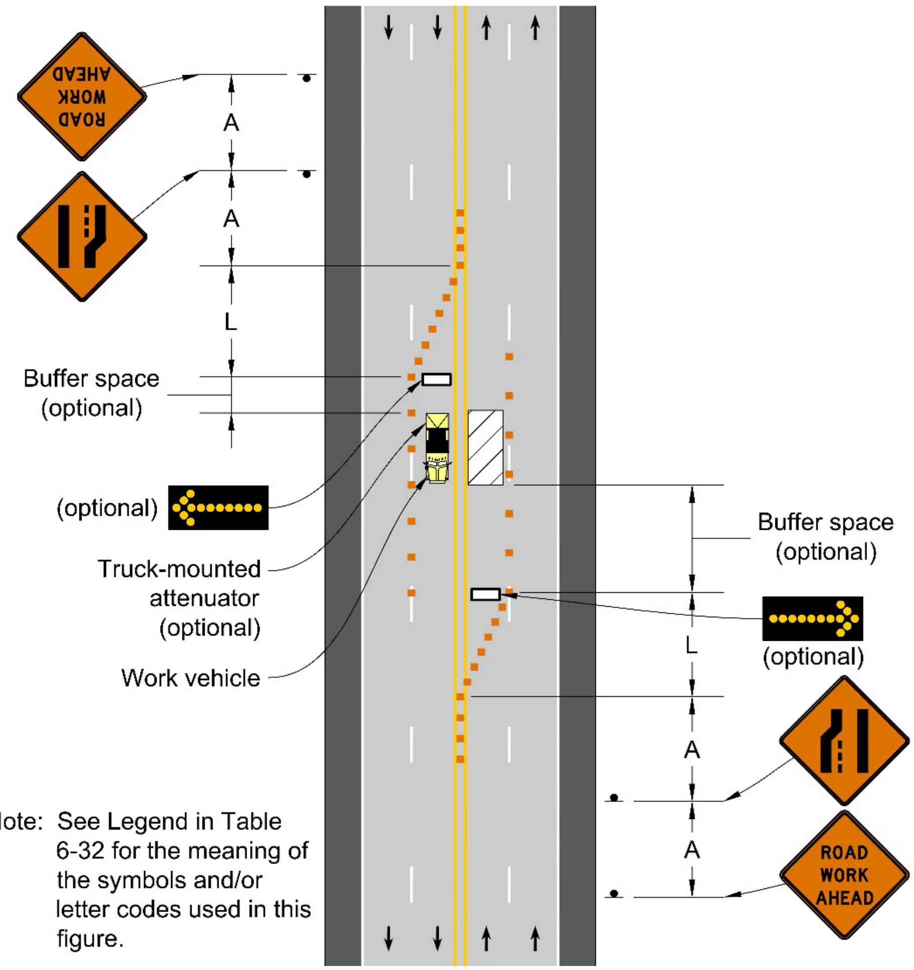
6.8.1 Undivided Multilane Highways

Many aspects of work zones on undivided multilane highways are similar to those for urban streets and two-lane highways, and the traffic control measures presented in the previous sections may apply. Undivided multilane highways introduce another aspect that provides some flexibility: the ability to close one lane of traffic and to shift travelers over the centerline as needed.

Several typical applications demonstrate common scenarios for undivided multilane highways:

- interior lane closures, as illustrated in **Figure 6-42**
- lane closures and shifts over the centerline, as illustrated in **Figure 6-43**
- lane closures with a bicycle diversion, as illustrated in **Figure 6-44**
- half-road closure on a multilane, high-speed highway, as illustrated in **Figure 6-45**

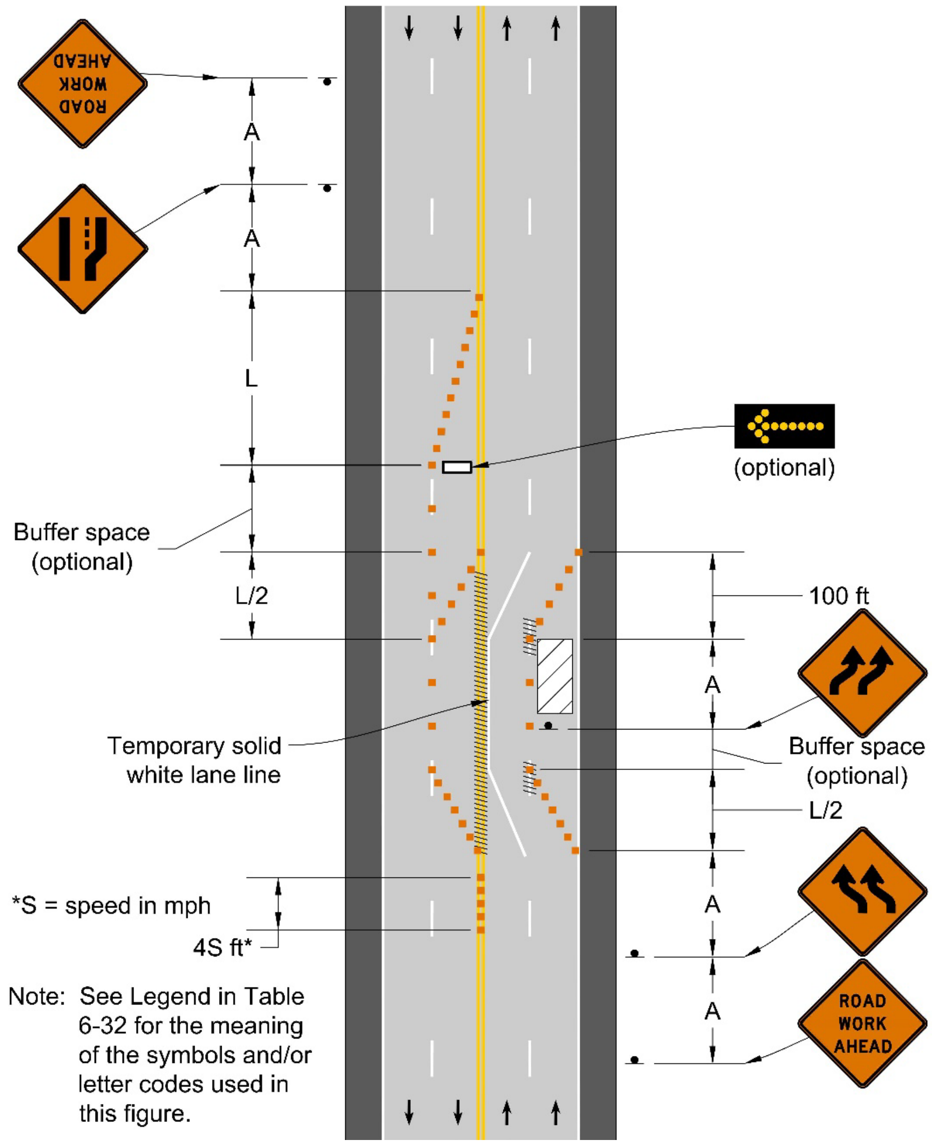
Figure 6-42
Interior Lane Closure on a Multilane Street



Note: See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

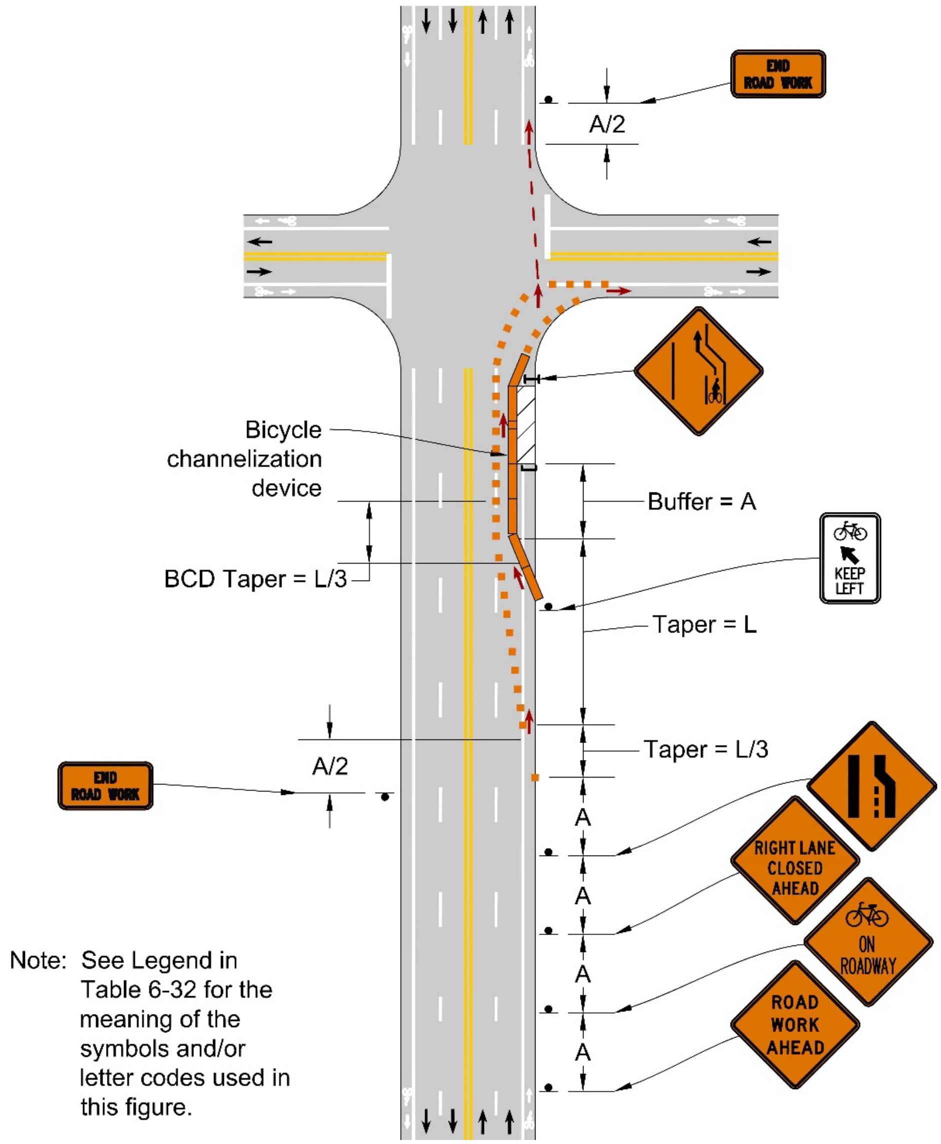
Source: *MUTCD*, Figure 6H-30 *(3)*

Figure 6-43
Lane Closures on a Street with Uneven Directional Volumes



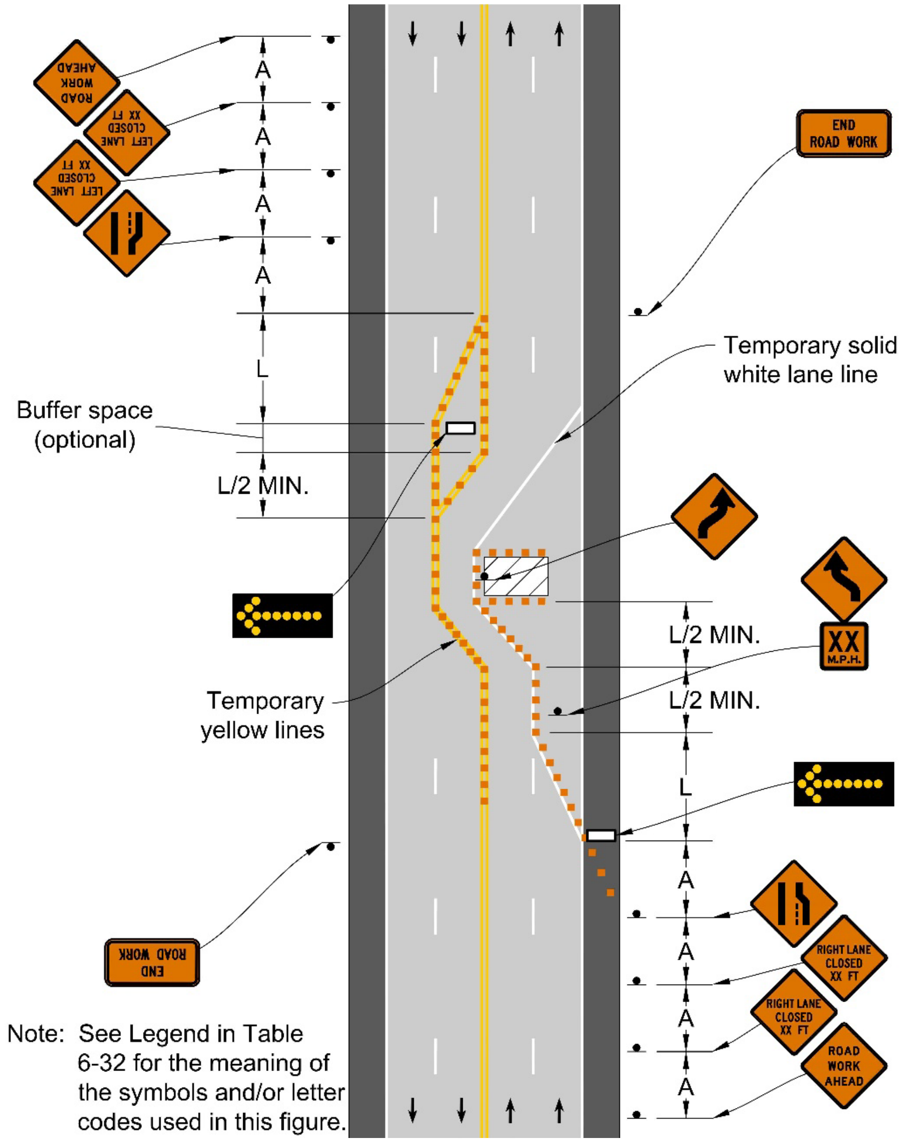
Source: *MUTCD*, Figure 6H-31 *(3)*

Figure 6-44
Lane Closure with Bicycle Diversion



Source: Oregon Department of Transportation, Figure 3-2 *(15)*

Figure 6-45
Half-Road Closure on a Multilane, High-Speed Highway



Source: *MUTCD*, Figure 6H-32 *(3)*

6.8.2 Divided Multilane Highways

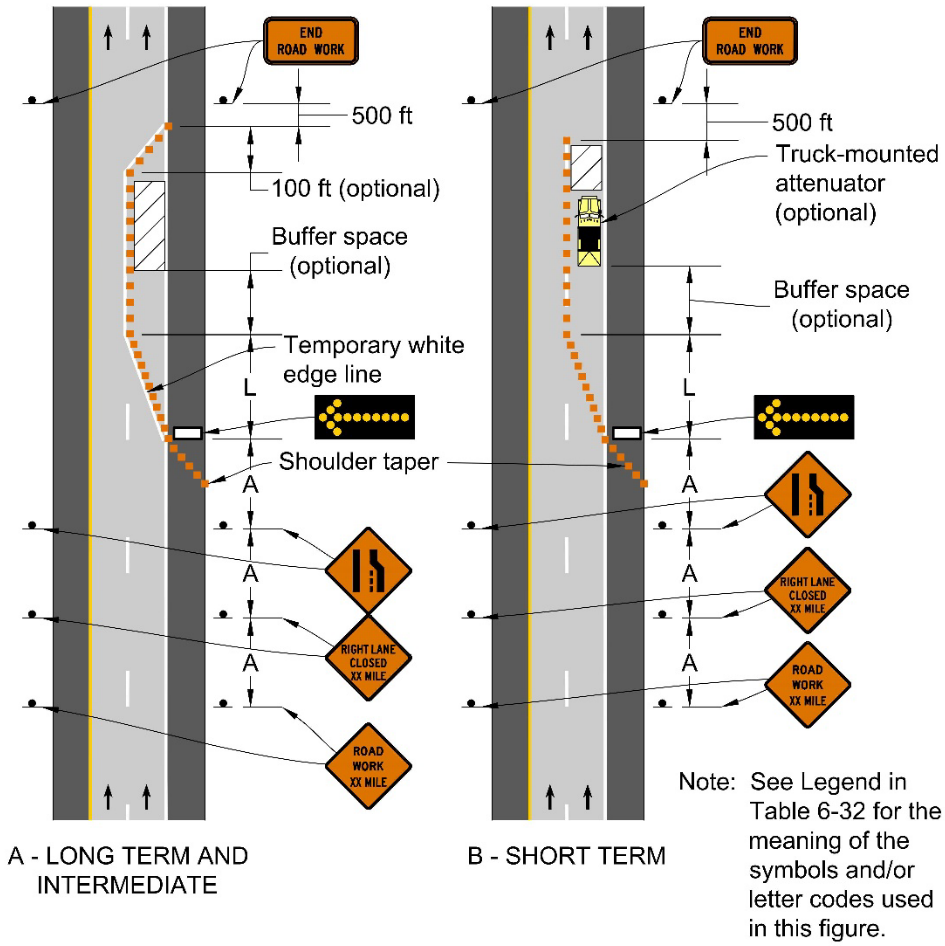
As with undivided multilane highways, many aspects of work zones on divided multilane highways are similar to those for urban streets or two-lane highways, and the traffic control measures presented in the previous sections may apply. Concepts in the following section about freeways and expressways may also apply, as some divided multilane highways have interchanges in place of some intersections.

Several typical applications demonstrate common scenarios for divided multilane highways:

- stationary lane closure on one side of a divided highway, as illustrated in **Figure 6-46**
- lane closure with a temporary traffic barrier, as illustrated in **Figure 6-47**

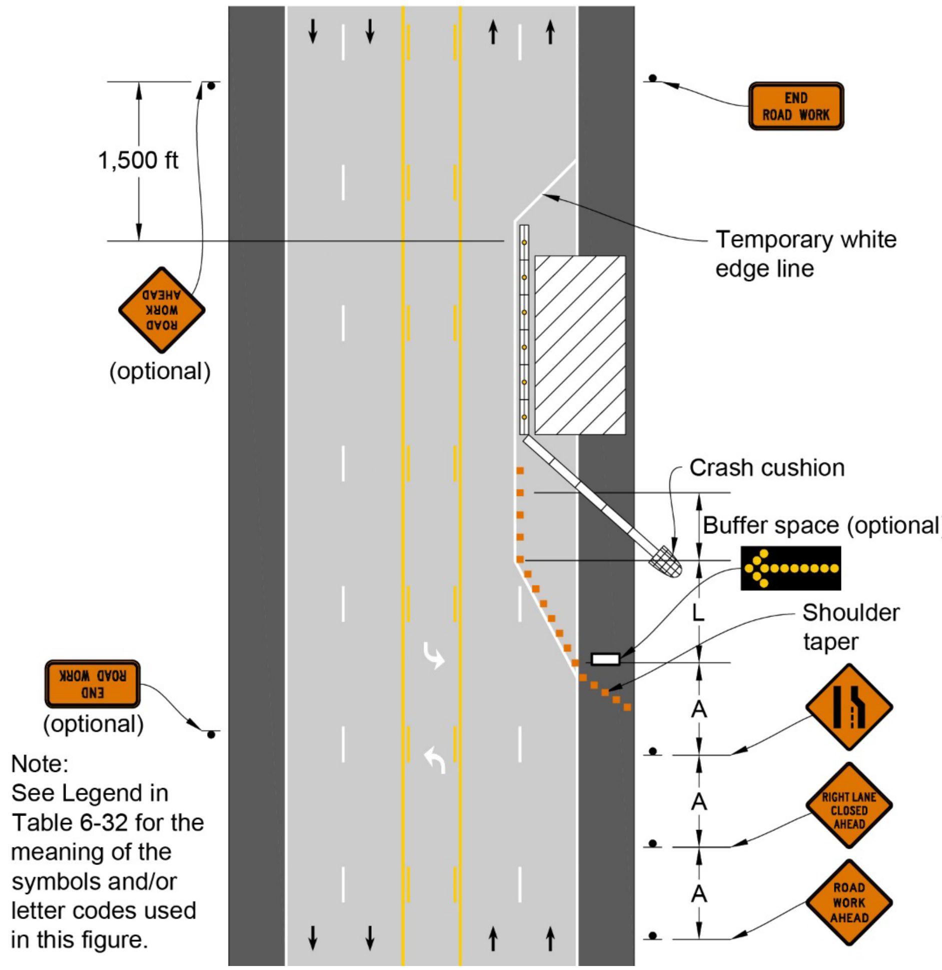
- Median crossover treatment, as illustrated in **Figure 6-48**.
  - Property access within the crossover area requires attention, given that traffic patterns on the multilane highway will be compressed into one lane in each direction, making ingress and egress more difficult. Where possible, access points should be shifted out of the section encompassing the crossovers and two-way traffic movements. If an access point is located within the two-way section of roadway, it may be beneficial to restrict access to right-in/right-out using raised channelization between the opposing lanes on the highway.
- mobile operations on a multilane road, as illustrated in **Figure 6-49**.

Figure 6-46
Stationary Lane Closure on One Side of a Divided Highway



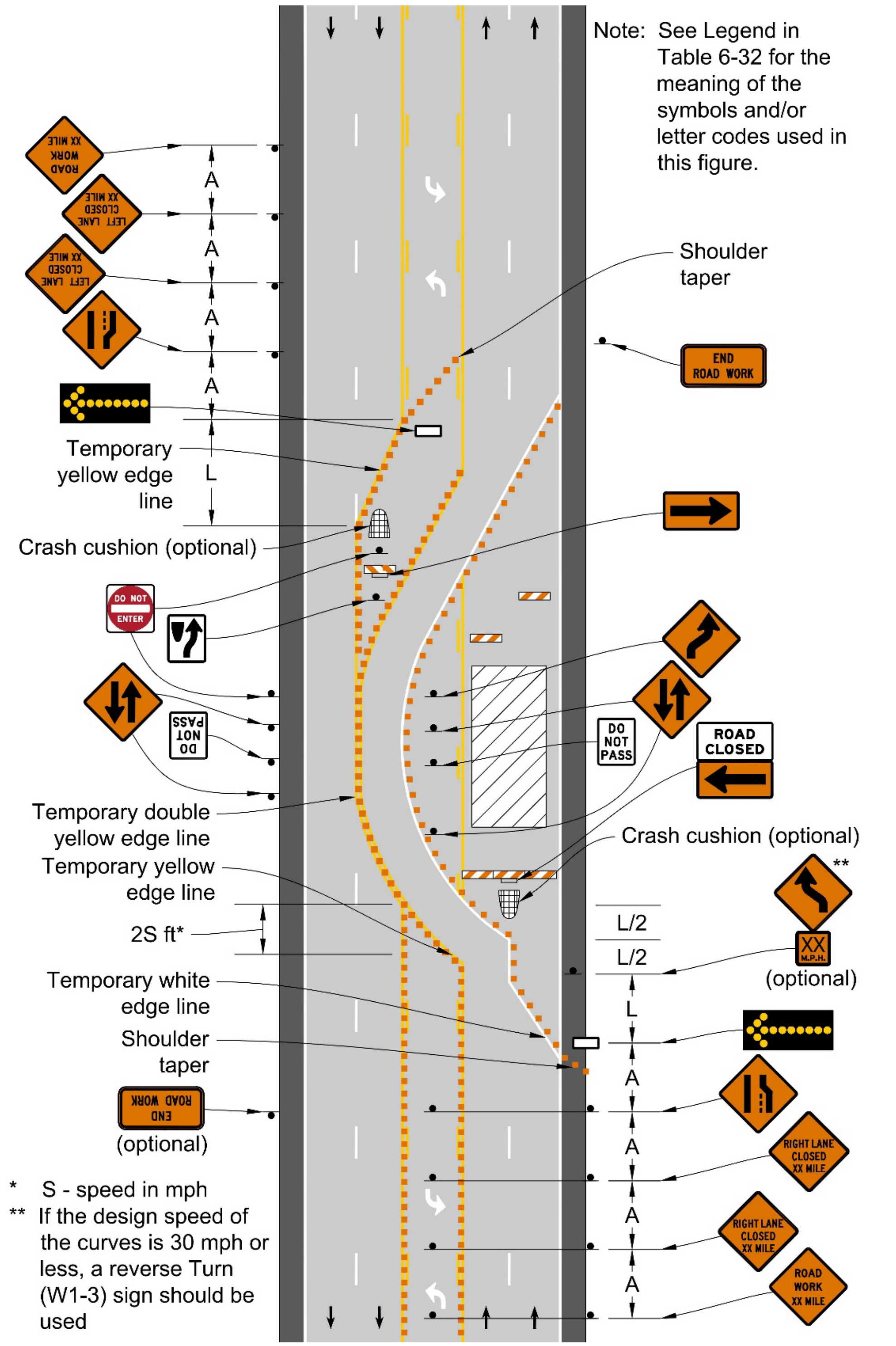
Source: *MUTCD*, Figure 6H-33 *(3)*

Figure 6-47
Lane Closure with a Temporary Traffic Barrier



Source: *MUTCD*, Figure 6H-34 *(3)*

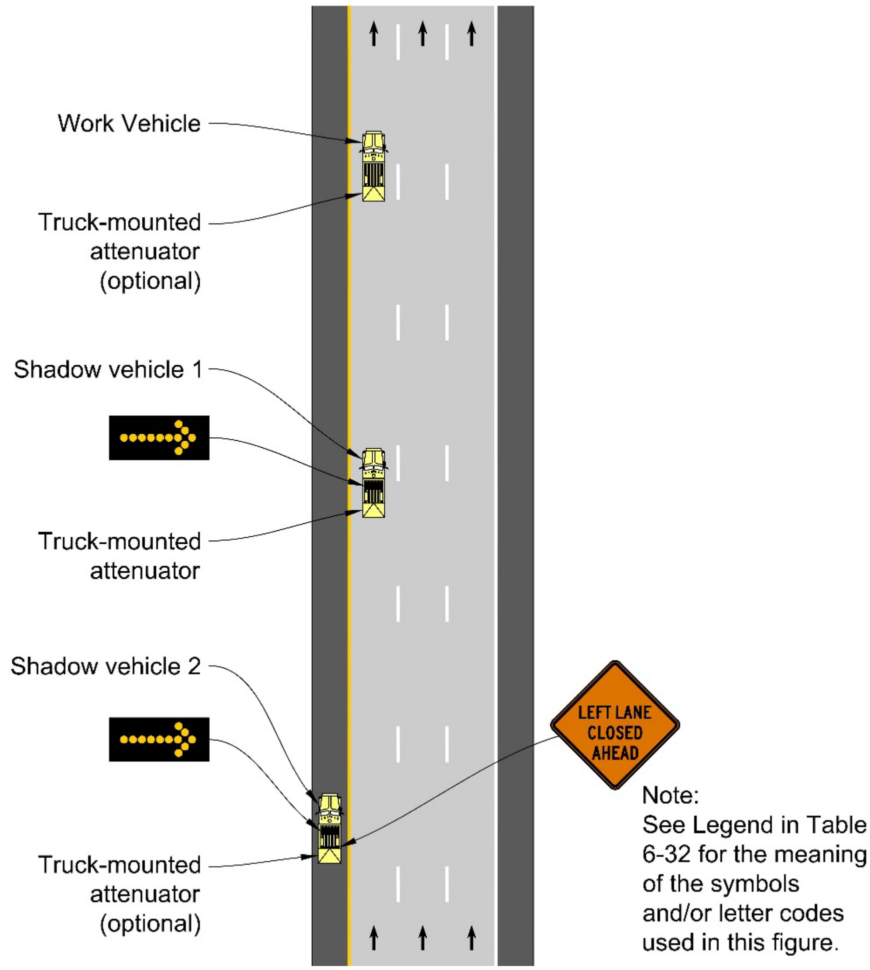
Figure 6-48
Median Crossover on a Divided, Non-Access-Controlled Multilane Highway



Source: *MUTCD*, Figure 6H-39 *(3)*

Figure 6-49
Mobile Operation on a Multilane Road

Consider including a Protect the Queue vehicle for this type of operation. Refer to SP 712 PTQ for additional information.



Source: *MUTCD*, Figure 6H-35 *(3)*

6.9 TYPICAL APPLICATIONS FOR FREEWAYS AND EXPRESSWAYS

Work zones on freeways and expressways share some of the features of multilane, non-access-controlled highways. The Design Team should consider the broader area of the project and verify any impacts that on- or off-ramps in the advanced warning area might have on lane closure. Drivers may need additional advanced warning to reduce conflict points. Freeways and expressways have the following key characteristics that factor into work zone design:

- **Cross Section:** The cross section is divided.
- **Speed:** Average travel speeds tend to be high.
- **Volume:** Average motor vehicle volumes tend to be medium to high, particularly in urban areas. Truck volumes tend to be higher than on other facility types. Pedestrians and bicyclists are generally prohibited.
- **Access:** Access is limited to exit ramps and entrance ramps at interchanges, and these are spaced farther apart than access points on a multilane, non-access-controlled highway. This makes work zones between interchanges simpler than for multilane, non-access-controlled highways but conversely makes work zones more challenging when they span one or more interchanges.

Table 6-36 shows the typical applications for freeways and expressways, characterized by duration.

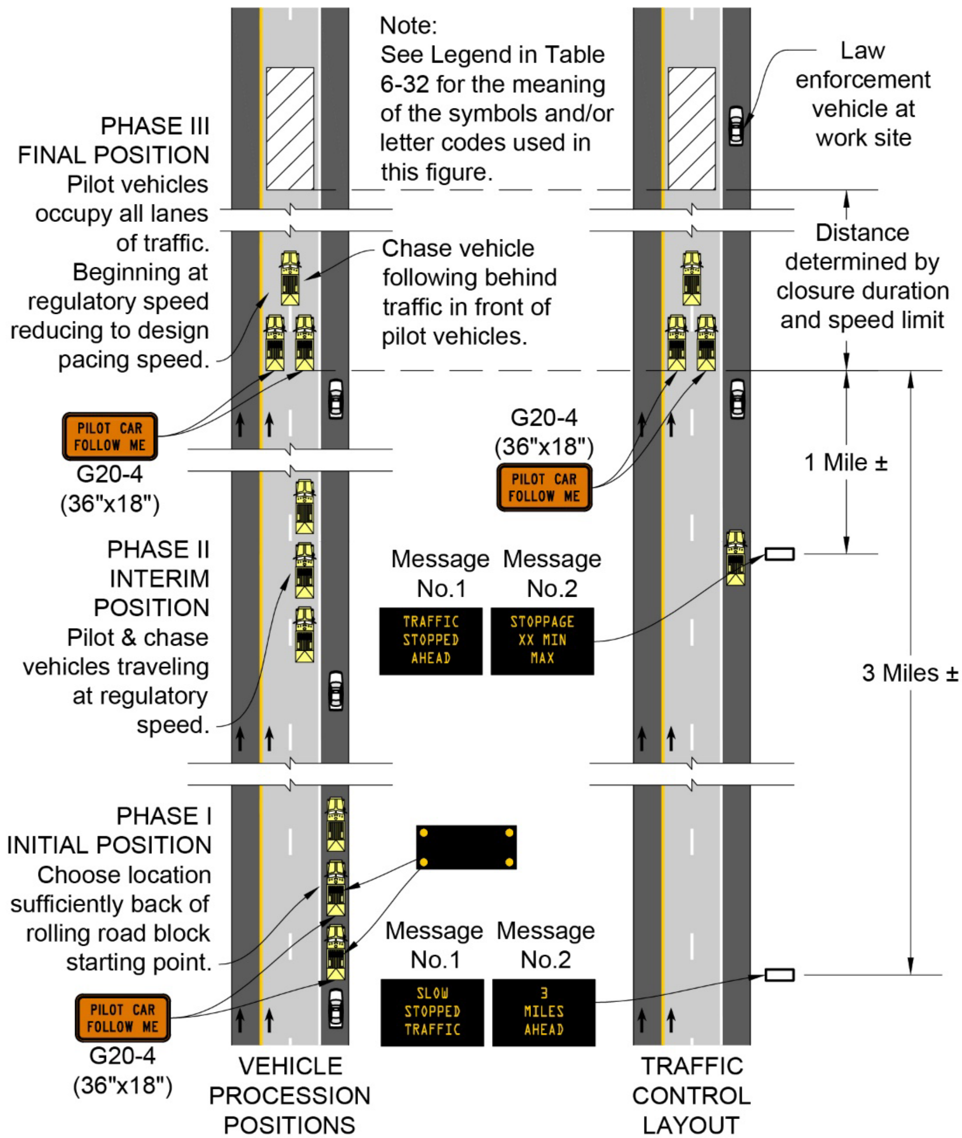
Table 6-36
Applications Summary Table for Freeways and Expressways

Typical Applications	Duration				
	Mobile	Short Duration	Short-Term	Intermediate-Term	Long Term
6.9.1: Rolling Slowdowns					
Rolling Slowdowns	X				
6.9.2: Work Zones Partially Extending into Direction of Travel					
Shoulder Closure on a Freeway		X	X	X	X
Lane Shift on a Freeway		X	X	X	X
6.9.3: Multiple Lane Closures on a Freeway					
Double Lane Closure on a Freeway		X	X	X	X
Interior Lane Closure on a Freeway		X	X	X	X
6.9.4: Work Zones Spanning Width of Direction of Travel					
Median Crossover on a Freeway				X	X
Temporary Reversible Lane Using Movable Barriers				X	X
Median Crossover for an Entrance Ramp				X	X
Median Crossover for an Exit Ramp				X	X
6.9.5: Work on or in the Vicinity of Interchange Ramps					
Work in the Vicinity of the Exit Ramp		X	X	X	X
Partial Exit Ramp Closure		X	X	X	X
Work in the Vicinity of an Entrance Ramp		X	X	X	X
Use of Interchange Ramps to Bypass Freeway		X	X	X	
Use of Interchange Ramps to Bypass Freeway for Vehicles Exceeding Reduced Vertical Clearance		X	X	X	X
6.9.6: Work Involving Closure of Interchange Ramps					
Exit Ramp Closure Using Detour that Follows Closure		X	X	X	X
Exit Ramp Closure Using Detour that Precedes Closure		X	X	X	X
Entrance Ramp Closure Using Detour on Parallel Route		X	X	X	X
Entrance Ramp Closure Using Detour on Freeway		X	X	X	X

6.9.1 Rolling Roadblock

A rolling roadblock should be used when installing, shifting, or removing temporary traffic control from the travel lanes or shoulder of a freeway. This is shown in **Figure 6-50.** Further guidance on setting up rolling roadblocks can be found in TDOT Standard Drawing T-WZ-61 and the *Field Manual*. *(1)*

Figure 6-50
Rolling Roadblock Extending Partially into Freeway



Source: TDOT Standard Drawing, Rolling Roadblock Detail for Divided Highways, T-WZ-61 *(2)*

If the rolling roadblock extends through an interchange, the affected entrance ramps should be temporarily closed for the duration of the rolling roadblock.

6.9.2 Work Zones Partially Extending into Direction of Travel

For simple work zones between interchanges involving the shoulder or that partially extend into one direction of travel, the techniques include shoulder closures, lane closures, and lane shifts.

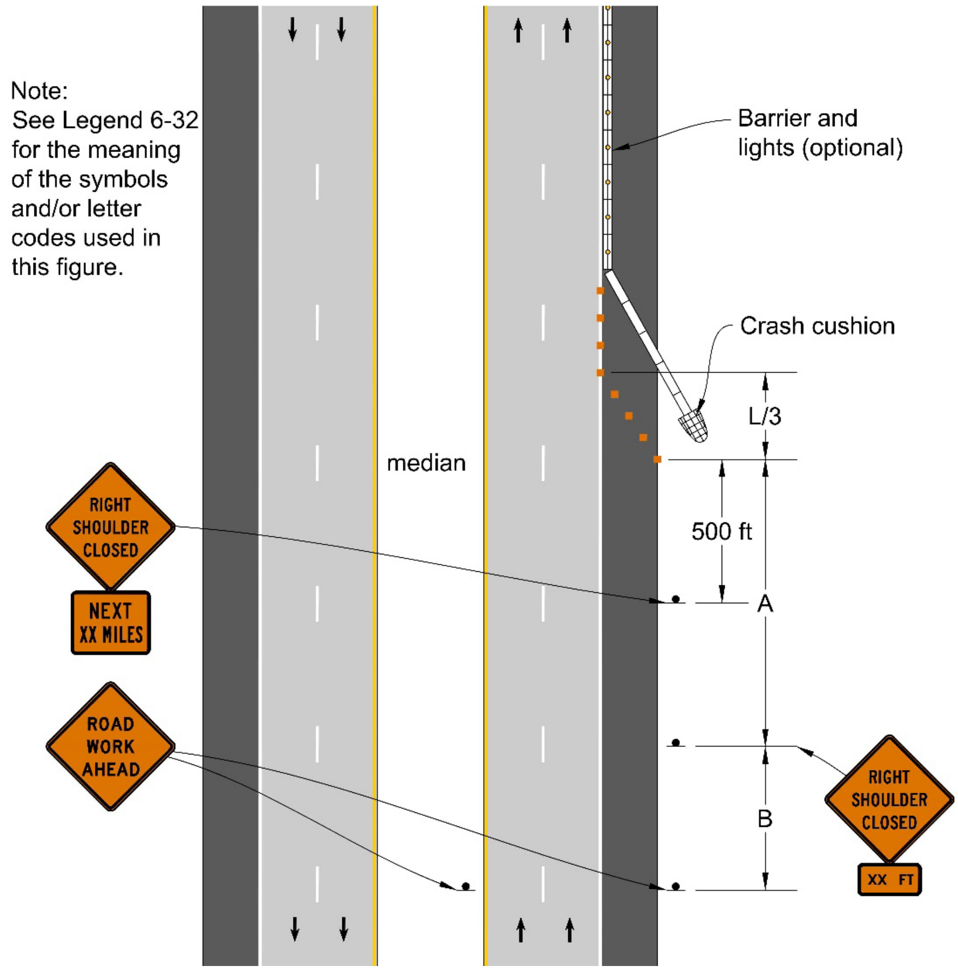
Simple Work Zones

These simple work zones include lane paving, shoulder paving, and other similar activities that are limited to a portion of the roadway, as well as work off the roadway but in close proximity. In the simplest cases, it is often possible to close only the shoulder or the shoulder and one travel lane, as shown in **Figure 6-51 and Figure 6-52**, respectively. See TDOT standard drawing T-WZ-11 for additional signing recommendations and design guidance.

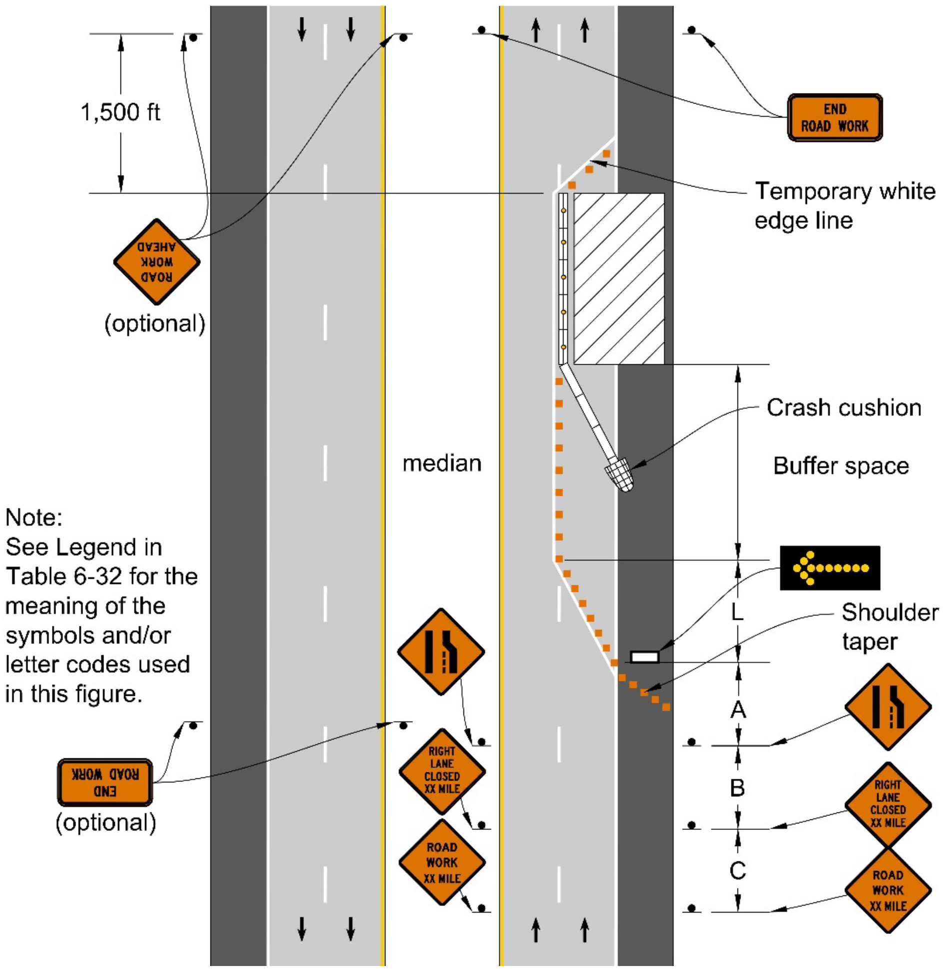
This can be for work on the shoulder where additional lateral space is needed for work activities as well as for work in the travel lane. Key features of the work zone design in these applications include the following:

- sufficient advance warning of the approaching work zone
- appropriate tapers to close the shoulder and the travel lane
- adequate physical protection of the work area.
    - For freeways, the use of concrete barriers with appropriate end treatments is essential due to the higher speed of freeway traffic.
- In some cases, it can be beneficial to also provide notification of the start and end of the work zone in the opposite direction of travel. This is particularly true when work activities may be visible and distracting to drivers traveling in the opposing direction of travel.

Figure 6-51
Shoulder Closure on a Freeway



Source: *MUTCD*, Figure 6H-5 *(3)*



Source: *MUTCD*, Figure 6H-34 *(3)*

Figure 6-52
Single Lane Closure on a Freeway

A primary consideration for using this work zone typical application is the traffic volume in the direction of travel within the work zone. If the traffic volume is projected to be higher than can be accommodated within the reduced capacity of the work area, then a slow-moving queue will form at the lane reduction area. The resulting speed differential between the slow-moving queue and approaching high-speed traffic substantially increases the risk of rear-end crashes approaching the work zone.

If a lane closure results in unacceptable traffic impacts, a lane shift may be an appropriate treatment. This is illustrated in **Figure 6-53**. A lane shift uses the shoulder, and in some cases, temporary pavement beyond the existing paved shoulder, to accommodate a lateral shift in each of the travel lanes. Before a lane shift is used, the structural section of the shoulder and any new temporary pavement should be verified and strengthened, if needed, to accommodate freeway traffic, including trucks.

Before a lane shift is used, the structural section of the shoulder and any new temporary pavement should be verified and strengthened, if needed, to accommodate freeway traffic, including trucks.

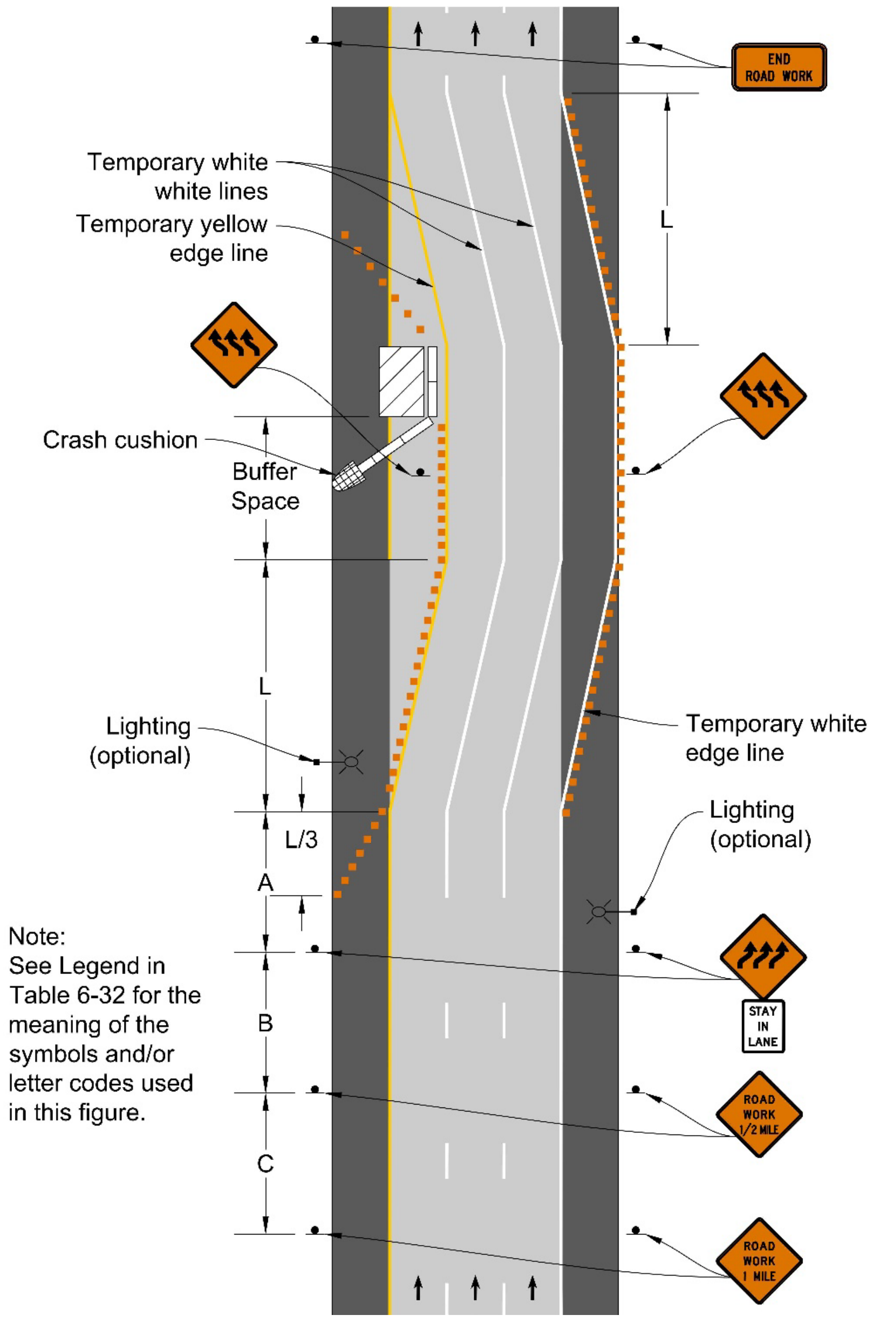
Key features of the work zone design in these applications include the following:

- sufficient advance warning of the approaching work zone
- appropriate shifting tapers for each travel lane
- reduction in lane widths (i.e., 11 feet) as needed to allow work zone to fit while continuing to serve design vehicles

- adequate physical protection of the work area.
    - For freeways, the use of concrete barriers with appropriate end treatments is recommended wherever possible due to the higher speed of freeway traffic.

Wide (8 inches) solid lane lines are recommended for temporary marking at lane transitions and lane shifts. Wide lines provide better guidance through changes in alignment, especially where conflicting traces of removed marking may remain. Wide-edge line marking is also recommended next to portable concrete barrier rail. TDOT Standard Drawing T-WZ-16 provides additional information if needed.

Figure 6-53
Lane Shift on Freeway

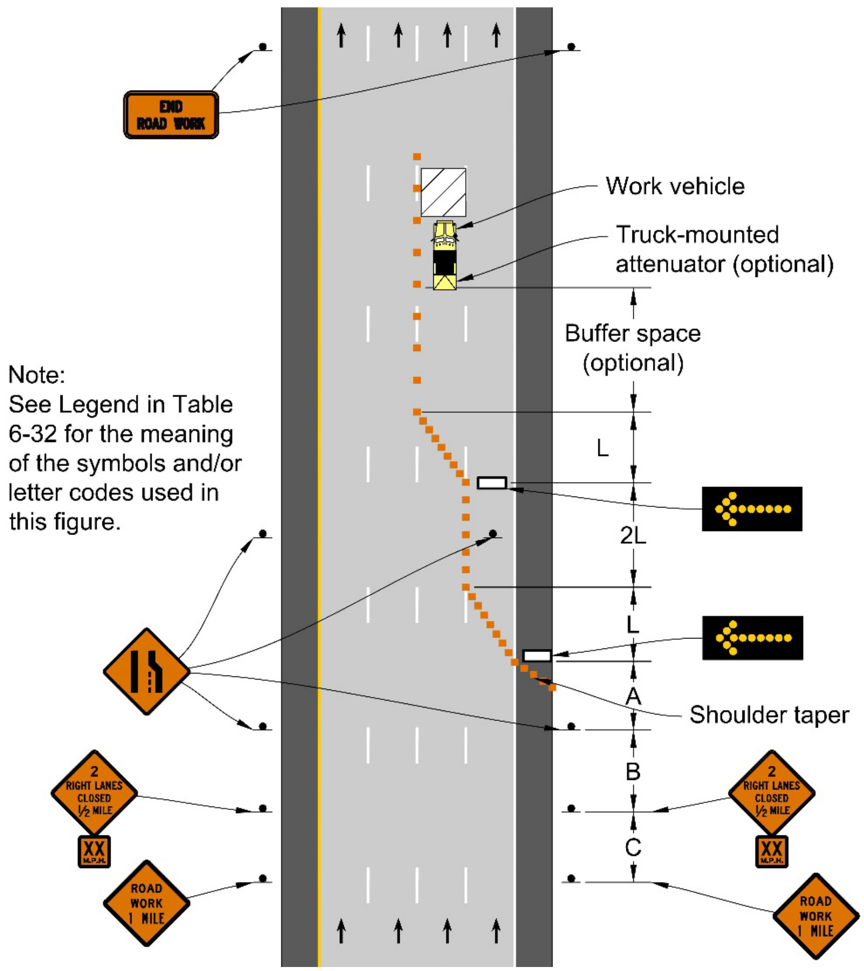


Source: TDOT Standard Drawing, Rolling Roadblock Detail for Divided Highways, T-WZ-16 *(2)*

6.9.3 Multiple Lane Closures on a Freeway

For freeways with more than two lanes in one direction, it may be necessary to work in multiple lanes or the interior lanes, as shown in **Figure 6-54 and Figure 6-55**, respectively. As a general principle, it is usually better to close lanes from one side only, as it better protects workers in the work area and is less confusing for drivers.

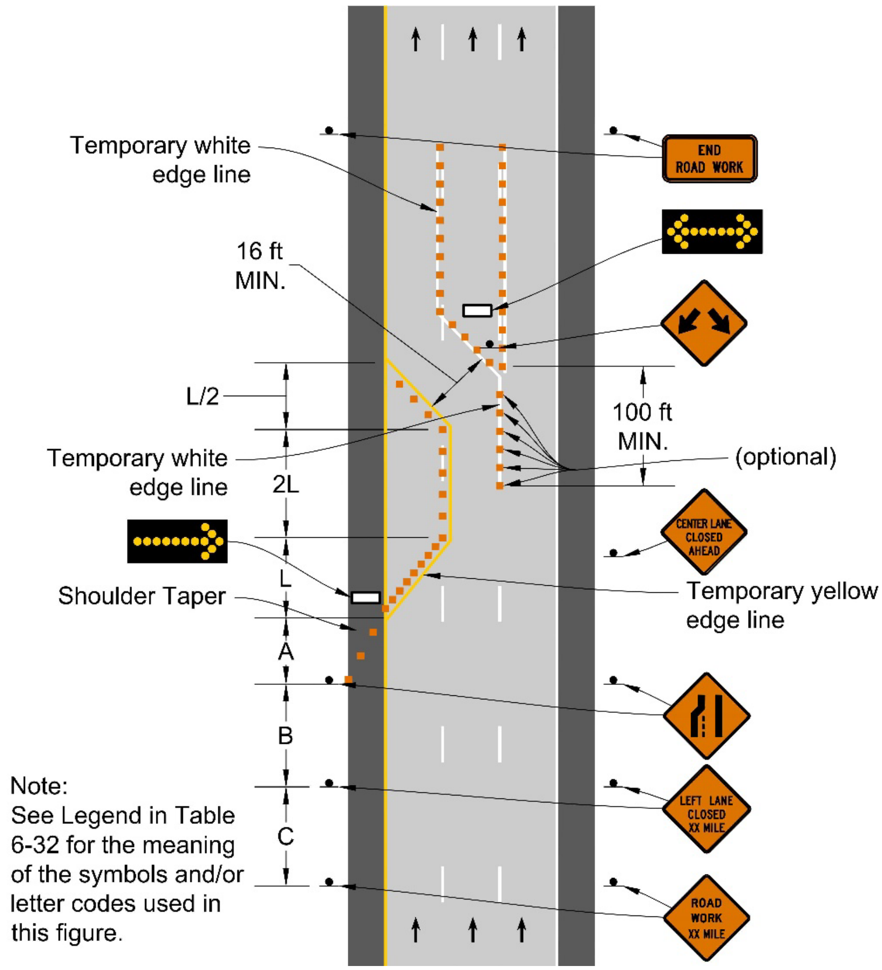
Figure 6-54
Double Lane Closure on a Freeway



Source: *MUTCD*, Figure 6H-37 *(3)*

Figure 6-55
Interior Lane Closure on a Freeway

This type of application is not typically used at TDOT.



Source: *MUTCD*, Figure 6H-38 *(3)*

6.9.4 Work Zones Spanning Width of Direction of Travel

If the work zone spans the width of the traveled way, the work zone typically requires complete closure of one direction of the freeway. Examples of this occurrence may include:

- reconstruction of a bridge that carries the freeway over another feature (e.g., a river, a railroad, or another highway)
- construction or reconstruction of a bridge that spans over the freeway

See Section 6.9.1 for additional information on rolling roadblocks.

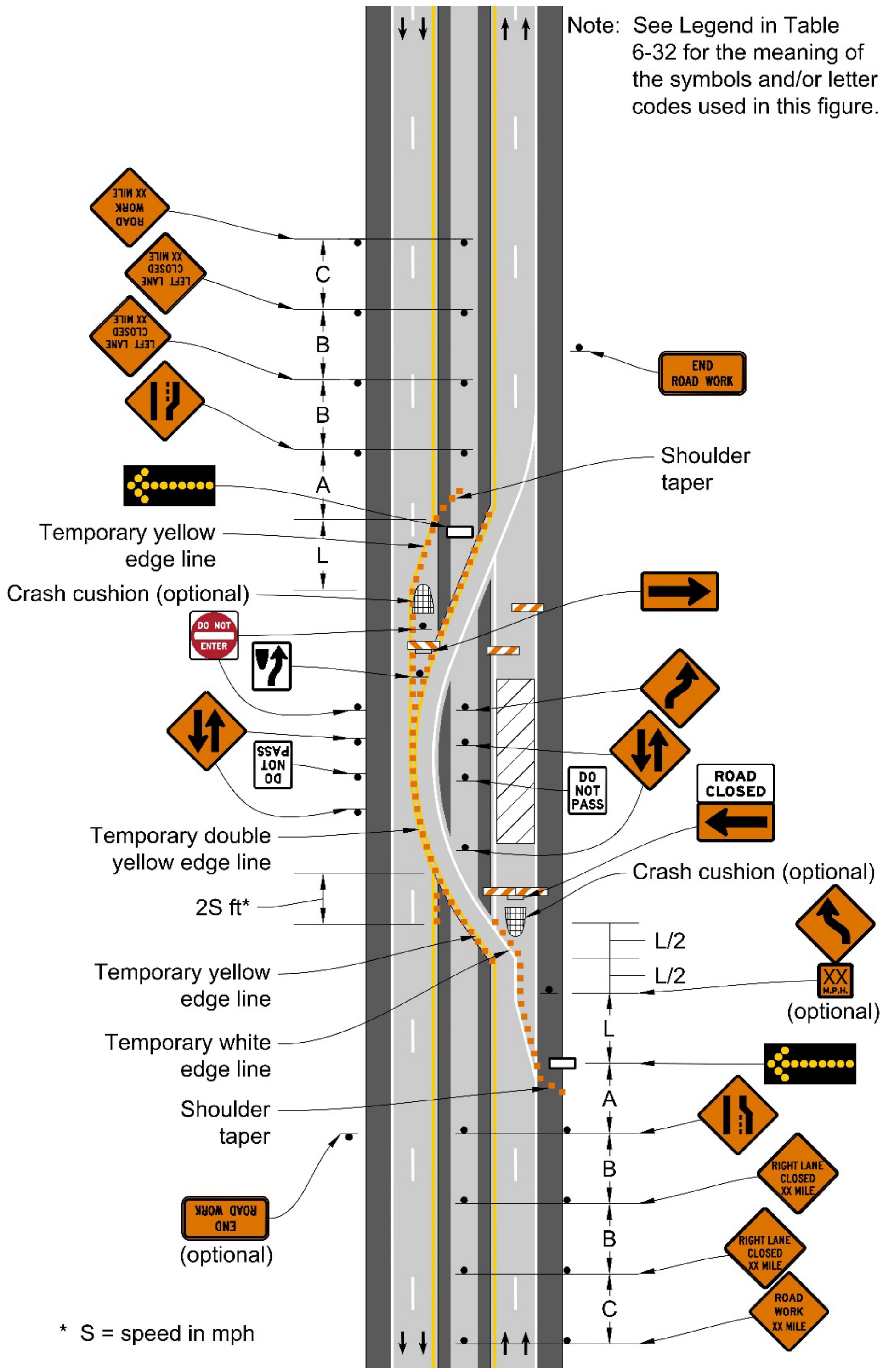
Technique for facilitating full closure of one direction of travel include crossovers and detours. The process for determining which technique to use can depend on a variety of factors:

- **Duration:** If the full closure is of short duration, a rolling roadblock may be employed. This is a useful method for both work zones of short duration and for transitions between construction stages to provide workers with enough time to set up temporary traffic control.
- **Traffic volumes:** If traffic volumes are low enough that a lane reduction in both directions is possible without creating excessive delay, then a lane reduction and crossover is often the best choice. This is particularly feasible and common in rural applications.

- **Width for on-site shifts and diversions:** If lane reductions are not possible due to traffic volumes, but the width between obstructions within the work area is sufficient, a lane shift onto the existing shoulder or creation of an on-site diversion may be the best choice. This may require an initial stage of shoulder reinforcement or the addition of a temporary structural pavement section to allow shifting of traffic. On-site shifts or diversions can maintain either the existing number of lanes or allow a manageable reduction in the number of lanes. This may be a feasible option in urban and suburban environments.

A crossover temporarily reduces the number of lanes in each direction of travel on the freeway and shifts one direction of the freeway laterally to share the alignment of the reverse direction of the freeway. **Figure 6-56** shows what may be possible when there are two lanes in each direction on the freeway and each direction is reduced to one lane in each direction.

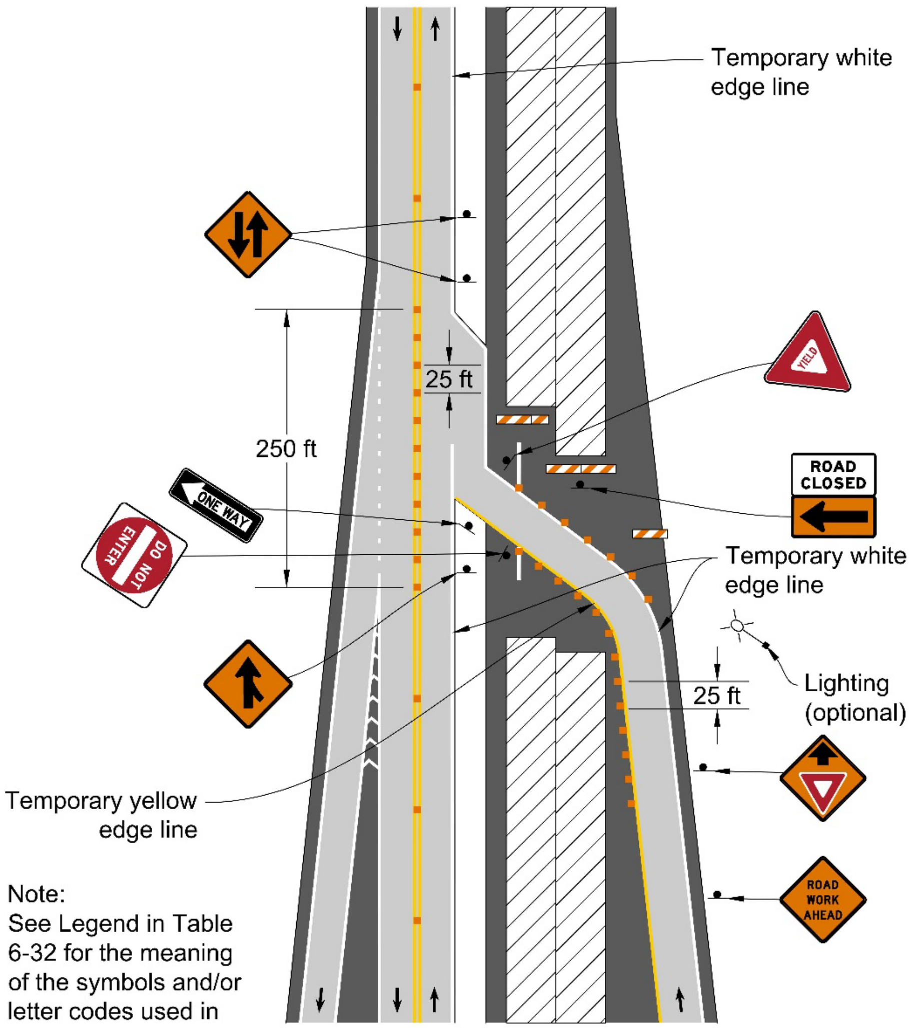
Figure 6-56
Median Crossover on Freeway



Source: *MUTCD*, Figure 6H-39 *(3)*

Where an interchange is located within the section of the roadway between crossovers, the affected entrance and exit ramps should be connected to the shifted roadway. This is shown in **Figure 6-57** for an entrance ramp and **Figure 6-58** for an exit ramp. If it is not possible, due to the nature of work activities, to connect an entrance or exit ramp, the ramp should be closed and detoured, as discussed in **Section 6.9.6**.

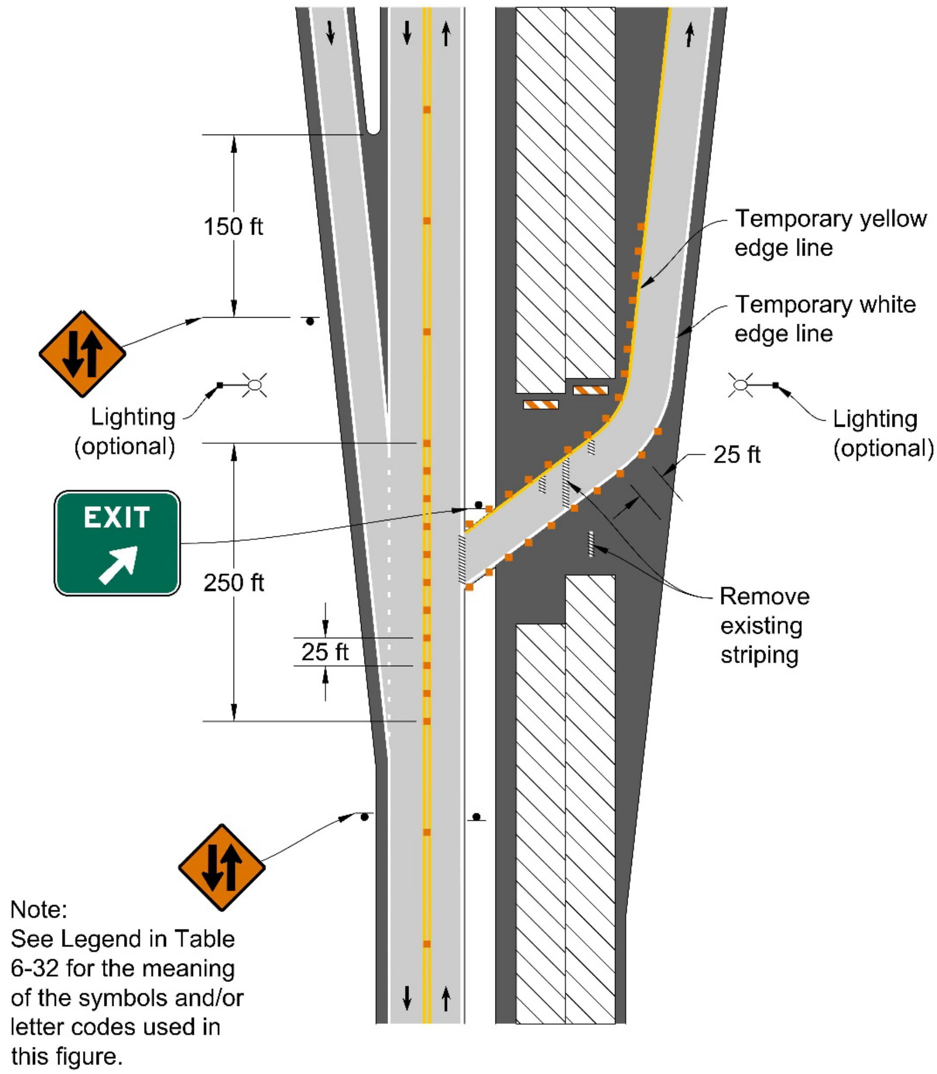
Figure 6-57
Median Crossover for an Entrance Ramp



Note:
See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

Source: *MUTCD*, Figure 6H-40 *(3)*

Figure 6-58
Median Crossover for an Exit Ramp



Source: *MUTCD*, Figure 6H-41 *(3)*

If the work zone spanning the travel lanes of the freeway is at an interchange and a crossover is not practical, it may be possible to divert the mainline through the ramps, as shown in **Figure 6-59**. This application is also appropriate when there is a risk of falling debris, such as full-depth concrete replacement or emergency bridge repair. This is generally only practical for lower-volume situations, due to the typical configuration of most exit ramps and entrance ramps. Temporary traffic control in the form of flaggers or a temporary traffic signal may be needed at the ramp terminal intersection; contact Traffic Operations for direction.

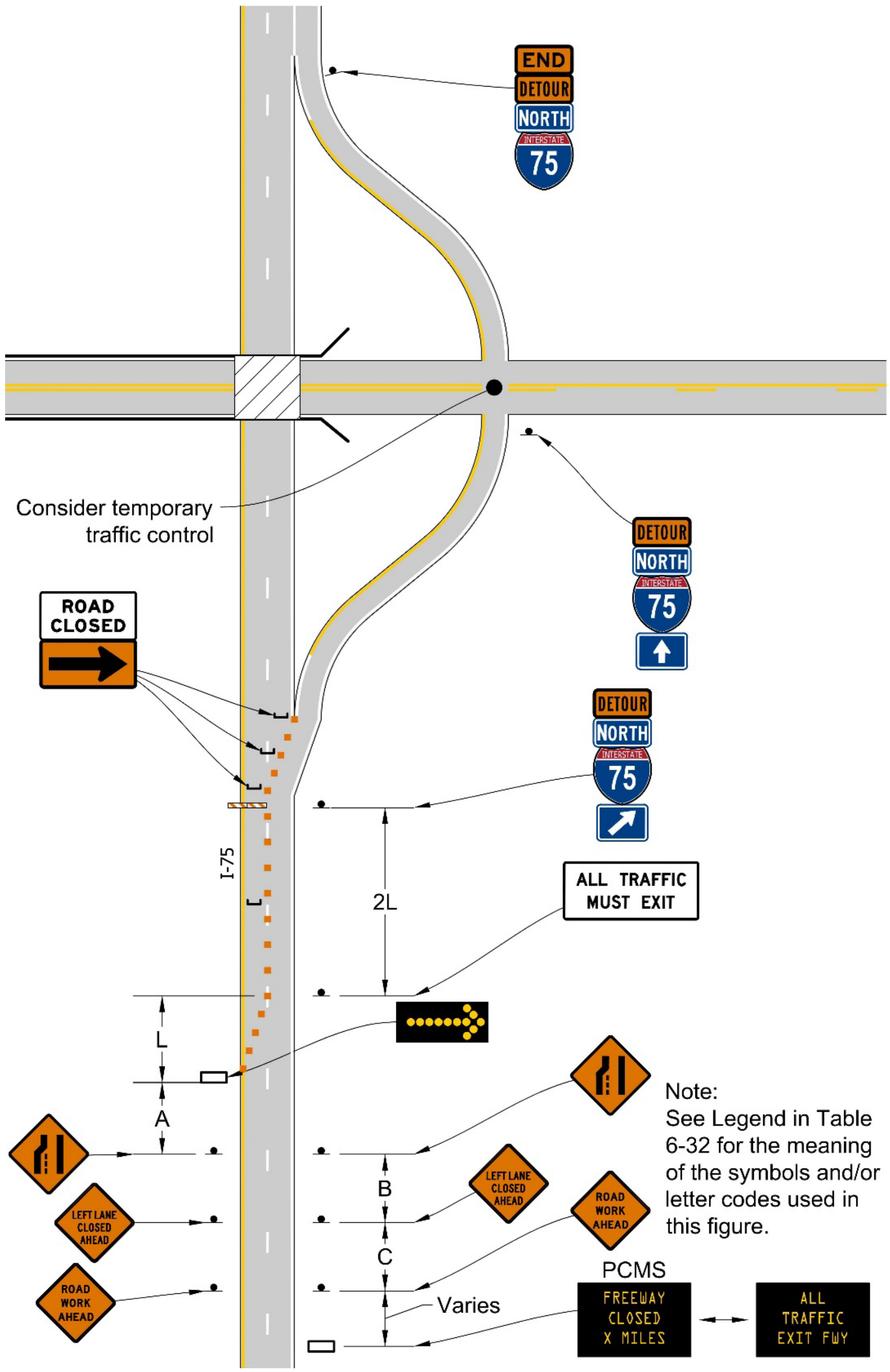
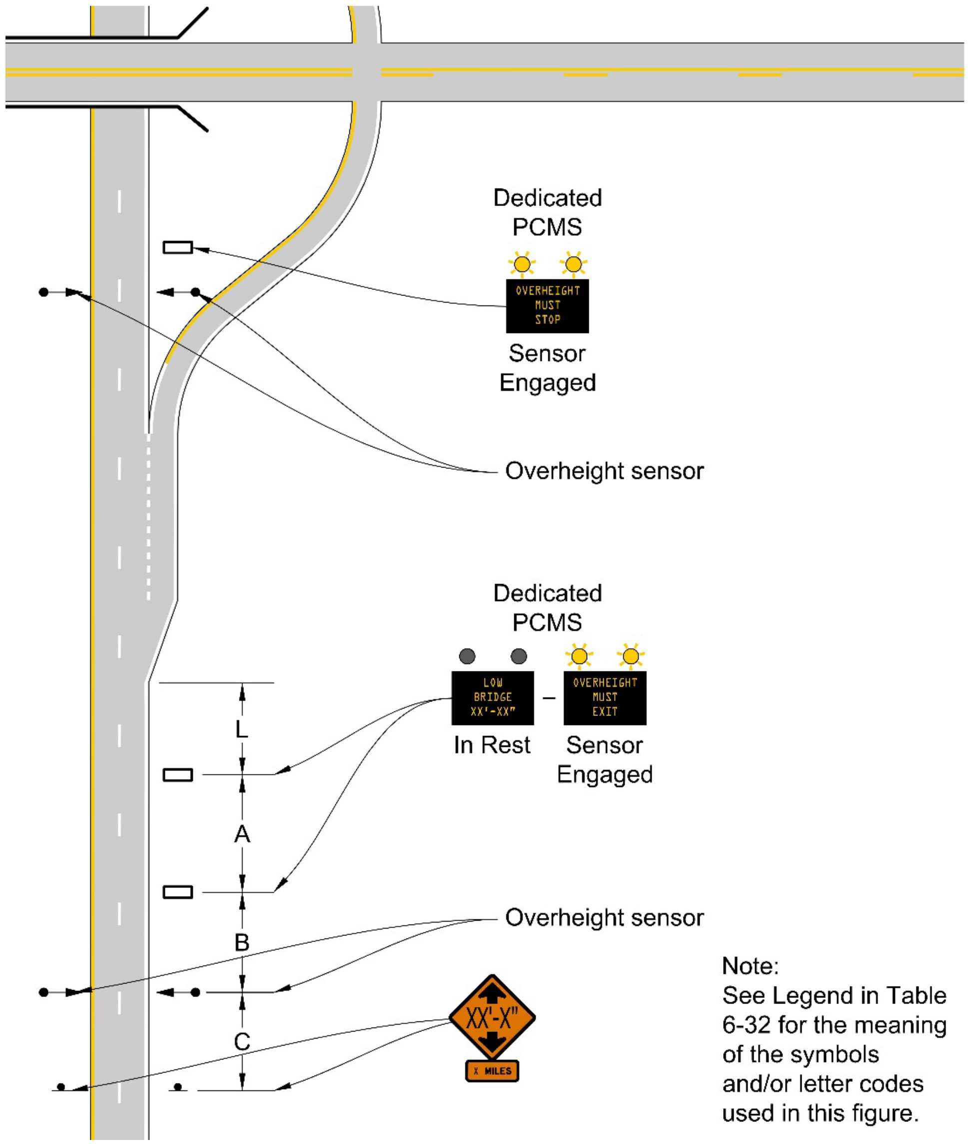


Figure 6-59
Use of Interchange Ramps to Bypass Freeway

This configuration may also be used when the freeway can be kept open for most vehicles but where construction activities temporarily reduce the available vertical clearance under the structure to below 16 feet. In this case, all vehicles that exceed the available vertical clearance would be required to use the detour through the ramps. Sensors that measure the height of vehicles and provide real-time warning to drivers exceeding the available vertical clearance are recommended; this is shown in **Figure 6-60**.

Additional information about the vertical design policy is provided in Section 6.4.6.

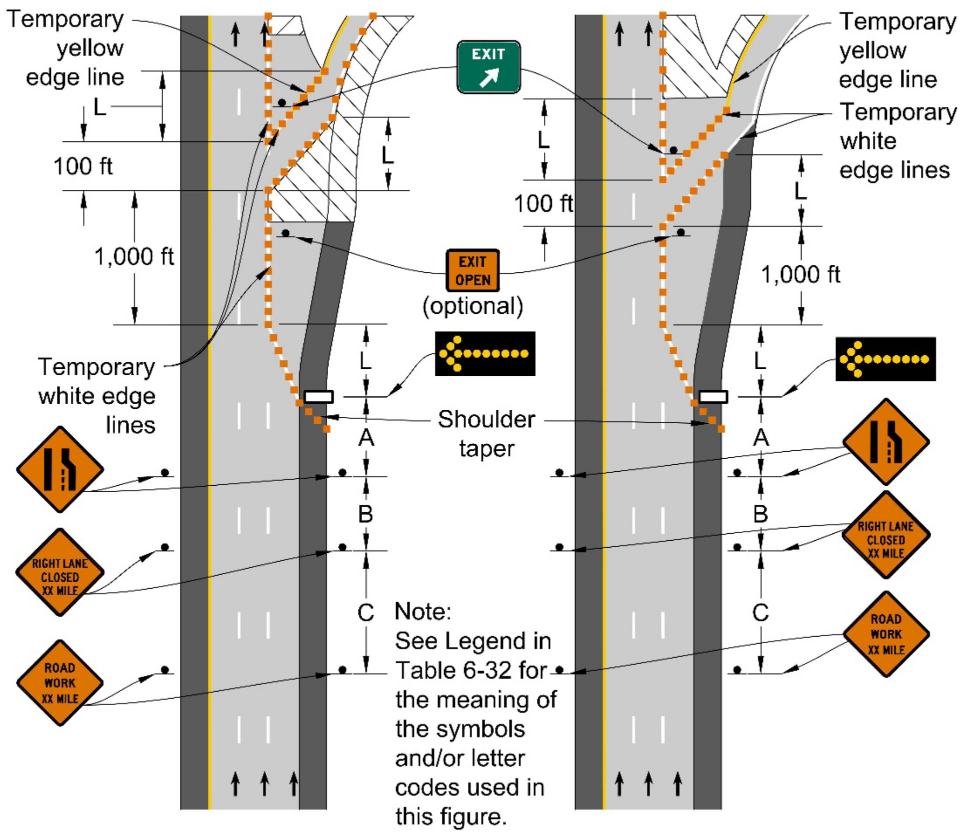
Figure 6-60
Use of Interchange Ramps to Bypass Freeway for Vehicles Exceeding Reduced Vertical Clearance



6.9.5 Work on or in the Vicinity of Interchange Ramps

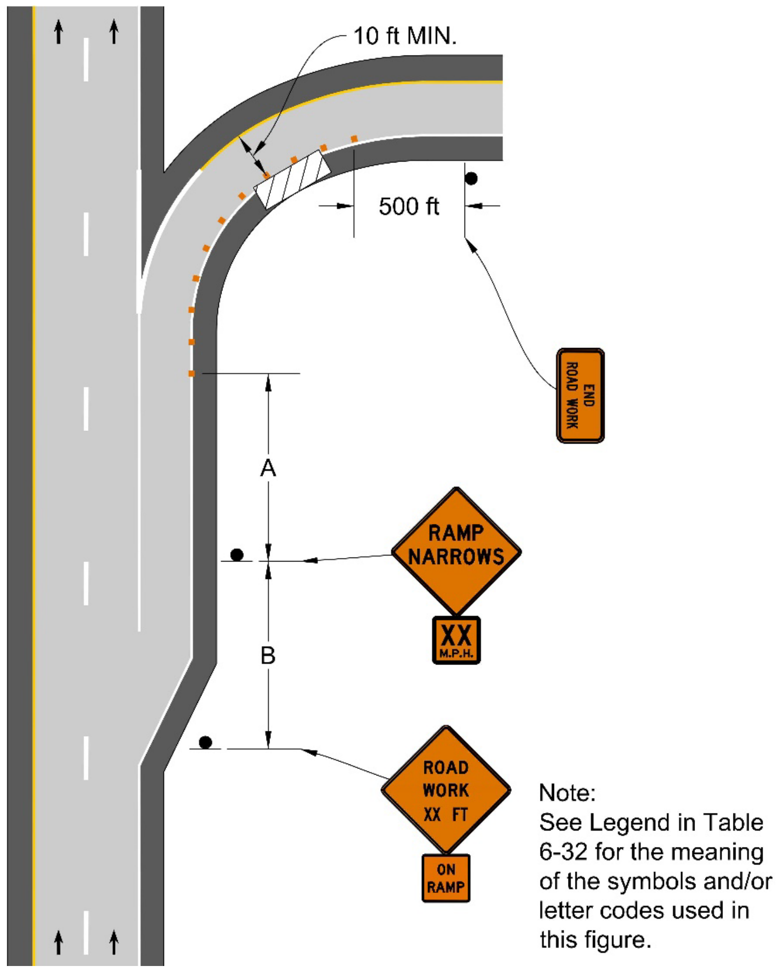
For work zones directly affecting ramps at an interchange and their junction with the mainline freeway, it may be necessary to close the outer lane of the freeway and part of the ramp to serve the work zone. **Figure 6-61** shows variations involving the closure of the right side and left side of an exit ramp, respectively. For simple work zones on the exit ramp, particularly in cases where the work area is far enough from the freeway mainline, it may be possible to provide a more limited work zone as shown in **Figure 6-62**. Design Teams should verify upstream conditions for work zones near ramps. Broader system considerations should be evaluated to reduce the potential for negative operational impacts, such as creating weaving conditions.

Figure 6-61
Work in the Vicinity of an Exit Ramp



Source: *MUTCD*, Figure 6H-42 *(3)*

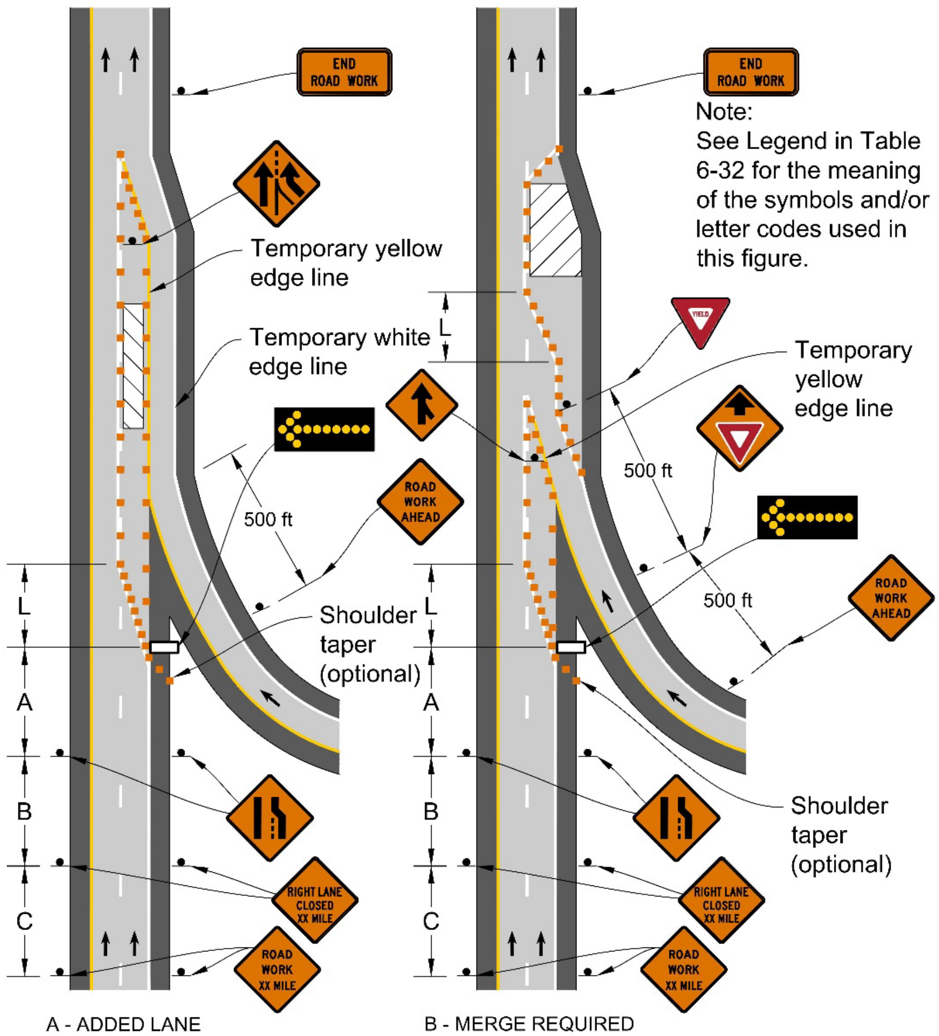
Figure 6-62
Partial Exit Ramp Closure



Source: *MUTCD*, Figure 6H-43 *(3)*

For work zones in the vicinity of an entrance ramp, the type of traffic control strategy depends on the specific location of the work zone relative to the entrance ramp. **Figure 6-63** shows two variations: one using an added lane for work areas near the freeway entrance gore, and one using a short merging zone for work areas near the end of the entrance ramp merging area. In some cases, it may be beneficial to further advance the lane closure to prevent a difficult merge area.

Figure 6-63
Work in the Vicinity of an Entrance Ramp



Source: *MUTCD*, Figure 6H-44 *(3)*

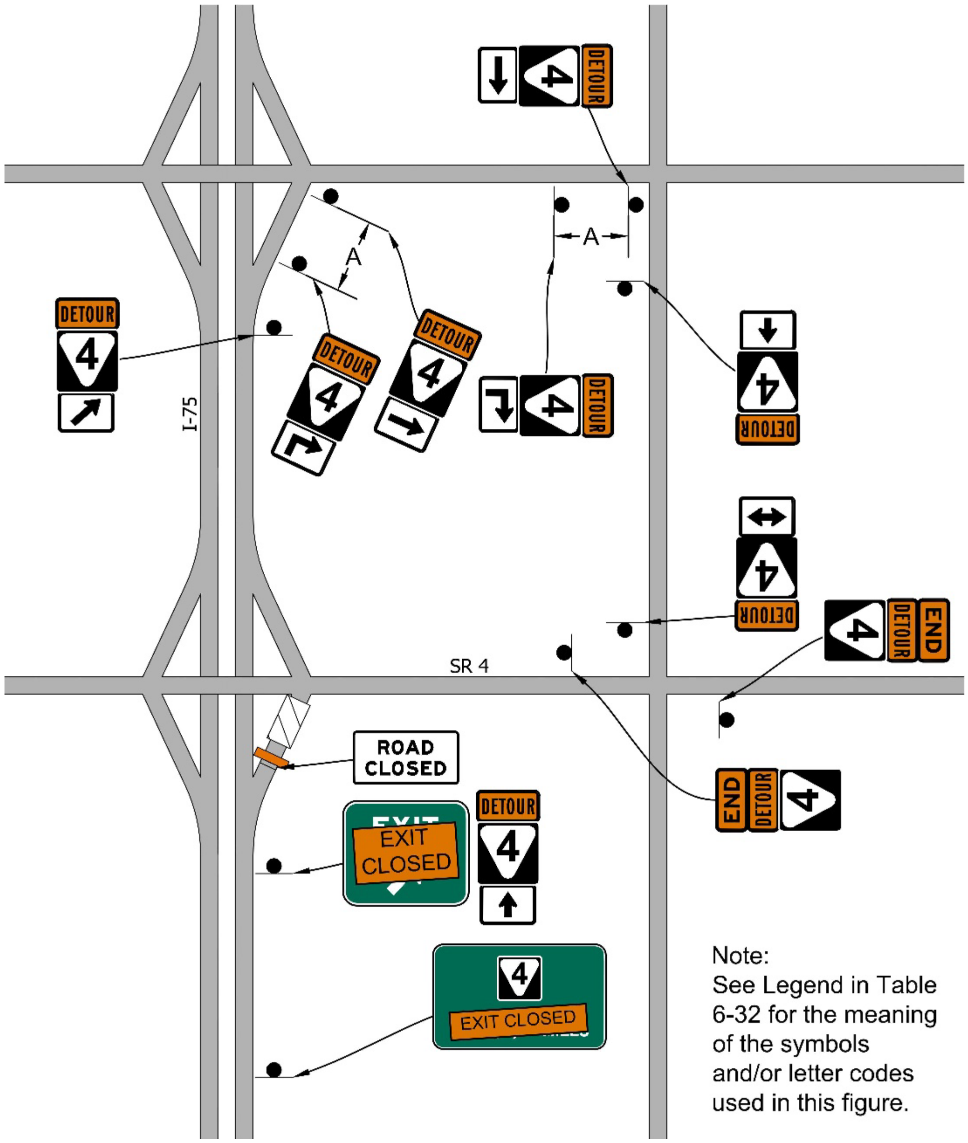
6.9.6 Work Involving Closure of Interchange Ramps

For cases where an exit ramp needs to be closed completely, a detour is needed for the affected movements. This is true for both service interchanges that connect the freeway with other streets and system interchanges that connect two freeways.

In ramp merge areas, Design Teams should provide proper stopping sight distance (SSD) when possible. Merge areas less than 500 feet on high-speed controlled access facilities should be considered for full closure.

Where possible, it is preferable for the detour route to use an exit ramp that *follows* the one being closed, as drivers will see the ramp closure and be more ready for the detour. This is shown in **Figure 6-64.**

Figure 6-64
Exit Ramp Closure Using Detour that Follows Closure



Only TDOT facilities are typically used for designated detour routes.

Additional details for ramp closures is provided on other application figures in Section 6.9.3.

If the detour route uses an exit ramp that *precedes* the one being closed, drivers need advance warning of the closure, as they will not see the ramp closure before the point they need to make a detour decision. This is shown in **Figure 6-65**.

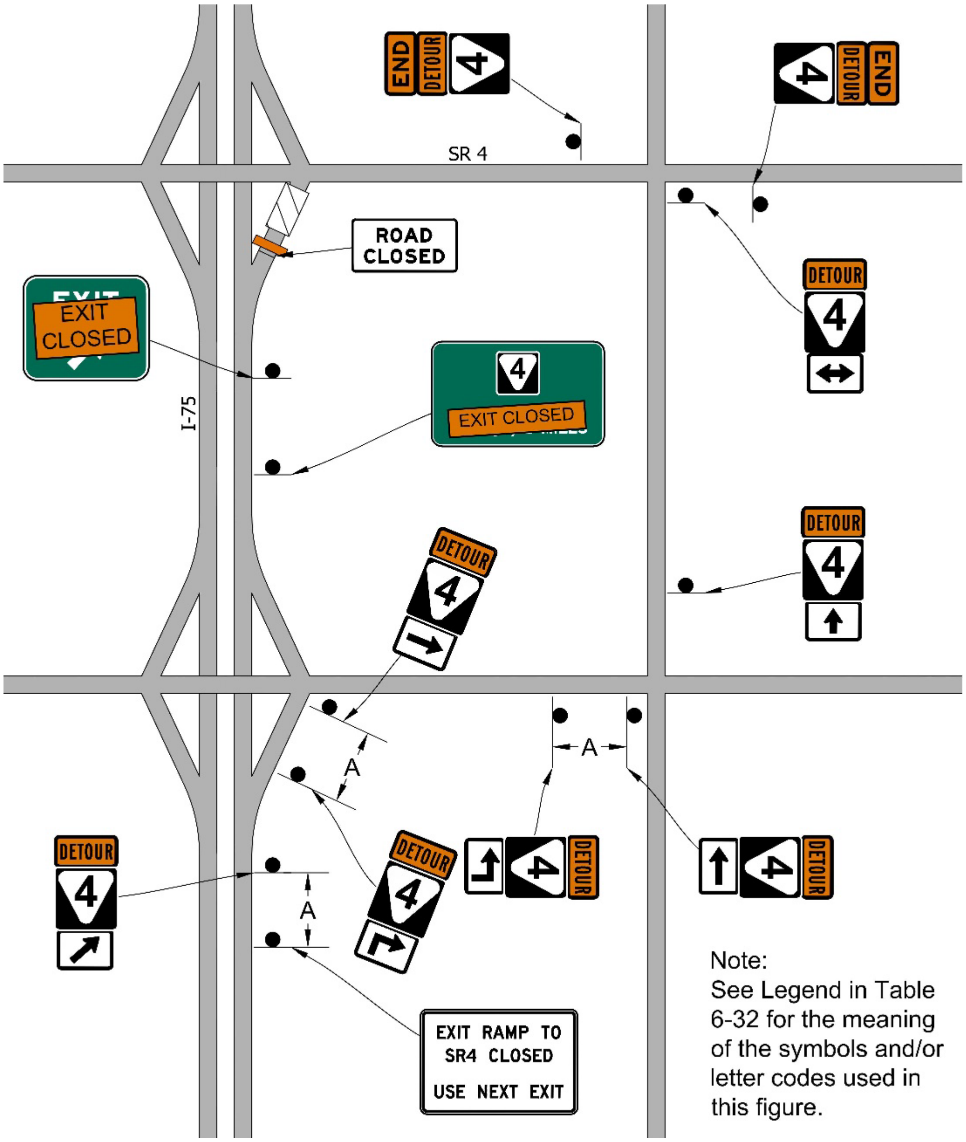
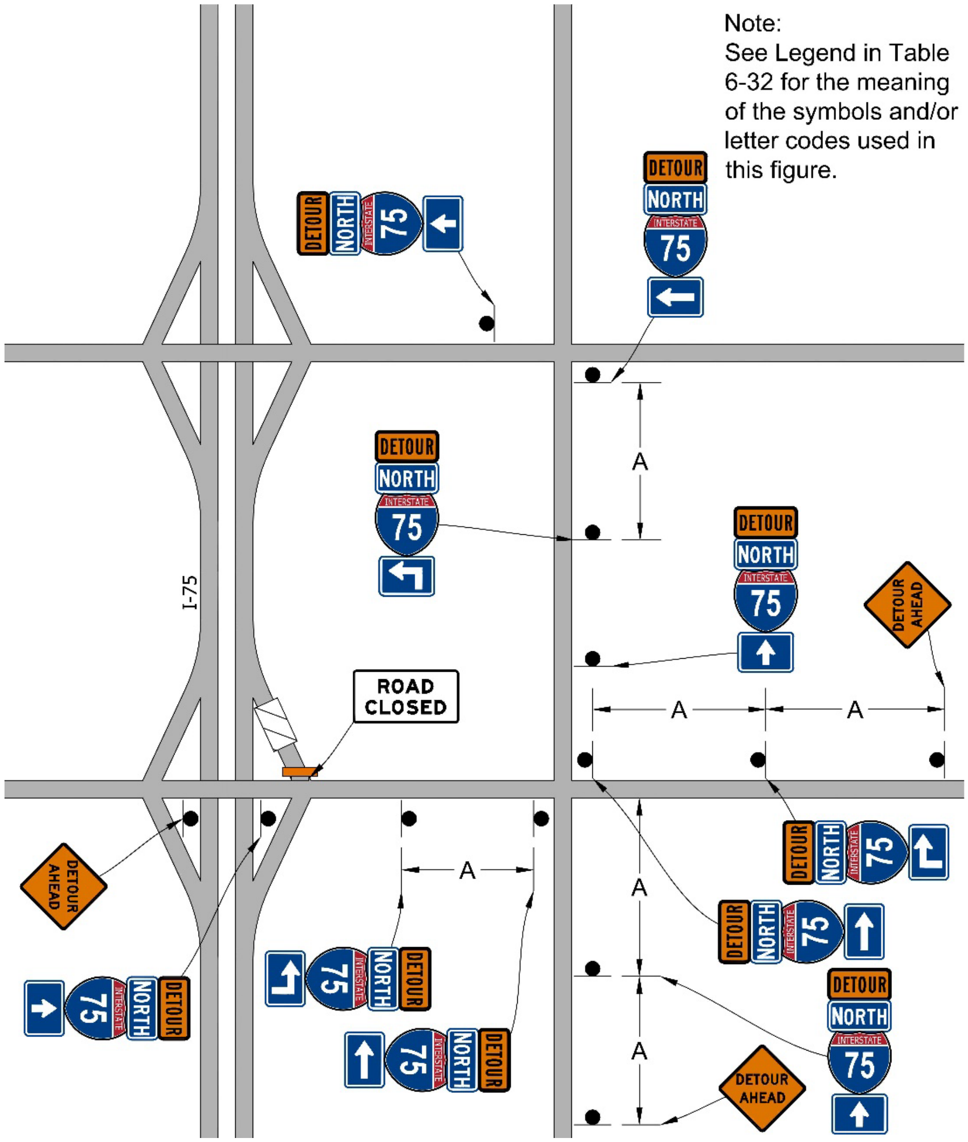


Figure 6-65
Exit Ramp Closure Using Detour that Precedes Closure

Only TDOT facilities are typically used for designated detour routes.

For cases where an entrance ramp needs to be closed, a variety of detour options are available. In some cases, it is most practical to detour traffic along parallel facilities until the next interchange downstream of the closed entrance ramp. This is particularly common in urban areas and in rural areas where a parallel route is available. This is shown in **Figure 6-66**.

Figure 6-66
Entrance Ramp Closure Using Detour on Parallel Route



A viable parallel route network may not always be available. In this case, it may be more practical to use the freeway, itself, as a detour route by first directing traffic in the opposite direction on the freeway and then directing motorists to exit and make a U-turn at the next interchange. This is shown in **Figure 6-67**.

Note:
See Legend in Table 6-32 for the meaning of the symbols and/or letter codes used in this figure.

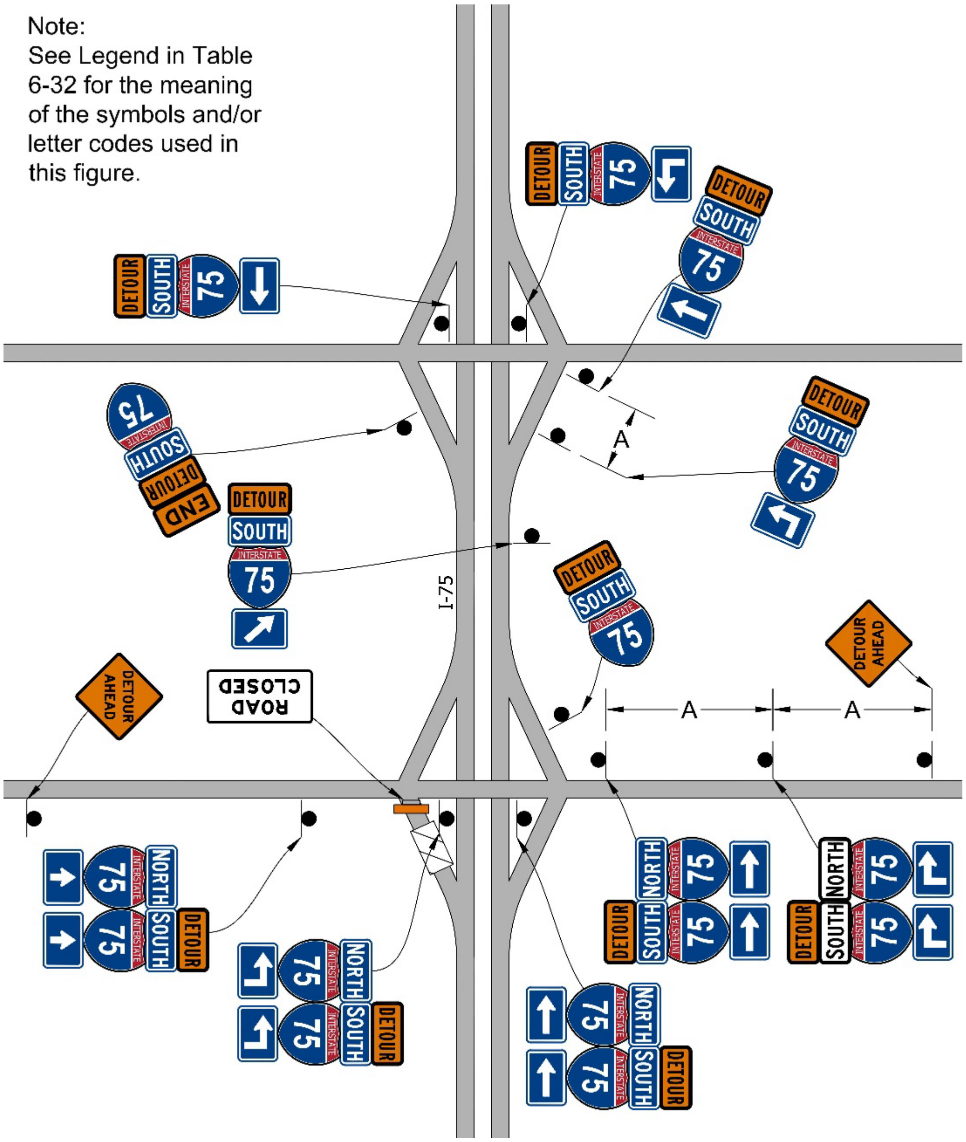


Figure 6-67
Entrance Ramp Closure Using Detour on Freeway

6.10 WORK IN THE VICINITY OF AN AT-GRADE RAIL CROSSING

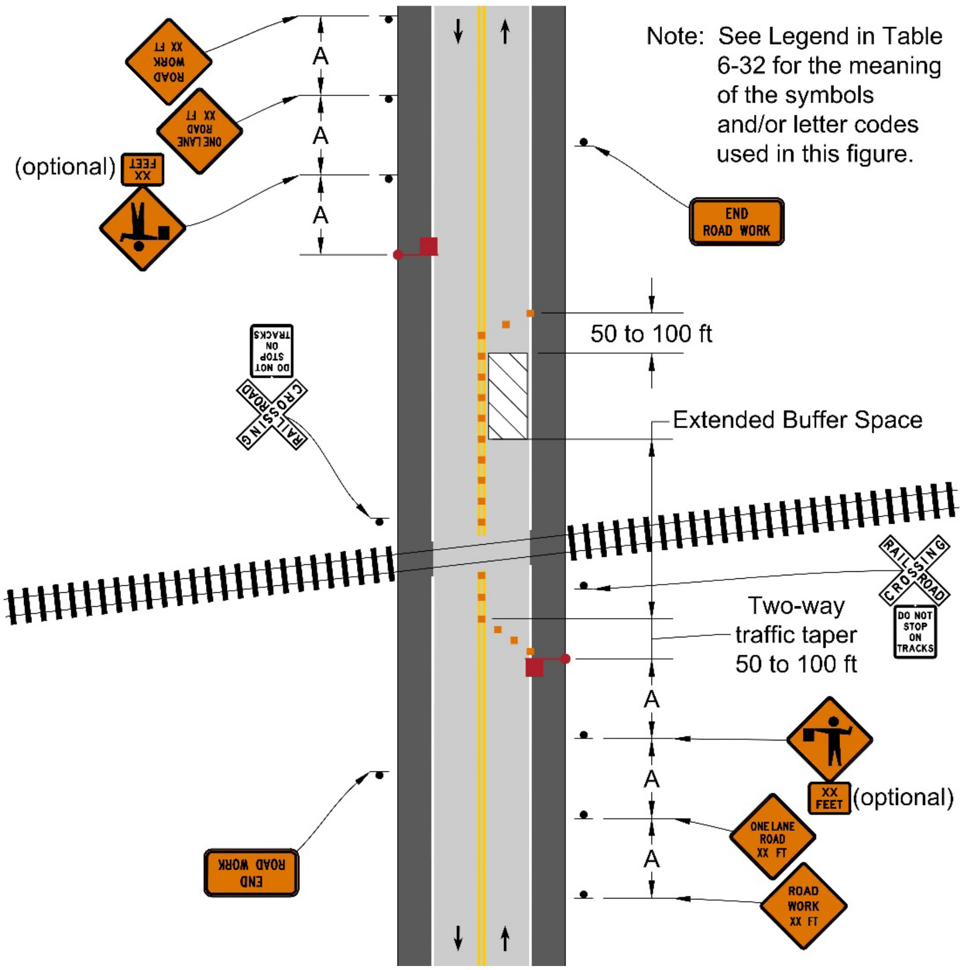
Work zones on urban streets, two-lane highways, and multilane highways may intersect with railroad or light-rail crossings. **Table 6-37** shows the typical applications for work in the vicinity of a grade crossing, characterized by duration.

Table 6-37
Applications Summary Table for At-Grade Rail Crossings

Typical Applications	Duration				
	Mobile	Short Duration	Short-Term	Intermediate-Term	Long Term
Work in the Vicinity of an At-Grade Rail Crossing		X	X		

The Design Team should coordinate with the Railroad Authority.

Work zones in the vicinity of at-grade rail crossings require careful attention to where traffic may be queued, particularly during flagging operations. A work zone that is close enough to an at-grade rail crossing may require traffic control measures to extend through the at-grade rail crossing and keep the tracks clear. An example of this for a two-lane highway is shown in **Figure 6-69**; the concept should be adapted as needed for urban and multilane highway environments.



Source: *MUTCD*, Figure 6H-46 *(3)*

Figure 6-68
Work in the Vicinity of an At-Grade Rail Crossing

6.11 SMART WORK ZONES

Smart work zones integrate electronic technologies and communication-based information into a highway construction project. These intelligent transportation systems (ITS) systems provide real-time traffic information, detour information, vehicle intrusions into the work area, vehicle queuing warnings, notification of construction vehicles entering the roadway, or project performance metrics. A smart work zone generally has the following characteristics:

- It provides real-time information including frequent updates.
- It is portable, allowing installation in multiple locations.
- It is automated with minimal human supervision.
- It is reliable.

Chapter 5 provides additional information about Smart Work Zone devices.

Smart work zones generally have four components:

- sensors and other components designed to collect traffic information such as traffic volumes and speed
- a communication link (wired or wireless) to transmit data for processing or to devices for dissemination
- software that processes and analyzes the data and converts it into a form of useful and meaningful information
- a device that is intended to disseminate the processed information to targeted stakeholders

Smart work zones are most effective when used as part of a systematic process to determine when to incorporate smart work zones and what type of ITS technology to use. The potential benefits of integrating smart work zones in the appropriate projects include:

- reduced frustration of motorists by providing accurate and reliable real-time information at regular intervals in advance of and through the work zone area, which may encourage them to take alternate routes based on information provided by the system
- reduced congestion and better flow of traffic
- reduced vehicle crashes, motorists delay costs, and fuel emissions and consumption
- prevention of secondary incidents due to swift clearance of initial incidents
- increased safety of motorists and highway workers
- enhancement of construction efficiencies by identifying and modifying work schedules
- delivery of construction materials around peak traffic times for greater productivity
- reduced liability

6.11.1 Portable Queue Warning System

TDOT uses a queue warning system as part of the traffic control strategies to provide protection to traffic queues caused by construction operations. The system consists of portable radar sensors, portable changeable message signs, and software that monitors and controls the operation. The deployment of the system alerts vehicles approaching the work zone of speed differentials that occur advance of and within the construction area. This warning system is called Portable Queue Warning System and is described further in Special Provisions (SP712PQWS) and include the Item Number 712-08.14. **Figure 6-69** provides a graphical example of this type of system. **Figure 6-70** provides an example from the Traffic Control Plan for a queue warning system. Additional details for this plan are provided in **Appendix C**.

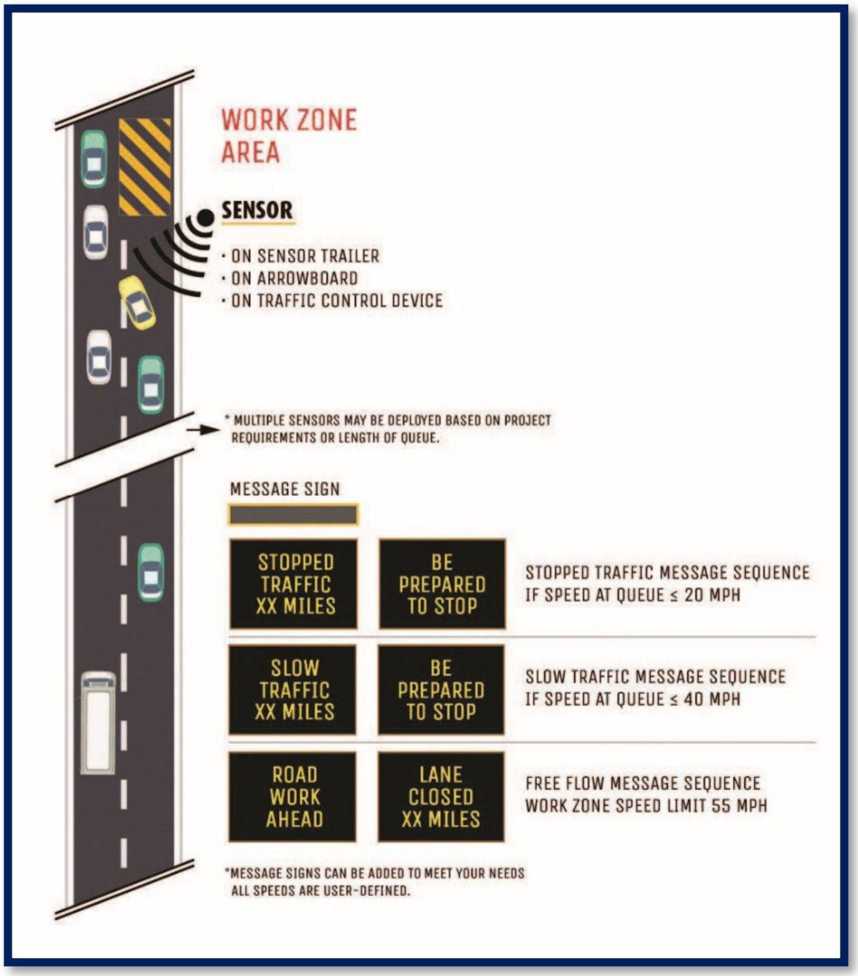
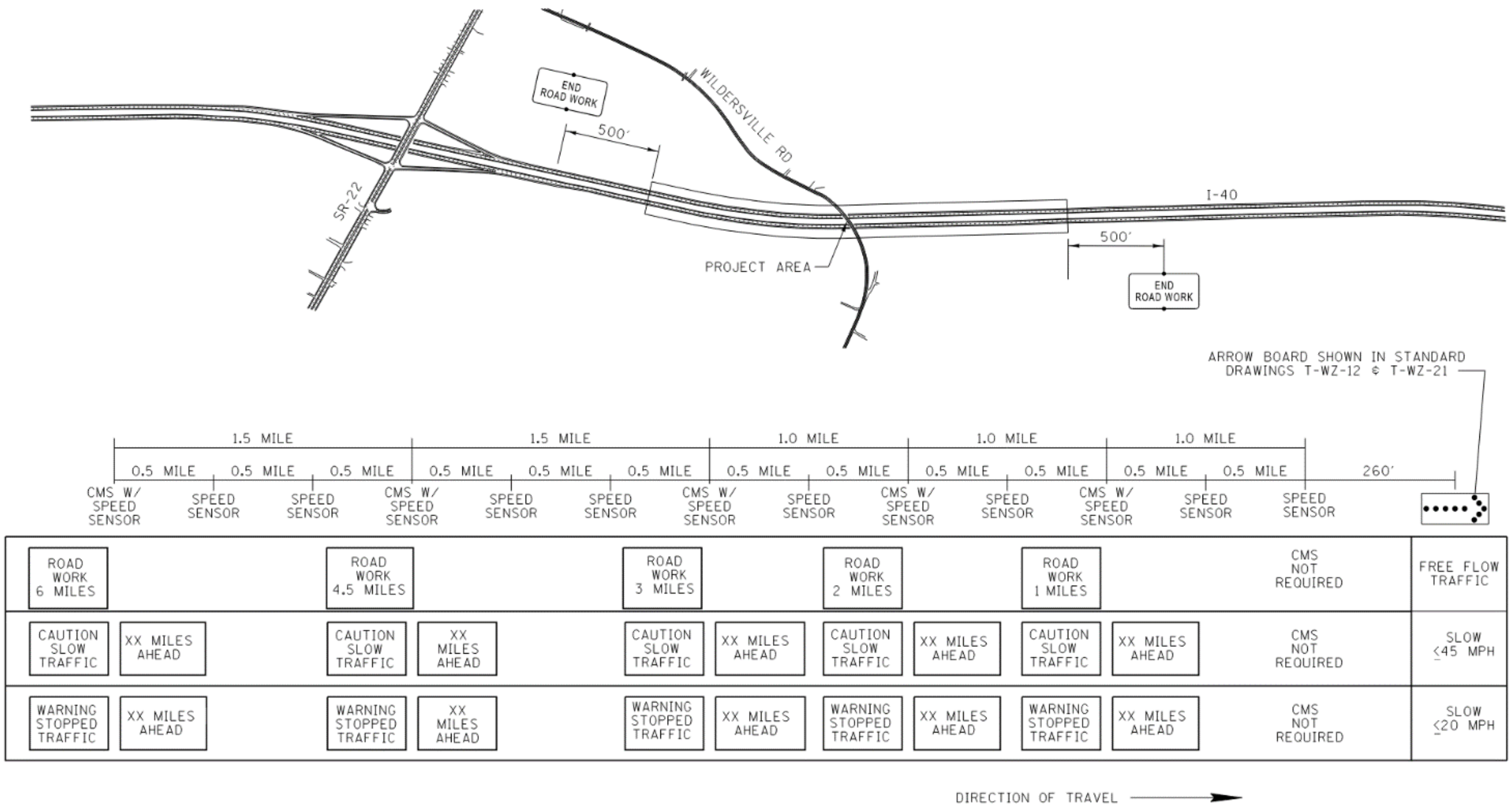


Figure 6-69
Portable Queue Warning System
Source: Ver-Mac

Figure 6-70 Example Queue Warning System
(See Appendix C for additional TCP informatino)



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TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 7

TRAFFIC CONTROL PLANS

March 2022

TN TDOT Department of Transportation

Contents

Chapter 7

Traffic Control Plans

7.1 OVERVIEW

Traffic control plans include engineered plans and written instructions for providing safe and efficient roadway user mobility (including pedestrians and bicycles) through and around the work zone area. This also includes protecting construction workers, flaggers and other traffic control personnel, emergency and incident responders, construction equipment, and traffic control devices. The Traffic Control Plans consider the range of staging and associated phasing and sequencing that may occur during construction, with an emphasis on maximizing safety for workers and the traveling public.

Design Teams should begin planning the Traffic Control Plans early in the project development process to allow for adequate coordination with other disciplines, such as utilities, structures, environmental, multimodal, right-of-way, and geotechnical staff. This is particularly important for "significant" and complex projects that may require more detailed staging options. Consistent collaboration and communication between the Design Team and Construction Staff can help optimize the traffic control planning and address a project's constructability early in the process.

Chapter 2 provides information about determining a project's significance.

The following sections outline the types of traffic control plan submittals that occur within the TDOT project development process and the information that the plans must include during each submittal.

7.2 TDOT PLAN SUBMITTAL PROCESS

Traffic control design is considered in three TDOT plan submittal packages at three stages of the project development process: Preliminary Design, Right-of-Way Design, and Construction (Design). Formal Traffic Control Plans are not included at all three stages but should be part of the discussion to allow for meaningful collaboration between disciplines and planning for future traffic control needs as the project progresses. **Table 7-1** describes the types of information included at each stage.

Chapter 1 provides additional information about the overall TDOT Project Development Process.

Table 7-1 Summary of Plan Submittals

Project Development Stage	Submittal Package	Plan Completeness	Key Plan Components
Preliminary Design	Preliminary Field Review	30%	• No formal Traffic Control Plans, conceptual discussions with Field Review Team. • Determine project significance. • Conceptual layouts for "significant" and complex projects. • Note road closure for traffic control on the Title Sheet.
	Site Review	40%	• Divisions meet to review the Site Review Questionnaire. • Traffic Control is discussed at this stage. • No formal Traffic Control Plans are submitted.
Right-of-Way Design	Right-of-Way Field Review	80%	• "Information Only" Draft Traffic Control Plan Submittal. • Include design details to communicate traffic control requirements and set-up. • Include Draft Transportation Management Plan.
	Final Right-of-Way Plans	80%	• Refine plans based on feedback.
Construction (Design)	Construction Field Review	100%	• Final Traffic Control Plans included in formal submittal package. • Include Final Transportation Management Plan.
	Final Construction Plans Review	100%	• Refined plans and submittal package based on feedback.
	Construction Submittal for Letting	100%	• Refined plans and submittal package based on feedback.

7.2.1 Preliminary Design Deliverables

Discovering constructability challenges early within the project development stage may influence the ultimate project footprint.

Preliminary Field Review

Formal Traffic Control Plans are not typically part of the Preliminary Field Review. However, the primary traffic control elements should be discussed, such as conceptual staging and associated phasing, constructability, and potential for road closures. Road closure information is noted on the Title Sheet on the roadway plans. The project significance is determined by the Preliminary Design Stage to help guide the required project documentation.

Projects that are projected to be "significant" and expected to involve complex traffic control phasing may be conceptualized during Preliminary Design. This will help the Design Team document discussions, weigh alternatives, and set the stage for more formal plans. Discovering constructability challenges early within the project development stage may influence the ultimate project footprint.

Site Review

During the Site Review, the Design Team and associated staff from each Division meet to review the Site Review Questionnaire, which includes a discussion regarding the project's traffic control needs. No formal plans are developed or submitted at this stage.

7.2.2 Right-of-Way Deliverables

Right-of-Way Field Review

For Right-of-Way Field Review, the Design Team should prepare Draft Traffic Control Plan sheets that are printed for informational purposes only as part of the Right-of-Way Field Review. Traffic Control Plans shall not be listed in the index. The sheet(s) shall have the "Info Only" stamp and be titled "ROW" in the project title block on each sheet. The following groups of plan sheets are included in the Draft Traffic Control Plans. Additional information on the details provided within each sheet is provided below in **Section 7.3**.

- Traffic Pavement Drop Off Notes
- Traffic Phasing Notes, Legend, and Tabulation
- Traffic Control Plans

The Right-of-Way Checklist includes a section detailing all necessary items to include on the Draft Traffic Control Plans. The Design Team should use this checklist as a guide to verify that all necessary traffic control design elements are communicated clearly. The Right-of-Way Checklist is provided at the following website link *(1)*:

TDOT Right-of-Way Checklist

At this stage, the Draft Transportation Management Plan (TMP) is prepared and included in the submittal package to communicate information regarding traffic control, traffic operations, and public outreach needs. The Draft Traffic Control Plans should reflect a feasible sequence illustrating how to implement the construction phases and associated sub-phasing. The information on the plans should provide sufficient details to reflect how a project may be constructed during each project phase and associated sub-phase(s). The Design Team should also consider how to transition between major phases of the project that may require a sub-phase at the end of the phase, such as temporary widening to accommodate traffic in the next phase.

Construction Phase: The significant project sequence of events that takes place to build the project.

Construction Sub-Phases: Occur within a construction phase and refers to an activity that takes place to execute the overall construction phase.

For Example:

- Phase 1 may include shifting traffic to the left while constructing the right side of the road.
    - Sub-Phase 1A, the contractor may have to construct temporary widening along the left side before shifting the traffic to the left.
    - Sub-Phase 1B, will allow the actual construction to the right while traffic is running along the left on the temporary widening.
- Phase 2 will shift traffic to the right on the road portion constructed during Phase 1 while completing construction on the left.

Final Right-of-Way Plans

After the Right-of-Way Field Review, changes shall be made to the traffic control sheets prior to Final Right-of-Way Submittal. When Right-of-Way plans are submitted, the draft Traffic Control Plans will be an independent PDF file placed on FileNet. After submittal, these plans will not be updated further during this stage of the project development process. Complete Traffic Control Plans will be prepared as part of the Construction Field Review and Final Construction Review and will become part of the Construction plans.

7.2.3 Construction Deliverables

Construction Field Review

During the Construction Field Review, Final Traffic Control Plans and a Final Transportation Management Plan are included as part of the submittal package. These incorporate refinements based on a review of the Traffic Control Plans. The following groups of plan sheets are included:

- Traffic Pavement Drop Off Notes
- Traffic Phasing Notes, Legend, and Tabulation
- Traffic Control Plans

Additional information about the details provided within each sheet are below in **Section 7.3**.

The Construction Plans Checklist includes a section detailing all the necessary items to include on the Final Traffic Control Plans. The Design Team should use this checklist as a guide to verify that all necessary traffic control design elements are communicated clearly. The Construction Plans Checklist is provided at the following website link *(2)*:

TDOT Construction Plans Checklist

Final Construction Plans Review

Based on the Construction Field Review, the Final Traffic Control Plans and Final Transportation Management Plan are refined.

Construction Submittal for Letting

Additional minor refinements to the Final Traffic Control Plans and Final Transportation Management Plan may be incorporated at this stage. The Construction Submittal is finalized and the letting process begins.

7.3 TRAFFIC CONTROL PLAN CONTENT

The TDOT Roadway Design Guidelines (Chapter 1) provide additional details about plan submittals and file naming conventions.

The following series of plan sheets are included as part of a Traffic Control Plan submittal:

- T1. Traffic Pavement Drop Off Notes
- T2. Traffic Phasing Notes, Legend, and Tabulation
- T3-T50Z. Traffic Control Plans

Additional information on the series of sheets included in the Traffic Control Plans is described below.

7.3.1 T1 Traffic Pavement Drop Off Notes

T1 Pavement Drop Off Notes is a plan sheet with typical notes to be included in the traffic control notes on the first sheet of the traffic control plan set for all projects. For resurfacing projects, these notes can be included in the plans as a separate sheet or on the special notes sheet. The Traffic Pavement Drop Off Notes can be found at the following website *(4)*:

T1 Traffic Pavement Drop Off Notes

7.3.2 T2 Traffic Phasing Notes, Legend, and Tabulation

The T2 sheet includes the following:

- construction phasing notes and sub-phase construction details (as necessary)
- quantities calculated to include all traffic control phases
- tabulation block for construction signs, barricades, lights, temporary pavement marking details, and temporary signals
  - footnotes for tabulation block (add for clarity such as placement, to identify maintenance schedules or cycles, etc.)
  - Design Team should check against footnotes on estimated quantities.
- traffic legend block with all relevant symbols and items used on the plans.

An example of the T2 Traffic Phasing Notes, Legend, and Quantities Tabulation is shown in **Figure 7-1**.

Figure 7-1
Example T2 Traffic Phasing Notes, Legend, and Quantities Tabulation

TRAFFIC CONTROL NOTES

(1) THESE TRAFFIC CONTROL PLANS DO NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY OF INSTALLING TRAFFIC CONTROL DEVICES IN ACCORDANCE WITH THE CURRENT EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.

(2) CONSTRUCTION SIGNING SHOWN IN THESE PLANS IS TO SERVE AS A GUIDE ONLY. OTHER SIGNS MAY BE REQUIRED DURING VARIOUS PHASES OF CONSTRUCTION.

(3) NO TRAFFIC SHALL BE DETOURED OR ROADWAY CLOSED, ABANDONED, OR REMOVED WITHOUT THE PRIOR APPROVAL OF THE ENGINEER.

(4) THE ADVANCE WARNING SIGNS ARE TO BE PLACED PRIOR TO BEGINNING OF CONSTRUCTION AND REMAIN IN PLACE UNTIL THE COMPLETION OF THIS PROJECT.

(5) SEE THE CURRENT EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES. THE TDOT SUPPLEMENT TO THE STANDARD HIGHWAY SIGNS, AND THE CONSTRUCTION WORK ZONE AND TRAFFIC CONTROL GENERAL NOTES FOR TRAFFIC DETAILS NOT SHOWN.

(6) CONTRACTOR IS TO COVER ALL CONFLICTING SIGNS DURING CONSTRUCTION. COVERINGS SHALL BE REMOVED AT COMPLETION OF CONSTRUCTION. COSTS ASSOCIATED WITH COVERING AND UNCOVERING SIGNS IS TO BE INCLUDED IN ITEM NO. 712-06, SIGNS (CONSTRUCTION).

(7) THE CONTRACTOR IS TO COORDINATE ALL LANE CLOSURES WITH THE TDOT REGIONAL OFFICE, THE COUNTY ENGINEER AND THE CITY ENGINEER.

(8) IF INGRESS/EGRESS IS REQUIRED FOR A PRIVATE ENTRANCE, THE CONTRACTOR SHALL USE A FLAGMAN TO DIRECT ANY TRAFFIC FOR THE PRIVATE ENTRANCE. ALL COST FOR THE FLAGMAN SHALL BE INCLUDED IN THE COST OF ITEM NO. 712-01, TRAFFIC CONTROL.

(9) FOR DETAILS NOT SHOWN, SEE STD. DWG. T-WZ-32, T-WZ-33, T-WZ-34 & T-WZ-35.

TRAFFIC CONTROL SIGN TABULATION

M.U.T.C.D. SIGN NO.	LEGEND	SIZE IN INCHES W	x	H	S.F.	TOTAL NO. REQUIRED	ITEM NO. 712-06 S.F.	STANDARD DRAWING NO.	REMARKS
G20-2	END ROAD WORK	36"	x	18"	4.5	2	9	T-WZ-32	
M4-8A	END DETOUR	24"	x	12"	2	1	2		
M4-9R	DETOUR WITH ARROW - RIGHT	30"	x	12"	2.5	2	5		
R3-1	NO RIGHT TURN	24"	x	24"	4	1	4		
R10-6	STOP HERE ON RED	24"	x	36"	6	2	12	T-WZ-32	
R10-6 (MOD)	STAY IN LANE TO EXTEND GREEN	30"	x	42"	8.75	2	17.5	T-WZ-32	
R10-11A	NO TURN ON RED	30"	X	36"	7.5	1	7.5	T-WZ-33	
R11-3A (MOD)	NO RIGHT TURN AHEAD	60"	x	30"	12.5	2	25		
SPECIAL 3	MAXIMUM _ MINUTE RED	42"	x	48"	14	2	28	T-WZ-32	
SPECIAL 4	MAINTAIN __ MPH SPEED	42"	x	36"	10.5	2	21	T-WZ-32	
W1-4R	REVERSE CURVE SYMBOL	30"	x	30"	6.25	2	12.5	T-WZ-32	
W3-3	SIGNAL SYMBOL	36"	x	36"	9	2	18	T-WZ-32	
W3-4	BE PREPARED TO STOP	36"	x	36"	9	2	18	T-WZ-32	
W16-2P	1000 FEET	24"	x	18"	3	2	6	T-WZ-32	
W20-1	ROAD WORK AHEAD	36"	x	36"	9	2	18	T-WZ-32	
W20-1	ROAD WORK 1/2 MILE	36"	x	36"	9	2	18	T-WZ-32	
W20-1	ROAD WORK 1500 FT	36"	x	36"	9	2	18	T-WZ-32	
W20-1	ROAD WORK 1000 FT	36"	x	36"	9	2	18	T-WZ-32	
W20-1	ONE LANE ROAD 500 FT	36"	x	36"	9	2	18	T-WZ-32	
W20-4	ONE LANE ROAD 1500 FT	36"	x	36"	9	2	18	T-WZ-32	
W20-7	FLAGGER	36"	x	36"	9	2	18	T-WZ-32	
						TOTAL	295.5	S.F.	

Figure 7-1 ***(continued)***
Example T2 Traffic Phasing Notes, Legend, and Quantities Tabulation

TRAFFIC CONTROL LEGEND	
SYMBOL	ITEM
	WORK ZONE
	FLEXIBLE DRUMS (CHANNELIZING)
	SIGN (CONSTRUCTION)
→	TRAFFIC FLOW
	ARROW BOARD TYPE C
	ARROW BOARD TYPE C (SINGLE ARROW)

TRAFFIC CONTROL LEGEND	
SYMBOL	ITEM
	WORK ZONE
	FLEXIBLE DRUMS (CHANNELIZING)
	SIGN (CONSTRUCTION)
→	TRAFFIC FLOW
	PORTABLE BARRIER RAIL
	TEMPORARY ATTENUATOR
	TEMPORARY BARRICADE (TYPE III)
A	WARNING LIGHT (TYPE A) (LOW-INTENSITY FLASHING)

7.3.3 T3-T50Z Traffic Control Plans

The Traffic Control Plans should show the project phases and associated sub-phases for the project, and how to physically build the project in a sequence that is feasible. It should consider three-dimensional aspects to verify the motorist can transition between phases. This includes reviewing elevation differences with existing and new alignments, including crossroads, side streets, bridges, and/or culvert construction. In addition, the plans should consider impacts to utilities (e.g., relocation required prior to a certain type of work), geotechnical needs (e.g., settlement), and drainage (e.g., converting from existing to new). These and the project context may impact the overall traffic control plan development as well as the project's ultimate footprint.

The T3-T50Z series outlines how a typical plan set will be developed and packaged. Traffic control plans are generally a portion of a larger construction project and will be included in the overall project plans. The sheet numbers for Traffic Control Plans begin with "T." **Table 7-2** outlines the types of plan sheets that may be included in the T3-T50Z Traffic Control Plans.

Table 7-2
Type of Plan Sheets within T3-T50Z

General

- North Arrow.
- Begin/End Construction project limits.
  - Labeled with construction project numbers for federal and state project(s).
  - Project limits must contain the word "CONSTRUCTION" or "CONST." and be labeled with station and North/East coordinates (4 decimal places).
- Begin/End right-of-way (R.O.W.) project limits.
  - Labeled with R.O.W. project numbers for federal and state project(s).
  - Project limits must contain the word "R.O.W." and be labeled with the station and North/East coordinates (4 decimal places).
- Coordinate Notation.
  - Datum adjustment note above sheet title.
- Existing natural features and text.
  - Names of streams and receiving waters.
- Existing shoulders that will be used for traffic during construction.
  - Discuss with Pavement Design personnel to obtain information on the type of material needed to effectively handle proposed traffic.
  - Items for removal of existing shoulder and addition of material needed prior to traffic shall be added to the Estimated Quantities.
  - The removal of the existing shoulder and the addition of new material shall also be noted in the traffic control phasing notes.

Traffic Control Staging/Phasing Sheets

- Layouts based on traffic control strategies are defined in **Chapter 6**.
- Phase construction typical cross section details (as necessary within sheets).
  - Typical sections are provided at constrained locations and locations where the cross section changes.
  - Example: Specify shoulder or other areas that will be used as riding surface during construction and include notes for consequential additional pavement width and/or depth necessary.
- Verify that signs associated with temporary traffic control and permanent signage provide a clear message that provides adequate time for roadway users to process.
- The traffic control phases should coincide with the erosion control phases. Therefore, the Design Team should coordinate with TDOT staff to verify this consistency.
- Traffic flow areas added for clarity.
- Work zone area patterned for each phase of construction.
- Considerations for utilities and temporary shoring.

Temporary Construction Items

- Lane Closure details (if needed).
- Median crossover details (if needed).
- Detours (passenger vehicles, oversize vehicles, pedestrians, and/or bicycles).
- Temporary paving information for specific phases/sub-phases
- Temporary culverts.
  - Labeled as temporary with lengths and diameter.

Table 7-2 *(continued)* Type of Plan Sheets within T3-T50Z

Proposed Construction Items

• Proposed bridge linework.
• Proposed drainage systems.
    ○ Catch basins, manholes, storm sewer, junction boxes, endwalls, etc.
    ○ For proposed drainage systems that tie into existing drainage structures, the existing structure to remain in place will be copied to the appropriate proposed level and labeled to remain in place.
• Proposed edge of pavement and shoulder lines.
• Proposed limits of construction stations labeled for sideroads.
• Proposed limit of paving labeled.
    ○ Clearly define station ranges that are overlay only and not full depth.
• Proposed median openings linework and width labeled.
• Proposed private drives, business entrances, and field entrances, edges of pavement, and radii shown (no shading).
• Proposed road centerlines (mainline, side roads, haul roads, construction run-arounds, and callout and bearing text).
    ○ Label road name, full station ticks every 500 feet, half station ticks every 100', and bearings (no curve data).

Temporary Signs, Markings, and Traffic Control Devices

• Schematic detail for construction signs and placement.
• Temporary signal details (as necessary).
• Temporary pavement marking details and/or removal of pavement striping (as necessary).
• Traffic control temporary devices (portable barrier wall, high visibility construction fence, barrels, temporary guardrail attenuator, flashing message boards, barricades, etc.).
    ○ Prioritization of messaging and clear communication should be considered.
• Traffic control temporary sign faces and text with vertical panels as needed.
    ○ Includes advance signing that likely remains in place for the duration of the project.
NOTE: Verify that all signs, markings, and TCDs are consistent with MUTCD and/or TDOT MUTCD Supplement and TDOT Supplement to the Standard Highway Signs Book.

Typical Sheets
• Standard Drawings are referenced if used as detail.

Within the T3-T50Z series of sheets, the following design elements and strategies provide necessary work zone design implementation details:

- phase construction layouts
- proposed detours and diversions
- typical sections
- grading
- references to forms and checklists associated with Traffic Control Plans.

The following sections provide additional information and layout examples.

7.3.4 Phase Construction Layouts

Chapter 2 provides additional information about design vehicle considerations.

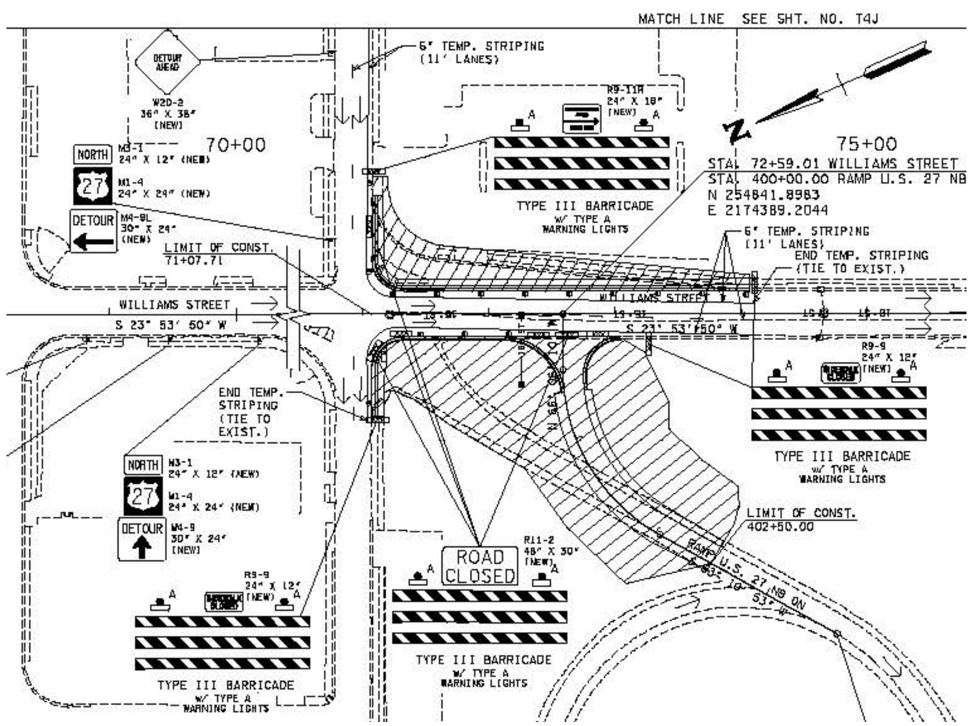
Layouts for phasing and sub-phasing should be provided within the Traffic Control Plans. This provides information about the physical layout of the traffic control strategies and overviews the entire approach to traffic control during construction. During the development of the traffic control layout, the Design Team should verify that temporary intersection configurations can accommodate the appropriate design vehicles. The layouts include the following information:

- extents of the work zone area
- location of permanent and temporary signing, pavement markings, and devices
    - includes those that will remain in place for all phases and sub-phases
    - includes those that will change depending on the phase and sub-phase of the project
- appropriate widths and tapers to guide roadway users through construction areas based on the context
- design vehicle turn radius
- lateral offsets from fixed objects

Chapter 6 provides additional information about work zone dimensions and tapers.

Figure 7-2 provides an excerpt from a layout for an urban intersection project, **Figure 7-3** provides an excerpt from a layout for an urban interchange project, and **Figure 7-4** provides an excerpt from a layout for a rural bridge project.

Figure 7-2
Example Layout – Intersection



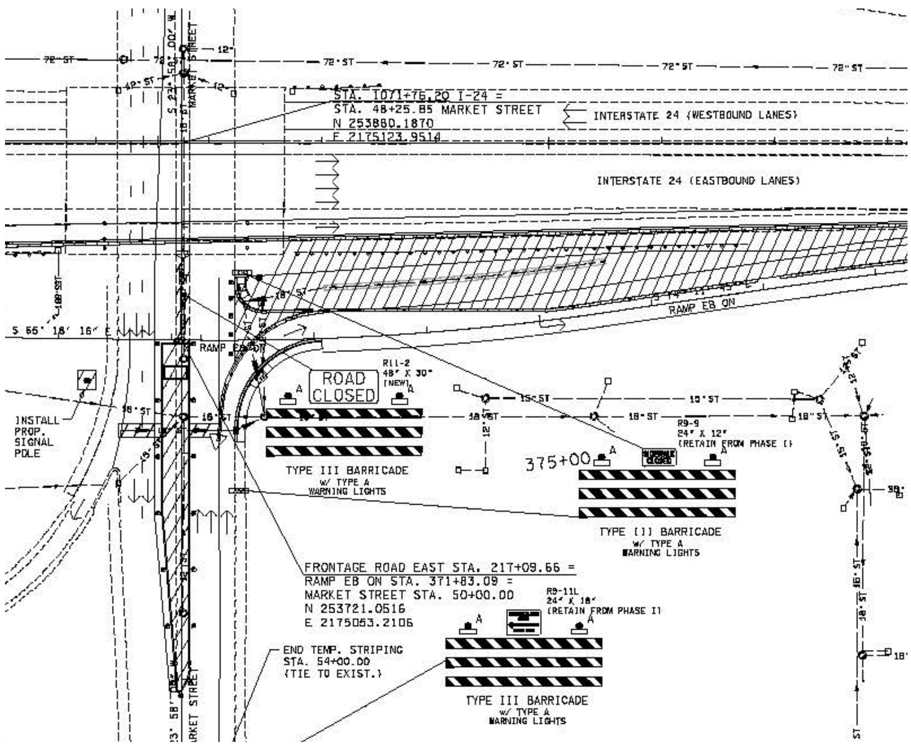


Figure 7-3
Example Layout – Interchange

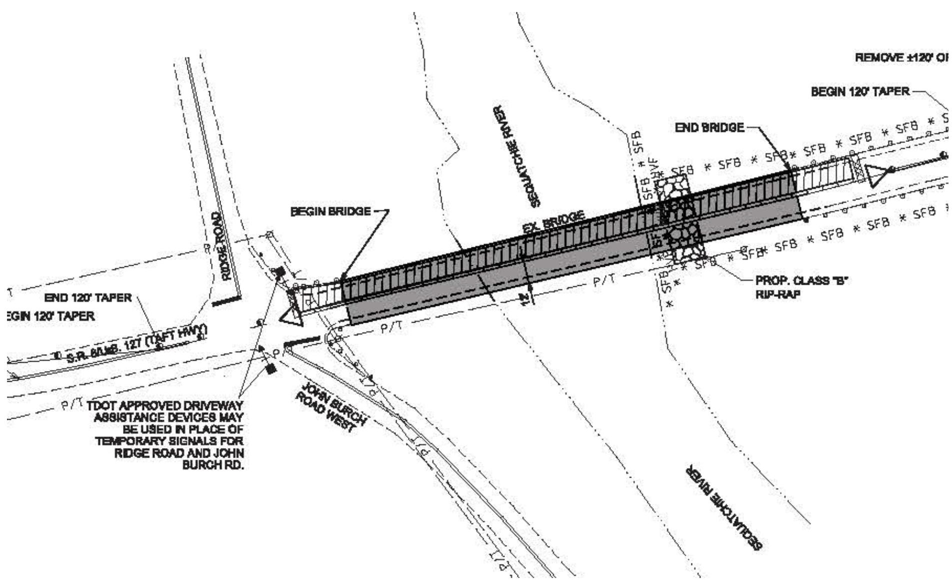


Figure 7-4
Example Layout – Bridge Project

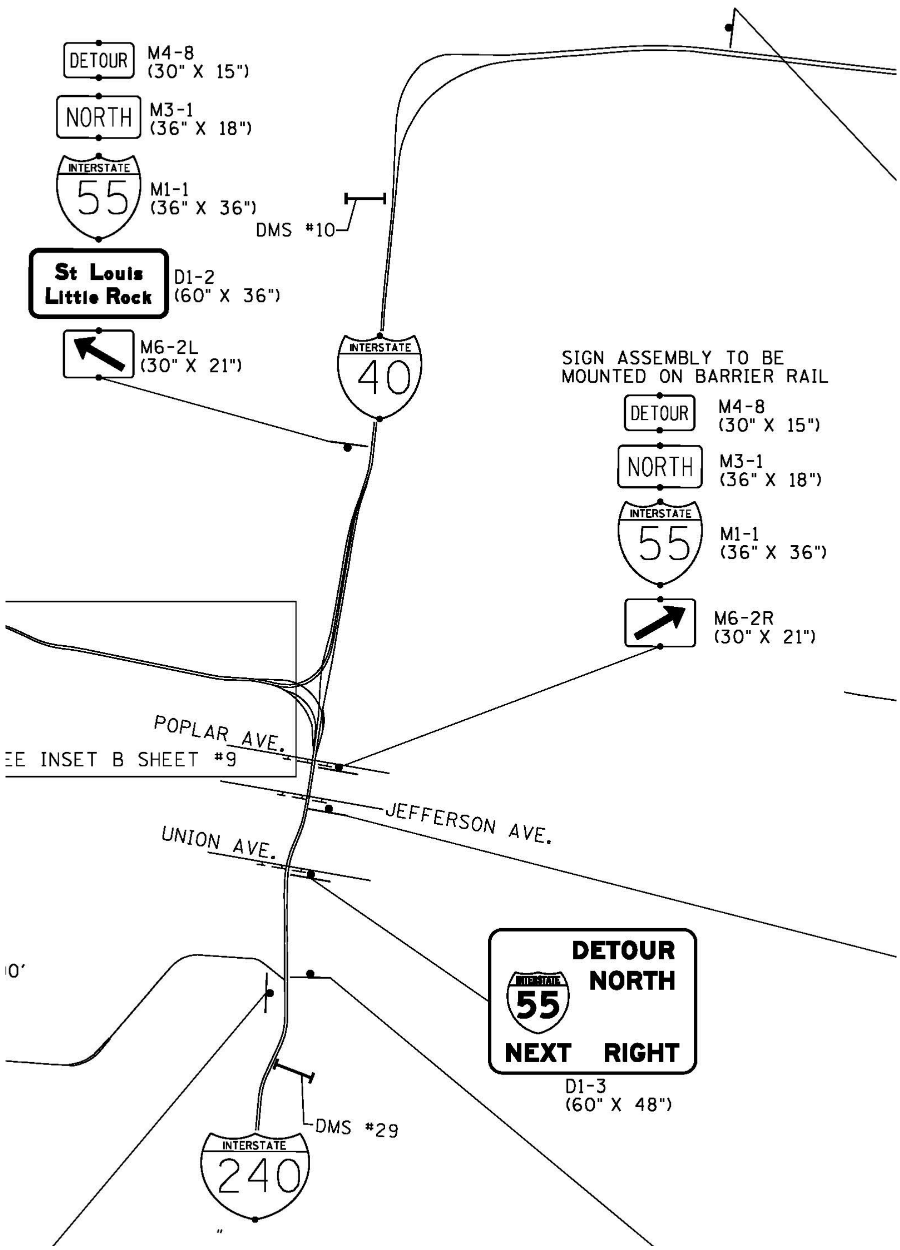
7.3.5 Detours and Diversions

Detours and diversions are useful components of the temporary traffic control toolbox because they aid in maintaining traffic around a work zone. Detours and diversions can apply to each mode of transportation: pedestrians, bicyclists, transit, cars, and trucks. Detours and diversions require additional plan sheets to communicate the route details to the contractors setting up the detour.

Figure 7-5 provides an example of a motor vehicle traffic detour layout for an interchange project.

Detours and Diversions may require additional traffic operations evaluations coordinated with the Traffic Operations staff and stakeholder outreach coordinated with the Community Relations Division. Additional details are in Chapter 6.

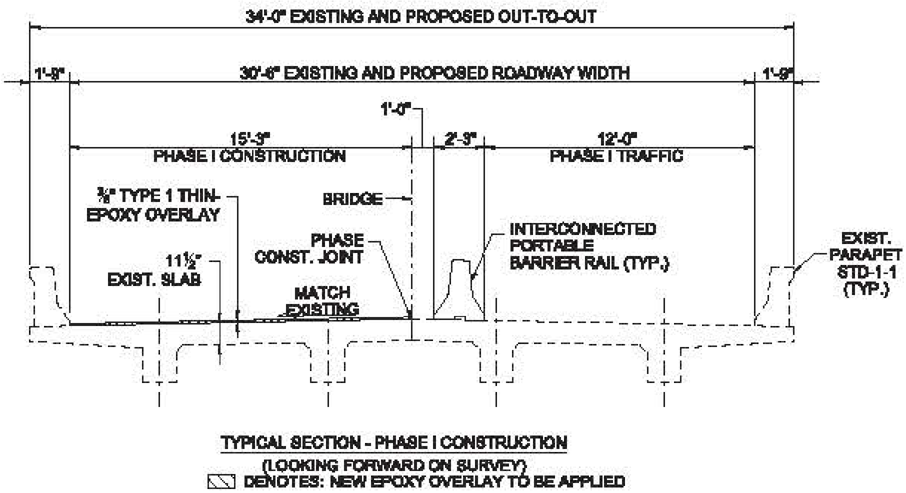
Figure 7-5
Example Detour– Motor Vehicle Traffic



7.3.6 Typical Sections

Typical sections should be provided for each phase and associated sub-phase(s) at critical locations throughout the work zone area. The objective of these cross sections is to confirm that there is sufficient space and separation for roadway users, placement of temporary traffic control devices, and construction areas.

Figure 7-6 provides examples of typical sections for a rural bridge project.



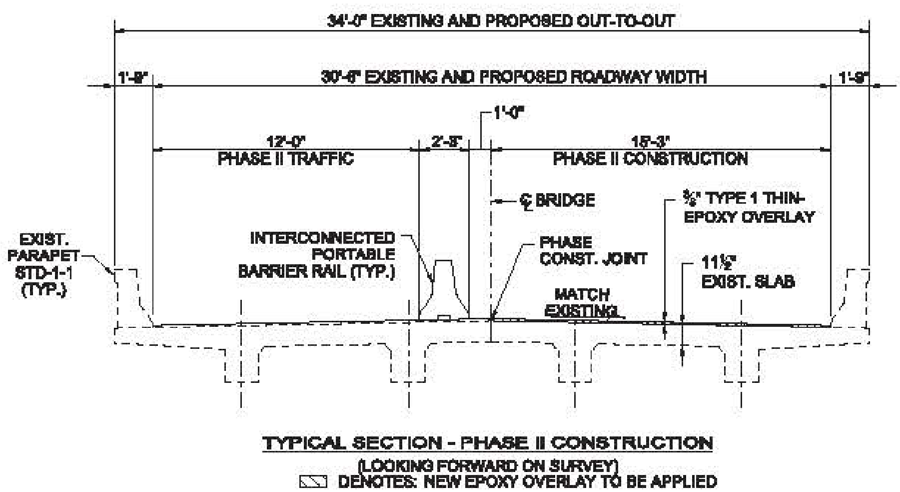


Figure 7-6 Example Typical Sections

7.3.7 Grading

For some projects, grading plans are required to show the elevation differences for specific areas of the project. This is especially needed when new construction has a different elevation than existing conditions. The elevation differences will likely require more space between roadway users and the construction areas to provide appropriate vertical transitions. To review the new grades, the cross section for the roadway typical sections may be used to compare to existing ground elevations.

7.3.8 Special Signs

In most projects, the Design Team will use standard signs for communicating with traffic in a work zone area. However, some Traffic Control Plans may require special signs that are supplemental to the standard signs and communicate specific project information (e.g., “Rumble Strips Ahead”).

The Design Team should use the following sources when determining the text, configuration, sizing, color, usage, and placement for temporary signs:

- *TDOT Supplement to the Standard Highway Signs Book*
- Federal Highway Administration (FHWA) "Standard Highway Signs"
- *Manual on Uniform Traffic Control Devices (MUTCD)*

7.4 DRAFTING STANDARDS

The TDOT *Survey & Roadway Design Computer-Aided Drafting & Design Standards Manual* shall guide the development of Traffic Control Plans. This includes TDOT staff, consultants, and anyone conducting surveys or producing plans for TDOT projects. The *Survey & Roadway Design Computer-Aided Drafting (CAD) & Design Standards Manual* provides information on file naming, text sizes, fonts, characters, and symbols and details for using the design software files *(5).* The standards verify that the Traffic Control Plans use correct file exchanges between external parties and within TDOT Divisions, Regions, and Departments. Draft standards also create consistency for printed and archived files to verify that the plans contain all necessary components and have the same appearance. TDOT's manual can be found at the following website link:

Survey & Roadway Design Computer-Aided Drafting & Design Standards Manual

7.5 EXAMPLE TRAFFIC CONTROL PLANS

Appendix C provides example Traffic Control Plans for three applications:

- Freeway Widening Project
- Bridge Repair Projects
- Intersection Projects

7.6 REFERENCES

1. Tennessee Department of Transportation (TDOT). Right-of-Way Checklist. Website: https://www.tn.gov/content/tn/tdot/roadway-design/design-standards/design-guidelines.html
2. TDOT. Construction Plans Checklist. Website: https://www.tn.gov/content/tn/tdot/roadway-design/design-standards/design-guidelines.html
3. TDOT. Work Zone Traffic Control Inspection Form. Website: https://www.tn.gov/content/dam/tn/tdot/traffic-engineering/Traffic%20Control%20Inspection%20Form.pdf
4. TDOT. T1 Pavement Drop Off Notes. Website: https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/tdot-documents/tdot-2nd-sheets/Pavement%20Edge%20Drop-Off%20Traffic%20Control%20Notes.dotx
5. TDOT. *Survey & Roadway Design Computer-Aided Drafting & Design Standards Manual.* Website: https://www.tn.gov/content/dam/tn/tdot/roadway-design/documents/cadd_documents/CCADDV8.pdf

TENNESSEE DEPARTMENT OF TRANSPORTATION

WORK ZONE DESIGN MANUAL

Chapter 8

Reference Materials for Specifications and Estimating

March 2022

Contents

CHAPTER 8
REFERENCE MATERIALS FOR SPECIFICATIONS AND ESTIMATING

Chapter 8

Reference Materials for Specifications and Estimating

8.1 INTRODUCTION

Chapter 8 provides information about reference materials used to complete the traffic control plan package, including:

- Standard Specifications
- Special Provisions
- Circular Letters
- Standard Drawings
- Special Details
- Qualified Products List
- Pay Items
- Quantity Calculations

The Design Team is not involved in preparing Special Provisions or Circular Letters, but these documents may guide aspects of the overall project.

The Standard Specifications, the Supplemental Specifications, the Traffic Control Plans, Special Provisions, and all other documents that are part of the Contract are intended to be complementary and to describe and provide for a complete contract. To avoid contradictions and conflicts with the contract documents, the TDOT *Standard Specifications for Road and Bridge Construction (Standard Specifications, also referred to as "Spec Book")* describe the coordination of plans and specifications in Section 105 *(1)*. Designers should review and become familiar with the hierarchy for the project contract documents. In case of discrepancy, the governing order is as follows:

1. Special Provisions
2. Plans
3. Supplemental Specifications
4. Standard Specifications

8.2 STANDARD SPECIFICATIONS

The *Standard Specifications for Road and Bridge Construction (Standard Specifications)* are standards that TDOT adopted for work methods and materials that are used for construction. The Standard Specifications are part of all construction contracts and provide criteria for bidding, awarding, and executing the contract. The Standard Specifications are published in book form and can be accessed at the following website *(1)*:

[Standard Specifications]

Specifications related to work zone design include Section 105: Control of Work and Section 712: Temporary Traffic Control.

TDOT may issue Supplemental Specifications that amend the Standard Specifications. These are interim updates to the Standard Specifications that are issued between major updates to the Standard Specifications. Supplemental Specifications provide an addendum to the Standard Specifications and serve to correct, add language to, or delete language from them.

8.3 SPECIAL PROVISIONS

TDOT Special Provisions provide scheduling considerations for when work may be conducted, including timeframes when activities are permitted or disallowed (e.g., nights, weekends, state holidays, special events). Special Provision 108b is prepared by the Headquarters Construction Office before bid letting advertisement to specify additional details regarding the project completion and liquidated damages. This may include specific timeframes for allowable lane closures on the roadways under construction. In addition, this special provision outlines potential penalties for any closures that extend beyond the allowable time periods. The TDOT Construction Special Provisions can be found at the following website link *(3)*:

[TDOT Construction Special Provisions]

There are several Special Provisions, and some provisions are used on every project. Most Special Provisions relate to items needed for the project and include information that is not currently in the Standard and Supplemental Specifications. Some Special Provisions are for a specific required process or equipment but not strictly associated with an item. If a new Special Provision is necessary, the Design Manager should notify the TDOT Headquarter Construction Office.

8.4 CIRCULAR LETTERS

Circular letters are for construction personnel and provide additional details about how to include measurements of some specific items, solutions to issues, additional information for documentation, or the application of processes/items. Circular letters provide a way for TDOT to provide timely updates to design practices that need to be communicated to TDOT staff involved in TDOT projects. Circular letters pertaining to work zone design are included in Section 700 and can be accessed by the Design Team at the following website link *(4)*:

[TDOT Circular Letters]

8.5 STANDARD DRAWINGS

TDOT Standard Drawings have been created to ensure consistency in TDOT projects across the state. Standard Drawings are referenced from the contract plans and contain standard notes and details. This reduces repetitiveness within the plans and prevents the designer from copying the commonly used notes and details into every set of plans. Standard Drawings help reduce both the number of drawings in project plans and the time it takes to prepare project plans. TDOT Standard Drawings are separated into eight sections; the Standard Drawings for Work Zones are located within the "Design-Traffic Control" Section and can be found at the following website *(5)*:

Work Zone Standard Drawings

TDOT Standard Drawings are routinely updated as design practices evolve. Design Teams should review the standard drawings regularly to ensure the latest drawings are referenced to support the traffic control plans.

8.6 SPECIAL DETAILS

Special details include information that does not appear in a TDOT Standard Drawing but may be regularly used in traffic control plans. The Design Team may coordinate with the TDOT Traffic Operations Division regarding special details that may be needed as part of the Traffic Control Plan. Examples of TDOT Special Details include:

- narrow entrances for parking lots
- use of snow plowable markers when reducing lanes from two lanes to one lane.

8.7 PROJECT ESTIMATES

To develop a cost estimate for a Traffic Control Plan, designers should focus on two items:

- a comprehensive list of traffic control pay items
- adequate quantities for each pay item

Identifying the correct pay items and quantities can help avoid contract change orders that can delay a project and increase the budget. Design Teams should compare the pay items and quantities to the specifications (Standard Specifications, Supplemental Specification, and Special Provisions) and plans (Traffic Control Plans, Standard Drawings, and Special Details).

The Design Team should update the quantities for the respective pay items as the traffic control design strategies are refined. Based on the project context, some pay items may have higher risks due to constraints or higher traffic volumes. It may be needed to provide a small contingency for additional items that may be damaged by construction activities, traffic, or vandalism. In addition, phase and sub-phase transitions where traffic control devices are installed, moved, or removed should be carefully quantified to accurately capture these cost items.

The TDOT *Roadway Design Guidelines* (Chapter 1, Section 4: Estimates) provides additional information on estimates provided as part of the plan submittal packages *(6)*. The *Roadway Design Guidelines* explain how to develop and submit the information to verify consistency across information and processes. Construction estimates are provided during the Construction (Design) stage of the project and include the following submittals.

- submittal of the preliminary estimate
- submittal of right-of-way estimate for right-of-way and utilities-only funding
- resubmittals of estimates due to an instructional bulletin or roadway design guideline change
- submittal of construction estimate for construction field review
- submittal of construction estimate for bid letting process
- revision of construction estimate for bid letting process

Information on TDOT average unit prices is provided at the following internal TDOT website:

TDOT Average Unit Price Information

8.7.1 Qualified Products List

Specific product information can be found in the TDOT Qualified Products List (QPL). The purpose of the QPL is to make available to Construction and Maintenance personnel a list of products that perform satisfactorily for TDOT. Inclusion on the QPL must not be considered prior approval and in no way precludes departmental testing and approval requirements. Products on the QPL have been evaluated and found acceptable for use, provided all testing and/or certification requirements have been met and the products are used per the manufacturer's recommendations.

There is not a QPL covering every type of product, and products that are found to perform satisfactorily and are not on a QPL may require the need for new QPLs to be developed. The Research and Product Evaluation Section is responsible for the testing and evaluation of all new products proposed for use in Tennessee's highway program. This section distributes information gained from testing and evaluating these products and maintains the Department's QPL. All in-house research projects are either conducted or coordinated by the Research and Product Evaluation Section.

Companies desiring to submit products for evaluation must complete a Product Evaluation Submittal Form and follow the evaluation procedures for data that is required. Additional information on this process and a complete list of the current TDOT Qualified Products List can be found at the following website link *(7)*:

TDOT Qualified Products List

8.7.2 Traffic Control Plan Pay Items

Multiple traffic control devices help develop a Traffic Control Plan, and designers should become familiar with the technical pay item name for each item and its unit of measure. Design Teams can identify pay items using the TDOT Roadway Item List provided at the following website link *(8)*. To identify traffic control pay items, items can be searched using "712" or part of the description.

[TDOT Roadway Item List]

The "Traffic Control" lump sum item is a single-pay item providing temporary work zone lighting and all equipment, labor, and materials. It is also used to furnish flaggers and traffic cones as well as remove conflicting and incorrect pavement markings. TDOT pay item numbers correlate to the specifications, and there may be special payment considerations for various devices. Such as, how the contractor may be paid for moving portable barrier rail or the type of striping used for projects extending multiple seasons.

Table 8-1 summarizes how the devices presented in **Chapter 5** are typically paid for in the project.

Table 8-1
Device Payment Type Summary

Device		Item Number	Lump Sum Item	Individual Pay Item	Measurement
Category 1 Devices					
Flexible Drums		712-04.01		X	Each
Tubular and Conical Markers	Surface Mounted Delineators	712-01		X	Each
	Tubular Markers		X		
	Opposing Traffic Lane Divider			X	Each
	Cones		X		
	Weighted Channelizer		X		
Temporary Delineators (White and Yellow)		712-01.51 712-04.10 712-04.50 712-12.10		X	Each
Temporary Pavement Markings	Temporary Striping	712-09		X	L.F.
	Temporary Pavement Legends, Crosswalks and Stop Bars			X	S.Y.
	Durable Striping			X	S.Y.
	Temporary Tape			X	L.F.
Temporary Pavement Markers	Temporary Reflective Pavement Markers	716-01.05 716-01.06 716-01.07		X	Each
	Flexible Overlay Pavement Markers			X	Each

Table 8-1 *(continued)* Device Payment Type Summary

<table>
<tr><th colspan="2">Device</th><th>Item Number</th><th>Lump Sum Item</th><th>Individual Pay Item</th><th>Measurement</th></tr>
<tr><td colspan="6">Category 2 Devices</td></tr>
<tr><td colspan="2">Type I and II Barricade</td><td>712-07.01
712-07.02</td><td></td><td>X</td><td>L.F.</td></tr>
<tr><td colspan="2">Type III Barricade</td><td>712-07.03
712-07.04</td><td></td><td>X</td><td>L.F.</td></tr>
<tr><td colspan="2">Pedestrian Channelizing Devices</td><td>604-44.10
707-07.02
707-08.03
707-11.01</td><td></td><td>X</td><td>L.F.</td></tr>
<tr><td colspan="2">Water-filled Barrier</td><td>712-01
712-02.02
712-04</td><td></td><td>X</td><td>L.F.</td></tr>
<tr><td colspan="2">Temporary Signs</td><td>712-06
712-06.16
713-16.41</td><td></td><td>X</td><td>S.F.</td></tr>
<tr><td colspan="2">Advisory Speed Signs</td><td>712-06.16</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Specialty Signs</td><td>712-06</td><td></td><td>X</td><td>Each</td></tr>
<tr><td rowspan="7">Additional Temporary Sign Details</td><td>Sign Sheeting</td><td rowspan="7">712-06</td><td></td><td>X</td><td>S.F.</td></tr>
<tr><td>Sign Flags and Sign Flag Boards</td><td></td><td>X</td><td>Each</td></tr>
<tr><td>Perforated Steel Square Tube Posts</td><td></td><td>X</td><td>LB.</td></tr>
<tr><td>Temporary Sign Supports</td><td></td><td>X</td><td>Each</td></tr>
<tr><td>Portable Sign Support</td><td></td><td>X</td><td>Each</td></tr>
<tr><td>Concrete Barrier Sign Support</td><td></td><td>X</td><td>Each</td></tr>
<tr><td>Existing Sign Support</td><td></td><td>X</td><td>Each</td></tr>
</table>

Table 8-1 *(continued)*
Device Payment Type Summary

<table>
<tr><th colspan="2">Device</th><th>Item Number</th><th>Lump Sum Item</th><th>Individual Pay Item</th><th>Measurement</th></tr>
<tr><td colspan="6">Category 3 Devices</td></tr>
<tr><td colspan="2">Portable Barrier Rail</td><td>712-02.60
712-01
712-02.02
712-04</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Temporary Steel Barrier</td><td>712-02.60
712-01
712-02.02
712-04</td><td></td><td>X</td><td>L.F.</td></tr>
<tr><td rowspan="4">Additional Temporary Traffic Barrier Details</td><td>Temporary Glare Screen/ Shields</td><td rowspan="4">712-01</td><td></td><td>X</td><td>L.F.</td></tr>
<tr><td>Reflective Barrier Panels</td><td></td><td>X</td><td>Each</td></tr>
<tr><td>Temporary Connections and Terminals</td><td></td><td>X</td><td>Each</td></tr>
<tr><td>Anchoring</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Temporary Impact Attenuator/Crash Cushion</td><td>712-02.60</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="6">Category 4 Devices</td></tr>
<tr><td colspan="2">Truck-Mounted Attenuator</td><td>705-07.11
713-16.02
712-08.20</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Trailer-Mounted Attenuator</td><td>712-01</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Digital Speed Limit Sign Assembly</td><td>712-08.09</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Speed Feedback Sign Assembly</td><td>712-08.08
712-08.07</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Flashing Arrow Boards</td><td>712-08.03</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Portable Changeable Message Signs (PCMS)</td><td>712-08.10
713-16.01
713-16.04</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Fixed Temporary Traffic Signals</td><td>730-40.02</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Portable Traffic Signals</td><td>730-40.01</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Driveway Assistance Device</td><td>712-01</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="2">Automated Flagger Assistance Device</td><td>712-01</td><td></td><td>X</td><td>Each</td></tr>
<tr><td colspan="6">Other</td></tr>
<tr><td colspan="2">Portable Queue Warning System</td><td>712-08.14</td><td></td><td>X</td><td>Day</td></tr>
</table>

NOTES:
S.F. = square feet
LB. = pounds
S.Y. = square yards
L.F. = linear feet

8.7.3 Quantity Calculations

Developing quantity calculations is a key element of Traffic Control Plan cost estimating. The Design Team will develop the quantity calculations in coordination with the pay items, Traffic Control Plans (including standard details), Standard Drawings, Standard Specifications, Supplemental Specifications, and Special Provisions.

The Design Team should match the quantities calculated from the plans with specific pay items and their units provided in the Special Provisions and Standard Specifications (with any applicable Supplements). For example, some items are measured dimensionally (e.g., linear feet or square feet, such as pavement markings and signs), while others are measured by "each" (e.g., number of drums).

The Design Team should consider the following items when developing quantity calculations:

- an allowance for replacement of traffic control devices (TCDs) that become unusable due to wear or damage; the allowance is typically on the order of 10 to 15 percent.
- temporary sign quantities
    - For example: On multilane sections, a pair of signs (one on each side of the roadway) are needed for each direction. The number of signs should be shown correctly on the traffic control plans.

- guidance for calculating accompanying traffic control devices
    - For example: For each Portable Changeable Message Sign (PCMS) placed on the roadway, Plastic Drums and a Type III Barricade have likely been installed in advance of this sign. The Design Team needs to either show these on the traffic control plans or provide a detailed illustration of the installation configurations with the respective pay items.

Figure 8-1 is an example of a Quantity Calculation that would be included in the traffic control plan.

712-06 SIGNS(CONSTRUCTION)						
DESCRIPTION	M.U.T.C.D. NO.	SIZE	SIGN AREA (S.F.)	QUANTITY	TOTAL AREA (S.F.)	REMARKS
ROAD WORK NEXT 2 MILES	G20-1	36"X18"	4.5	2	9	
END ROAD WORK	G20-2	36"X18"	4.5	10	45	
ROAD WORK AHEAD	W20-1	36"X36"	9	11	99	
ROAD WORK 500 FT	W20-1	36"X36"	9	2	18	
ROAD WORK 1000 FT	W20-1	36"X36"	9	2	18	
ROAD WORK 1/2 MILE	W20-1	36"X36"	9	2	18	
ROAD WORK 1 MILE	W20-1	36"X36"	9	2	18	
REVERSE CURVE	W1-4L	36"X36"	9	1	9	
LANE SHIFT 1000 FT	W1-4MD	36"X36"	9	1	9	
STOP	R1-1	36"X36"	9	8	72	
TOTAL					315	

TRAFFIC CONTROL QUANTITIES				
ITEM NO.	DESCRIPTION	UNIT	QUANTITY	REMARKS
303-01	MINERAL AGGREGATE, TYPE A BASE, GRADING D	TON	14235	
307-01.01	ASPHALT CONCRETE MIX (PG64-22) (BPMB-HM) GRADING A	TON	52955	
307-01.08	ASPHALT CONCRETE MIX (PG64-22) (BPMB-HM) GRADING B-M2	TON	2242	
402-01	BITUMINOUS MATERIAL FOR PRIME COAT (PC)	TON	233	
402-02	AGGREGATE FOR COVER MATERIAL (PC)	TON	827	
403-01	BITUMINOUS MATERIAL FOR TACK COAT (TC)	TON	72	
411-01.10	ACS MIX(PG64-22) GRADING D	TON	1113	
411-03.12	ACS MIX(PG64-22) THIN LIFT D ASPHALT	TON	5892	
415-01.01	COLD PLANING BITUMINOUS PAVEMENT	TON	3891	
712-01	TRAFFIC CONTROL	LS	1	
712-02.02	INTERCONNECTED PORTABLE BARRIER RAIL	LF	198661	
712-02.60	TEMPORARY CRASH CUSHION (MASH TL-3)	EA	75	
712-04.01	FLEXIBLE DRUMS (CHANNELIZATION)	EA	2159	
712-04.50	BARRIER RAIL DELINEATOR	EA	3291	
712-05.01	WARNING LIGHTS (TYPE A)	EA	8	
712-06	SIGNS (CONSTRUCTION)	S.F.	10554	
712-07.03	TEMPORARY BARRICADES (TYPE III)	LF	400	
712-08.03	ARROW BOARD (TYPE C)	EA	10	
712-08.10	MOBILE MESSAGE SIGN UNIT W/ATTENUATOR	HOUR	2000	
712-08.13	QUEUE PROTECTION TRUCK (EMERGENCY CALL OUT)	DAY	30	
712-09.08	REMOVABLE PAVEMENT MARKING (6" LINE)	LF	58001	
712-10.02	TEMPORARY TRANVERSE RUMBLE STRIPS	LF	384	
713-16.01	CHANGEABLE MESSAGE SIGN UNIT	EA	20	
716-01.11	RAISED PVMT MARKERS (BI-DIRECTIONAL) (1 COLOR LENS)	EA	169	
716-01.13	RAISED PVMT MARKERS (BI-DIRECTIONAL)(2 COLOR LENS)	EA	5301	
716-01.30	REMOVAL OF SNOWPLOWABLE REFLECTIVE MARKER	EA	2200	
716-05.02	PAINTED PAVEMENT MARKING (8" BARRIER LINE)	LF	253930	
716-05.20	PAINTED PAVEMENT MARKING (6" LINE)	L.M.	39.1	
716-08.01	REMOVAL OF PAVEMENT MARKING (LINE)	L.F.	180000	
725-21.07	PORTABLE SMART WORK ZONE SYSTEM	DAY	1460	

Figure 8-1
Quantity Calculation Example

8.8 REFERENCES

1. Tennessee Department of Transportation (TDOT). *The Standard Specifications for Road and Bridge Construction* (Spec Book). Website: https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-division-resources/transportation-construction-2015-standard-specifications.html
2. TDOT. Supplemental Specifications. Website: https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-division-resources/transportation-construction-2015-standard-specifications.html
3. TDOT. Construction Special Provisions. Website: https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-division-resources/construction-special-provisions.html
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5. TDOT. *Standard Roadway Drawings*. TDOT, Nashville, TN, 2020. Website: https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/design---traffic-control.html#workzones2.
6. TDOT. *Roadway Design Guidelines.* TDOT, Nashville, TN, 2020.
7. TDOT. Qualified Products List. Website: https://www.tn.gov/tdot/materials-and-tests/research---product-evaluation-and-qualified-products-list.html.

   TDOT. Roadway Items. Website: https://www.tdot.tn.gov/APPLICATIONS/RoadwayItems