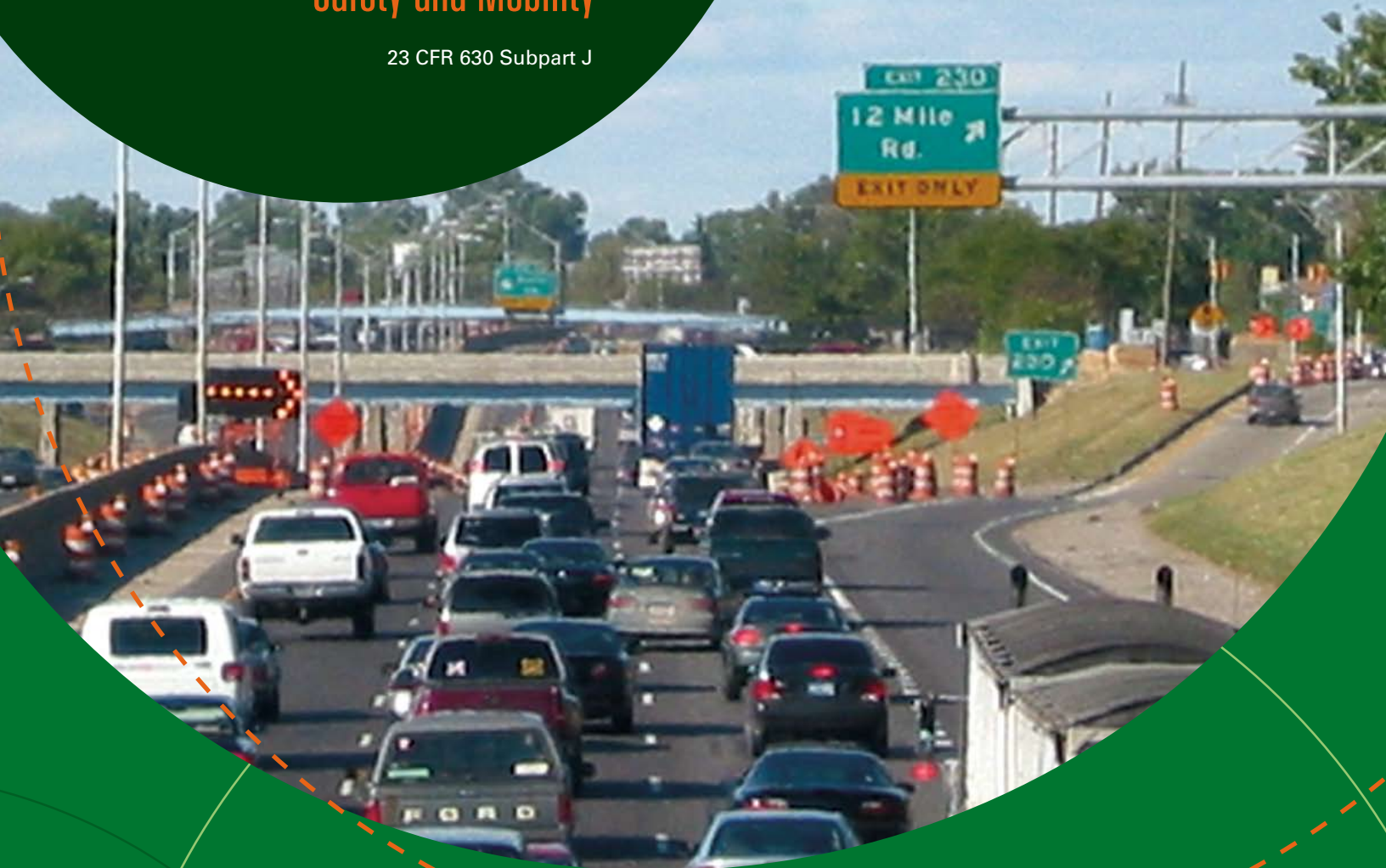


RULE on  
**WORK ZONE**  
Safety and Mobility

23 CFR 630 Subpart J



**Work Zone Impacts Assessment:**  
*An Approach to Assess and Manage Work Zone Safety and  
Mobility Impacts of Road Projects*



U.S. Department of Transportation  
**Federal Highway Administration**

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# **Work Zone Impacts Assessment:**

*An Approach to Assess and Manage Work Zone  
Safety and Mobility Impacts of Road Projects*

August 2006

U.S. Department of Transportation  
Federal Highway Administration  
Office of Operations



## List of Acronyms

<b>AAA</b>	– American Automobile Association
<b>AASHTO</b>	– American Association of State Highway and Transportation Officials
<b>ADT</b>	– Average Daily Traffic
<b>AGC</b>	– Associated General Contractors of America
<b>ARTBA</b>	– American Road and Transportation Builders Association
<b>ATSSA</b>	– American Traffic Safety Services Association
<b>CBD</b>	– Commercial Business District
<b>CCTV</b>	– Closed-Circuit Television
<b>CFR</b>	– Code of Federal Regulations
<b>CMS</b>	– Changeable Message Sign
<b>DMS</b>	– Dynamic Message Sign
<b>DOT</b>	– Department of Transportation
<b>EIS</b>	– Environmental Impact Statement
<b>FHWA</b>	– Federal Highway Administration
<b>FR</b>	– Federal Register
<b>HAR</b>	– Highway Advisory Radio
<b>HCM</b>	– Highway Capacity Manual
<b>HOV</b>	– High-Occupancy Vehicle
<b>HPMS</b>	– Highway Performance Monitoring System
<b>HSIS</b>	– Highway Safety Information System
<b>IDAS</b>	– ITS Deployment Analysis System
<b>ITS</b>	– Intelligent Transportation System(s)
<b>LOS</b>	– Level of Service
<b>L RTP</b>	– Long-Range Transportation Plan
<b>MOT</b>	– Maintenance of Traffic
<b>MPO</b>	– Metropolitan Planning Organization
<b>MUTCD</b>	– Manual on Uniform Traffic Control Devices
<b>NEPA</b>	– National Environmental Policy Act
<b>NHI</b>	– National Highway Institute
<b>NHS</b>	– National Highway System
<b>PI</b>	– Public Information
<b>PS&amp;Es</b>	– Plans, Specifications, and Estimates
<b>ROW</b>	– Right of Way
<b>SAFETEA-LU</b>	– Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
<b>STIP</b>	– Statewide Transportation Improvement Program
<b>STP</b>	– Surface Transportation Program
<b>TCP</b>	– Traffic Control Plan
<b>TIP</b>	– Transportation Improvement Program
<b>TMA</b>	– Transportation Management Area
<b>TMC</b>	– Transportation Management Center
<b>TMP</b>	– Transportation Management Plan
<b>TO</b>	– Transportation Operations
<b>TTC</b>	– Temporary Traffic Control
<b>WWB</b>	– Woodrow Wilson Bridge



# Executive Summary

In September 2004, the Federal Highway Administration (FHWA) published updates to the work zone regulations at 23 CFR 630 Subpart J. The updated Rule is referred to as the Work Zone Safety and Mobility Rule (Rule) and applies to all State and local governments that receive Federal-aid highway funding. Transportation agencies are required to comply with the provisions of the Rule by October 12, 2007. The changes made to the regulations broaden the former Rule to better address the work zone issues of today and the future.

Growing congestion on many roads, and an increasing need to perform rehabilitation and reconstruction work on existing roads already carrying traffic, are some of the issues that have led to additional, more complex challenges to maintaining work zone safety and mobility. To help address these issues, the Rule provides a decision-making framework that facilitates comprehensive consideration of the broader safety and mobility impacts of work zones across project development stages, and the adoption of additional strategies that help manage these impacts during project implementation. At the heart of the Rule is a requirement for agencies to develop an agency-level work zone safety and mobility policy. The policy is intended to support systematic consideration and management of work zone impacts across all stages of project development. Based on the policy, agencies will develop standard processes and procedures to support implementation of the policy. These processes and procedures shall include the use of work zone safety and operational data, work zone training, and work zone process reviews. Agencies are also encouraged to develop procedures for work zone impacts assessment. The third primary element of the Rule calls for the development of project-level procedures to address the work zone impacts of individual projects. These project-level procedures include identifying projects that an agency expects will cause a relatively high level of disruption (referred to in the Rule as significant projects) and developing and implementing transportation management plans (TMPs) for all projects.

To help transportation agencies understand and implement the provisions of the Rule, FHWA has developed four guidance documents. This Guide is designed to help transportation agencies develop and/or update their own policies, processes, and procedures for assessing and managing the work zone impacts of their road projects throughout the different program delivery stages. An overall Rule Implementation Guide provides a general overview of the Rule and overarching guidance for implementing the provisions of the Rule. Two additional technical guidance documents cover other specific aspects of the Rule: TMPs for work zones, and work zone public information and outreach strategies. All four of the guides include guidelines and sample approaches, examples from transportation agencies using practices that relate to the Rule, and sources for more information. The examples help illustrate that many transportation agencies already use some policies and practices that the Rule either encourages or requires, and that there is more than one way to achieve compliance with the Rule. While what these agencies are doing may not yet be fully compliant with the Rule, their current practices still serve as good examples of how to work toward Rule implementation. While the guides cover aspects of the Rule, they also contain information that can be useful to agencies in all of their efforts to improve safety and mobility in and around work zones and thereby support effective operations and management of our transportation system.

State and local transportation agencies and FHWA are partners in trying to bring about improved work zone safety and mobility. Consistent with that partnership, the Rule advocates a partnership between agencies and FHWA in Rule implementation and compliance. Staff from the respective FHWA Division Offices, Resource Center, and Headquarters will work with their agency counterparts to support implementation and compliance efforts. This guidance document is one key element of that support.

## Contents of this Guide

Work zone impacts assessment is the process of understanding and managing the safety and mobility impacts of a road construction, maintenance, or rehabilitation project. Assessing work zone impacts is important for developing effective work zone TMPs that provide for safety, mobility, and quality in maintaining, rehabilitating, and rebuilding our highways.

Over the years, State Departments of Transportation (DOTs) and local transportation agencies (hereafter collectively referred to as agencies) have used many successful approaches, innovative strategies, and tools to mitigate work zone impacts. However, in light of the work zone needs of today and the future, and the principles advocated by the Rule, practitioners generally recognize the need for a systematic process to assess and manage work zone impacts. This Guide presents a general approach for work zone impacts assessment. It is not the only way, and is not intended to advocate a “one-size-fits-all” approach. Throughout the Guide there is a recognition that different projects have different needs, and that the same level of work zone impacts assessment is not appropriate for every project. For some projects (e.g., less complex projects) a high-level qualitative assessment may be sufficient, while for others a detailed quantitative analysis (e.g., modeling /simulation) may be needed.

*The intended audience for this Guide is transportation agency staff, including technical staff (planners, designers, construction/traffic engineers, highway/safety engineers, etc.); management and executive-level staff responsible for setting policy and program direction; field staff responsible for building projects and managing work zones; and staff responsible for assessing performance in these areas. Appropriate non-agency staff that partner with or are contracted by the agency, such as FHWA staff with oversight responsibilities, contractors, highway workers, and consultants also may find this Guide useful.*

Incorporating work zone impacts assessment in program delivery does not entail an entirely new process. Many agencies already perform key work zone impacts assessment activities. This Guide re-emphasizes them and incorporates additional concepts and principles advocated by the Rule (e.g., transportation operations, public information, performance assessment). Agencies can use the Guide to review and update existing policies, processes, and procedures, or for creating entirely new ones. The assessment process described in this Guide mirrors the typical program delivery process of transportation agencies. The assessment process is summarized as follows:

- Adopting a **Policy** that facilitates systematic work zone impacts assessment and management, and implementing policy provisions for decision-making during program delivery.
- Conducting a first-cut assessment during **Systems Planning** to conceptually identify work zone management strategies, address project coordination, and estimate costs.
- Conducting early project-level assessments and investigations during **Preliminary Engineering** to further identify construction approaches, management strategies, costs, and other coordination issues.
- Performing more detailed assessments throughout the various **Design** iterations to finalize the construction approach and management strategies, and develop the final design, TMP, and plans, specifications, and estimates (PS&Es).
- Implementing the TMP during **Construction**, monitoring actual work zone impacts in the field, and managing the impacts by making adjustments (as needed) to the TMP.
- Conducting **Performance Assessment** to develop recommendations for improving work zone policies, processes, and procedures.
- Incorporating work zone impacts assessment and management in **Maintenance and Operations**.



**This Guide is structured as follows:**

- **Section 1** provides a brief introduction to work zone impacts assessment, explains its importance, identifies the target audience, and explains how it relates to the Rule.
- **Section 2** outlines the overall structure of the assessment process described in this Guide, and explains how it fits into program delivery. It also discusses key issues related to work zone impacts.
- **Section 3** discusses the development and implementation of a work zone policy, and provides examples of potential policy provisions for use in decision-making during program delivery.
- **Sections 4, 5, 6, and 7**, respectively, discuss principles and a process that can be used for work zone impacts assessment during systems planning, preliminary engineering, design, and construction. The introductory portions of each of these sections contain a process overview, and present the potential participants, inputs, and outputs. The key elements in each of these sections are the respective process flow diagrams and accompanying process explanations that provide a step-by-step approach that can be used for work zone impacts assessment.
- **Section 8** discusses work zone performance assessment and how it aids in the process of understanding and managing the safety and mobility impacts of work zones. The section includes suggestions for possible work zone performance assessment categories and measures.
- **Section 9** discusses work zone impacts assessment for maintenance and operations (M&O) along four key themes: improving agency procedures to minimize the direct impacts of M&O activities; planning and coordinating M&O such that overall system-wide impacts are minimized; addressing impacts of M&O on other construction projects and vice-versa; and incorporating features in construction projects that would facilitate future M&O with minimum disruption.
- The Guide has three appendices. **Appendix A** presents a real-world example of how the work zone impacts assessment process described in this Guide can be applied to a project. **Appendix B** provides an overview of different traffic analysis tools that may be used for analysis of work zone impacts. **Appendix C** presents a list of the resources referenced in this Guide.



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# 1.0 Introduction

## 1.1 What is Work Zone Impacts Assessment?

Work zone impacts assessment is the process of understanding the safety and mobility impacts of a road construction/maintenance/rehabilitation project. This constitutes:

- Assessing the likely work zone impacts and developing appropriate work zone transportation management plans (TMPs) during project development and delivery.
- Monitoring the actual impacts of the project and making adjustments to the TMP (if necessary) during project implementation.
- Conducting performance assessment to track performance, document lessons learned, and identify trends towards overall improvement of work zone policies, procedures, and practices.

Factors that will influence the level of impacts caused by a work zone include traffic conditions and characteristics, project characteristics, geographic/physical features, and aspects of the surrounding area (e.g., alternate routes, nearby businesses). The assessment process may involve a high-level, qualitative review of these factors for some projects, and a detailed quantitative analysis using modeling and/or simulation tools for other projects.

## 1.2 Why Assess Work Zone Impacts?

Current and future work zone safety and mobility issues mean that transportation practitioners need to minimize and manage the work zone impacts of road projects. Some of the key work zone issues of today include:

- Traffic volumes and congestion are increasing on our roads, but there is very little growth in road miles.
- Highways are approaching middle age, requiring more construction and repair, which means more work zones. More work is done on existing roadways, affecting traffic using the road under construction and possibly other nearby roads. This adds pressure to compress schedules, finish projects early, and sometimes perform work at night, while maintaining safety and the quality of work.
- Work zone safety continues to be a concern, with more than 41,000 injuries and around 1,000 fatalities in work zones each year (from 1999 – 2003)<sup>1</sup>.
- Travelers are frustrated with the delays and unexpected road conditions caused by work zones.

In order to meet safety and mobility needs during highway maintenance and construction, and to meet the expectations of the traveling public, it is important to systematically assess the work zone impacts of projects and take appropriate action to manage these impacts.

<sup>1</sup> U.S. Department of Transportation, National Highway Traffic Safety Administration, Fatality Analysis Reporting System and General Estimates System. Washington D.C., 2003.

Assessing work zone impacts is intended to help transportation professionals:

- Identify and understand the work zone safety and mobility impacts of road projects (construction, maintenance and utility work).
- Understand the work zone safety and mobility implications of alternative project options and design strategies.
- Identify those projects that are likely to have greater work zone impacts to allocate resources more effectively to projects.
- Identify transportation management strategies to manage the expected work zone impacts of a project.
- Estimate costs and allocate appropriate resources for the implementation of the work zone transportation management strategies.
- Understand, coordinate, and manage multiple projects and construction schedules to minimize overall impacts.
- Monitor and manage work zone impacts during construction, maintenance, and utility work, and adjust the transportation management strategies if needed.
- Provide information for conducting performance assessment.
- Use work zone performance assessment information to improve and update work zone policies, procedures and practices.

Recognizing the above, the Federal Highway Administration (FHWA), updated the work zone regulation in 23 CFR 630 Subpart J to help States and local transportation agencies<sup>2</sup> better address and manage the work zone safety and mobility impacts of their road projects. Section 1.6 provides a discussion of the updated regulation.

## 1.3 Purpose of This Document

The purpose of this document is to provide guidance to practitioners on developing and/or updating procedures to assess and manage the work zone impacts of their road projects.

Over the years State Departments of Transportation (DOTs) and other transportation professionals have taken several successful measures and used innovative strategies and tools to manage the safety and mobility impacts of work zones. Practices and procedures vary greatly across the country and the decision-making process for work zone impacts assessment and management is not always consistent. This is both appropriate and essential, as what applies in one part of the country may not apply equally in another. However, the FHWA and many State and local practitioners recognize that some guidance on an approach for work zone impacts assessment and management could be helpful.

This document presents a general approach for conducting work zone impacts assessment and management. This approach is not the only way to perform work zone impacts assessment, and is not intended to advocate a “one-size-fits-all” approach. The guidance provided in this document will:

- Assist agencies with developing and/or updating their own policies, processes, and procedures for assessing work zone impacts throughout the different program delivery stages.



- Set forth some basic guiding principles and describe one possible approach for conducting work zone impacts assessment.
- Provide practitioners with information to support work zone related decision-making based upon relevant project information that is available at each stage.
- Help agencies implement the provisions of the updated work zone regulation.

## 1.4 Target Audience

This guide primarily applies to staff belonging to State and local transportation agencies. Categories of staff include:

- Technical staff, including planners, engineers, designers, construction engineers, traffic engineers, and specialists such as environmental engineers, hydraulics experts, and right-of-way (ROW) experts. Technical staff will typically be responsible for assessing work zone impacts during the respective stages of program delivery and developing appropriate work zone management strategies.
- Field staff, including construction managers, project engineers, construction and safety inspectors, and highway maintenance workers, who are responsible for building road projects in the field and for managing work zone impacts during construction.
- Management-level and executive-level staff who are responsible for formulating policies, identifying program vision, goals, and objectives, and setting program-level priorities.
- Appropriate representatives from the above areas who are responsible for assessing the performance of work zones and developing recommendations for improving policies, practices, and procedures.

Appropriate non-agency staff that partner with, or are contracted by the agency, to plan, design, and build road projects may also find this guidance useful. This group includes industry representatives, consultant staff, contractor staff, and highway workers.

## 1.5 How to Use This Guide

This document is intended to serve as a resource for conducting work zone impacts assessments. It covers a wide range of related topics applicable to the different program delivery stages. Given the exhaustiveness of the subject matter and to minimize document length, the Guide does not always present all of the issues that fall under a specific topic area, and neither does it focus on providing detailed explanations on individual topics/issues. It does provide both generic and real-world examples to help put discussions in context, and also points to resources where more information on specific topics/issues can be obtained. Appendix A contains an example of how the overall impacts assessment process described in this Guide has been applied to the Virginia Department of Transportation I-495/U.S. Route 1 Interchange project, which is part of the Woodrow Wilson Bridge reconstruction project in the Washington, D.C. area.

The basic process steps discussed in this Guide for the different program delivery stages may seem identical; however the work zone impacts related topics/issues are specific to the level of information and project-detail that progressively becomes available from one stage to another. The Guide does include some repetition and many cross references

between chapters. This is intended to facilitate its use as a reference document, so that someone who refers primarily to the chapter pertaining to his/her role (e.g., as a designer), will readily see how that step relates to the rest of that process.

Agencies are encouraged to use this guidance as a general framework to update and/or develop their own work zone impacts assessment process and identify relevant issues that need to be addressed under a specific topic area. This Guide is written to be a helpful reference for conducting a work zone impacts assessment for a wide range of projects. The basic principles presented in this Guide can be applied to any type of project. Some of the more in-depth or detailed analysis may be most appropriate for complex projects and projects likely to cause a relatively greater amount of work zone impacts.

## 1.6 Work Zone Impacts Assessment and the Work Zone Rule

The FHWA published the Work Zone Safety and Mobility Rule (the Rule) on September 9, 2004 in the Federal Register (69 FR 54562). The Rule updates and renames the former regulation on “Traffic Safety in Highway and Street Work Zones” in 23 CFR 630 Subpart J. All State and local governments that receive Federal-aid highway funding are affected by this updated Rule, and are required to comply with its provisions no later than October 12, 2007. The purpose of this update is to help States and local transportation agencies<sup>3</sup> better address and manage the work zone safety and mobility impacts of their road projects. While the Rule applies specifically to Federal-aid highway projects, agencies are encouraged to apply the good practices that it fosters to other road projects as well.

The Rule brings about a new focus and new requirements to address work zone safety and mobility. It advocates comprehensive and systematic consideration of the *broader safety and mobility impacts of work zones*<sup>4</sup> through a project’s life cycle, and the implementation of appropriate strategies to help manage these impacts.

The Rule is characterized by a policy-driven focus to institutionalize work zone processes and procedures, with specific provisions for application at the project-level. The Rule’s provisions are organized under three primary components:

- **Policy-level provisions** that help agencies implement an overall work zone safety and mobility policy for the systematic consideration and management of work zone impacts.
- **State-level processes and procedures** that help agencies implement and sustain their respective work zone policies. These include procedures that address work zone impacts assessment, work zone data, work zone training, and process reviews.
- **Project-level procedures** that help agencies assess and manage the work zone impacts of projects.

As evident from these three primary components, the Rule places an emphasis on comprehensive and systematic assessment and management of the work zone impacts of road projects. While the Rule does not require a specific work zone impacts assessment process/procedure, it recommends that agencies develop and implement systematic procedures to assess work zone impacts in project development, and to manage safety and mobility during project implementation. Table 1.1 describes the key provisions in the Rule that pertain to work zone impacts assessment

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<sup>3</sup> Hereinafter referred to as agencies.

<sup>4</sup> The phrase “broader safety and mobility impacts of work zones” emphasizes that work zone impacts may extend beyond the physical location of the work zone itself. Impacts may be felt on the roadway on which work is being performed, adjacent facilities, highway corridors, other transportation facilities, other modes of transportation, and on businesses and the community.

Section No.	Section Name and Provisions
§ 630.1002	<p><b>Purpose.</b> This section conveys that work zones have safety and mobility impacts, and that the Rule establishes requirements and provides guidance for systematically addressing the safety and mobility impacts of work zones, and developing strategies to help manage these impacts.</p>
§ 630.1004	<p><b>Definitions and Explanation of Terms.</b> This section defines work zone impacts as, “work zone-induced deviations from the normal range of transportation system safety and mobility. The extent of the work zone impacts may vary based on factors such as, road classification, area type (urban, suburban, and rural), traffic and travel characteristics, type of work being performed, time of day/night, and complexity of the project. These impacts may extend beyond the physical location of the work zone itself, and may occur on the roadway on which the work is being performed, as well as other highway corridors, other modes of transportation, and/or the regional transportation network.”</p>
§ 630.1006	<p><b>Work Zone Safety and Mobility Policy.</b> This section requires States to implement a policy for the systematic consideration and management of work zone impacts on all Federal-aid highway projects. It also emphasizes that this policy <b>shall</b> address work zone impacts throughout the various stages of the project development and implementation process.</p>
§ 630.1008	<p><b>State-level Processes and Procedures.</b></p> <ul style="list-style-type: none"> <li>■ <i>Paragraph (b), “Work Zone Assessment and Management Procedures,”</i> recommends that States develop and implement systematic procedures to assess work zone impacts in project development, and to manage safety and mobility during project implementation.</li> <li>■ <i>Paragraph (c), “Work Zone Data,”</i> requires States to use field observations, available work zone crash data, and operational information to manage work zone impacts for specific projects during implementation. It also <b>requires</b> States to continually pursue improvement of work zone safety and mobility by analyzing work zone crash and operational data from multiple projects to improve State processes and procedures.)</li> </ul>
§ 630.1010	<p><b>Significant Projects.</b></p> <ul style="list-style-type: none"> <li>■ <i>Paragraph (a)</i> of this section defines a significant project as, “one that, alone or in combination with other concurrent projects nearby is anticipated to cause sustained work zone impacts (as defined in § 630.1004) that are greater than what is considered tolerable based on State policy and/or engineering judgment.”</li> <li>■ <i>Paragraph (b),</i> requires States to identify upcoming projects that are expected to be significant. It recommends that significant projects be identified as early as possible in the project delivery and development process and in cooperation with the FHWA. It also recommends that the State’s work zone policy provisions, the project’s characteristics, and the magnitude and extent of the anticipated work zone impacts be considered when determining if a project is significant or not.</li> </ul> <p>NOTE: The purpose of identifying significant projects is to help develop and implement transportation management plans (TMPs) for projects based on their expected work zone impacts. This is addressed in § 630.1012, “Project-Level Procedures.”</p> <ul style="list-style-type: none"> <li>■ <i>Paragraph (c)</i> further qualifies significant project designations by requiring all Interstate system projects within the boundaries of a designated Transportation Management Area (TMA)<sup>1</sup> that occupy a location for more than three days with either intermittent or continuous lane closures to be considered as significant projects.</li> <li>■ <i>Paragraph (d)</i> provides an exception clause for the above requirement in paragraph (c). For an Interstate system project or categories of Interstate system projects that are classified as significant through the application of the provisions in paragraph (c), but in the judgment of the State they do not cause sustained Work Zone impacts, the State may request the FHWA for an exception. Exceptions specifically apply to sections 630.1012(b)(2) and 630.1012(b)(3) or the Rule. Exceptions may be granted by the FHWA based on the State’s ability to show that the specific Interstate system project or categories of Interstate system projects do not have sustained work zone impacts.</li> </ul>

**Table 1.1 Key Provisions in the Rule that Pertain to Work Zone Impacts Assessment**

<sup>1</sup> 23 U.S.C. 134 (i)(1)(A) & (B) requires the Secretary of Transportation to designate as a TMA each urbanized area with a population of over 200,000 individuals. In addition, at the request of the Governor and metropolitan planning organization (MPO) (or affected local officials), other areas may be officially designated as TMAs by the Administrators of the FHWA and the FTA. The list of TMAs is contained in the July 8, 2002 Federal Register on pages 45173 to 45178 ([http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2002\\_register&docid=02-16998-filed](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2002_register&docid=02-16998-filed)).

Section No.	Section Name and Provisions
§ 630.1012	<p><b>Project-level Procedures.</b> Paragraph (b), “Transportation Management Plan (TMP),” lays out the TMP requirements for road projects, which include the following:</p> <ul style="list-style-type: none"> <li>■ A TMP consists of strategies to manage the work zone impacts of a project and its scope, content, and degree of detail may vary based upon the State’s work zone policy, and the State’s understanding of the expected work zone impacts of the project.</li> <li>■ For significant projects (as defined in § 630.1010), the State shall develop a TMP that consists of a temporary traffic control (TTC) plan and addresses both transportation operations (TO) and public information (PI) components.</li> <li>■ For individual projects or classes of projects that the State determines to have less than significant work zone impacts, the TMP may consist only of a TTC plan. States are encouraged to consider TO and PI issues for all projects.</li> <li>■ A TTC plan addresses work zone safety and traffic control; the TO component addresses sustained operations and management of the work zone impact area; and the PI component addresses public communications, outreach, and traveler information.</li> </ul>

**Table 1.1 Key Provisions in the Rule that Pertain to Work Zone Impacts Assessment (Continued)**

## 1.7 Overview of Guidance Material for the Rule

To help agencies implement the provisions of the Rule, the FHWA has developed a suite of guidance documents that address the following topics:

- **Overall Rule Implementation.** Provides an overview of the Rule and general guidance for implementing the Rule, lays out fundamental principles, and presents agencies with ideas for implementing the Rule’s provisions.
- **Work Zone Impacts Assessment.** The guidance material provided in this document addresses this topic.
- **Work Zone Transportation Management Plans (TMPs).** Provides guidance on developing TMPs for managing work zone impacts of projects.
- **Work Zone Public Information and Outreach Strategies.** Provides guidance on developing communications strategies to inform affected audiences about construction projects, their expected work zone impacts, and the changing conditions on projects.

All Rule resources are available on the FHWA work zone web site at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm).

## 2.0 Overview of the Work Zone Impacts Assessment Process

### 2.1 Overall Structure

Transportation agencies strive to provide for a safe, efficient, and reliable transportation system for the public. To achieve this, they perform the following two basic types of functions:

- Operate, manage, and maintain the existing transportation system.
- Identify system deficiencies and improvement needs, and develop and implement appropriate solutions that serve the identified needs.

State Departments of Transportation (DOTs) perform these two functions using a set of processes that include policy, planning, project development, construction/implementation, maintenance and operations, and performance assessment, as shown in Figure 2.1. In the figure, policy is shown as a vertical bar because an agency's policies affect all the steps of the program delivery process to some degree. Performance measurement and system management, maintenance, and operations are shown as vertical bars in Figure 2.1 because these are ongoing activities that are done continuously, rather than at one step in the program delivery process. Work zones are a necessary part of system maintenance and system improvement. Each work zone causes some level of safety and mobility impacts that can be managed by decisions made during the program delivery process.

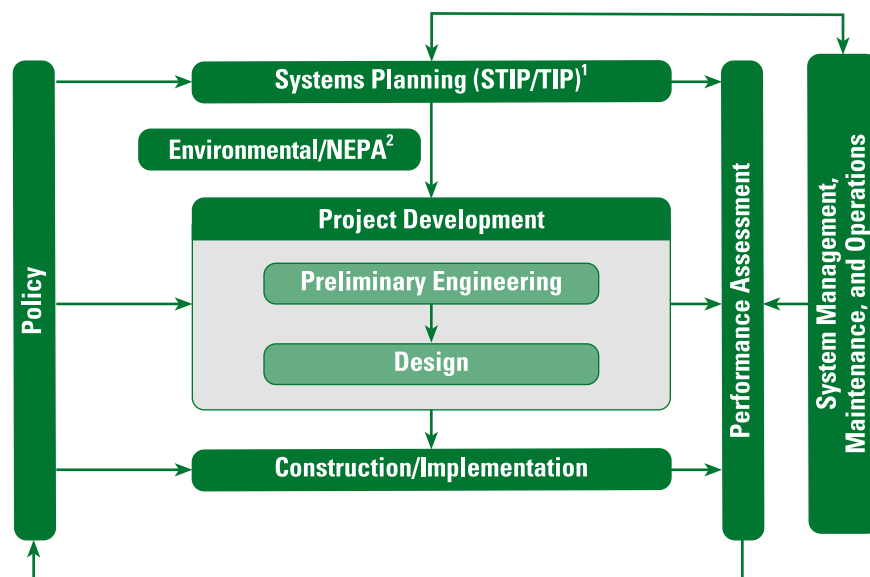


Figure 2.1 Typical Program Delivery Process

<sup>1</sup> STIP – Statewide Transportation Improvement Plan; TIP – Transportation Improvement Program

<sup>2</sup> NEPA – National Environmental Policy Act

## 2.2 Incorporating Work Zone Impacts Assessment in Program Delivery

Incorporating work zone impacts assessment in program delivery does not entail an entirely new process; rather, it involves the consideration of work zone impacts issues during pre-existing program delivery activities. Thus, the work zone impacts assessment process described in this Guide is structured to mirror the typical State DOT program delivery process.

Work zone impacts assessment may be incorporated into program delivery by:

- Implementing an overall work zone safety and mobility policy at the **policy-level**.
- Conducting a first-cut work zone impacts assessment at the **systems planning-level**.
- Conducting a preliminary project-level work zone impacts assessment during **preliminary engineering**.
- Conducting detailed project-level work zone impacts assessment during **design**.
- Managing work zone impacts during **construction**.
- Conducting work zone **performance assessment** on a regular basis.
- Incorporating work zone impacts assessment procedures in ongoing **systems management, maintenance, and operations**.

The level of detail and type of work zone impacts assessment varies depending upon the program delivery stage. For example, during systems planning work zone impacts assessment may involve qualitatively identifying the potential work zone impacts of a project, whereas, during design it may involve a more detailed analysis of the work zone impacts. The flowchart shown in Figure 2.2 provides an overview of the overall work zone impacts assessment process described in the remainder of this Guide.



Figure 2.2 Overall Work Zone Impacts Assessment Flow Diagram

Tables 2.1 – 2.6 provide an overview of what happens during the program delivery stages, and how work zone impacts assessment may be incorporated. Many of the key work zone impacts assessment activities are already being performed by agencies. This discussion re-emphasizes them, and incorporates the additional aspects of work zone impacts assessment and management that are advocated by the updated work zone Rule (the Rule). Subsequent chapters provide more detail on work zone impacts assessment during the individual program delivery stages.

What Happens at the Policy-Level?	How Can Work Zone Impacts Assessment be Incorporated?
<p>At the policy-level, overall policies and program priorities are established, and applied to the different program delivery stages. As shown in Figures 2.1 and 2.2, policy development and implementation is an over-arching aspect of program delivery that takes place on an ongoing basis. This includes:</p> <ul style="list-style-type: none"> <li>■ Setting a vision and developing goals and objectives.</li> <li>■ Setting policy provisions in the form of requirements, performance standards and/or guidance.</li> <li>■ Developing and implementing processes, procedures, and practices that help sustain the policy.</li> <li>■ Applying the policy and its components to the respective program delivery stages.</li> <li>■ Refining and updating the policy (and its components) periodically.</li> </ul>	<p>Work zone impacts assessment starts at the policy-level by setting the tone for an <b>overall work zone policy that supports the systematic consideration and management of work zone safety and mobility impacts</b>. This overall work zone policy may then translate to specific policy components (i.e., vision, goals, objectives, and policy provisions) that help assess and manage work zone impacts through the respective program delivery stages. Many agencies have existing work zone policies. These policies may be updated and/or further developed as needed. In the absence of a pre-existing overall policy, a new one may have to be developed and implemented.</p> <p>Work zone impacts assessment may be addressed at the policy-level by:</p> <ul style="list-style-type: none"> <li>■ Adopting an overall work zone policy that supports the systematic consideration and management of work zone safety and mobility impacts.</li> <li>■ Setting work zone related vision, goals, and objectives; and work zone related policy provisions in the form of requirements, performance standards and/or guidance.</li> <li>■ Developing processes, procedures, and practices that help sustain the overall work zone policy, and applying them for decision-making during the respective program delivery stages.</li> <li>■ Updating the work zone policy and its components periodically.</li> </ul>

**Table 2.1 Policy-Level**



What Happens During Systems Planning?	How Can Work Zone Impacts Assessment be Incorporated?
<p>Systems planning constitutes two major groups of activities, namely, "Identifying Transportation Improvement Needs," and "Developing Long-range and Short-term Transportation Plans and Programs."</p> <ul style="list-style-type: none"> <li>■ In identifying transportation improvement needs, alternative solutions are developed and evaluated to meet transportation system needs and deficiencies. This is done in many ways, including ongoing review of needs and deficiencies, regional/sub-area/corridor studies, major investment studies (MISs), benefit-cost analyses, environmental/NEPA analyses, and air-quality conformity analyses.</li> <li>■ Transportation plans and programs are developed by prioritizing the projects identified in the previous step, identifying funding sources, scheduling and coordinating projects, and programming projects to develop Statewide Transportation Improvement Programs (STIPs) and regional Transportation Improvement Programs (TIPs).</li> </ul>	<p>The purpose of work zone impacts assessment during systems planning is to <b>understand the work zone impacts of projects at the conceptual planning-level, and identify and cost potential management strategies.</b> This will help allocate resources more effectively to projects early in the project delivery cycle and potentially avoid delays, cost over-runs and change orders in later stages.</p> <p>Work zone impacts assessment may be incorporated in systems planning as follows:</p> <ul style="list-style-type: none"> <li>■ Considering work zone impacts issues as a decision-making factor in the assessments/analyses that are performed during alternatives evaluation (e.g., during MISs, NEPA, etc.).</li> <li>■ Allocating sufficient funds for work zone impacts mitigation and management (based on the considerations and assessments from the previous step).</li> <li>■ Addressing combined work zone impacts of multiple projects at the regional and corridor levels, coordinating their schedules to minimize impacts.</li> </ul>

**Table 2.2 Systems Planning**

The transition from systems planning to project development may not always be distinct. Some activities may extend across both systems planning and project development. For example, environmental/NEPA analyses, and the consideration of regional and corridor impacts may extend well into the preliminary engineering phase of projects. Practitioners are encouraged to consider work zone impacts issues during these activities irrespective of the stage in which they take place.

What Happens During Project Development?	How Can Work Zone Impacts Assessment be Incorporated?
<p>Project development is where individual projects are developed and designed, and plans are developed for building the project in the field. The majority of work zone impacts assessment currently takes place during project development. The former Rule required only traffic control plans (TCPs) for projects; therefore a majority of work zone impacts mitigation is centered around developing TCPs for projects.</p> <p>Project development consists of two stages – Preliminary Engineering and Design.</p> <ul style="list-style-type: none"> <li>■ Preliminary engineering is where early project-level planning and engineering is performed to identify potential construction approaches and develop a preliminary design concept. Currently, very little is done by way of accounting for work zone impacts during preliminary engineering.</li> <li>■ Design is where detailed analyses and design are performed to develop the final design, construction staging approach, and TCP. Currently, most of the work zone impacts assessment takes place during design.</li> </ul>	<p>Current project-level work zone impacts assessment practices may be further enhanced by systematically assessing work zone impacts through the project development stages and by <b>looking at work zone impacts mitigation from a transportation management perspective rather than just a traffic control perspective</b>. The updated Rule requires the development of a transportation management plan (TMP) for each project.</p> <ul style="list-style-type: none"> <li>■ During preliminary engineering, this may be accomplished by accounting for the work zone impacts of the potential construction approaches and overall design concept for the project. The assessment during preliminary engineering is generally expected to be qualitative.</li> <li>■ Design-level work zone impacts assessment may include consideration of corridor and network level impacts, coordination with other projects, addressing work zone impacts issues in conjunction with the project design and construction approaches, work zone transportation management, and development of TMPs. Qualitative and/or quantitative approaches may be used based upon the project characteristics and its expected work zone impacts.</li> </ul>
<p>Note: In September 2004, the Federal Highway Administration (FHWA) updated the work zone regulation at 23 CFR 630 Subpart J and renamed it the Work Zone Safety and Mobility Rule (the Rule). Refer to Section 1.6 of this Guide for information on the Rule.</p>	

**Table 2.3 Project Development (Preliminary Engineering and Design)**

What Happens During Construction?	How Can Work Zone Impacts Assessment be Incorporated?
<p>Construction/implementation is where projects are built in the field. Generally, the focus is on implementing the TCP prior to construction, maintaining traffic through the work zone, facilitating safety for motorists and workers, and monitoring and managing the work zone and the construction.</p>	<p>During construction/implementation, the objective is to <b>monitor and manage</b> the work zone impacts of projects on an ongoing basis. This may be done by implementing the TMP, monitoring work zone impacts, and revising the TMP if necessary to improve the performance of the work zone.</p>

**Table 2.4 Construction/Implementation**

What Happens During Performance Assessment?	How Can Work Zone Impacts Assessment be Incorporated?
<p>Performance assessment is where the performance of the processes, practices, and procedures are assessed for their effectiveness, successes, and failures at the project and program levels.</p>	<p>Assessing the performance of individual work zones, analyzing area-wide impacts of multiple projects (before, during, and after construction), synthesizing information to identify trends, and conducting process reviews all provide information that can be used to <b>improve the agency's work zone processes, practices, and procedures</b>.</p>

**Table 2.5 Performance Assessment**

What Happens During Maintenance and Operations?	How Can Work Zone Impacts Assessment be Incorporated?
<p>Maintenance and operations encompass the ongoing activities that are typically performed by an in-house maintenance crew. They encompass both planned and emergency maintenance. Examples of typical activities include installation and maintenance of traffic signs and other roadside devices, debris removal, painting/stripping, minor guardrail work, mowing operations, and minor utility work. Such activities generally require short-term and/or mobile work zones. Currently, most agencies employ typical temporary traffic control (TTC) approaches for different types of operations/maintenance work zones. These typically are based on engineering judgment and analyses, and generally focus on the safety aspects of these work zones.</p>	<p>Current work zone impacts assessment and management practices for maintenance and operations may be enhanced by:</p> <ul style="list-style-type: none"> <li>■ Applying work zone impacts assessment and management to different categories of operations/maintenance projects, monitoring their performance, and making revisions to processes and practices on an ongoing basis.</li> <li>■ Mainstreaming processes to assess impacts of operations and maintenance work zones.</li> <li>■ Revisiting typical TTC approaches and updating them to meet current work zone safety and mobility needs.</li> <li>■ Considering the mobility aspects of maintenance work in addition to safety.</li> </ul>

**Table 2.6 Maintenance and Operations**

## 2.3 Work Zone Impacts Considerations

The essence of assessing and managing the work zone impacts of road construction and maintenance projects lies in:

- Maximizing the **safety of road users and highway workers**. Safety
- Maximizing **mobility and accessibility** on roadways. Mobility
- Planning, designing, and **building projects as effectively and efficiently as possible**. Constructability

Safety, mobility, and constructability are the three critical work zone related issues that need to be addressed while planning, designing, and building road projects. Constructability can be defined as the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. The objective of constructability is to facilitate rational bids and minimize problems during construction. Benefits of constructability include cost reduction, schedule adherence, higher productivity, enhanced quality, and more safety and convenience for the traveling public<sup>3</sup>. Constructability reviews are performed to facilitate the practicality of construction and minimize project delays, changes, and costs, while at the same time maximizing productivity, quality, safety, and convenience.

<sup>3</sup> National Cooperative Highway Research Program (NCHRP) Report 390, Constructability Review Process for Transportation Facilities, Stuart Anderson and Deborah Fisher, National Academy Press, 1997.



**TIP:** Constructability and value engineering may be similar in that they require reviews of project plans and designs; however, their purposes are vastly different. Value engineering provides for the necessary functions while reducing or eliminating project costs. Value engineering is normally performed during the design and/or construction phase, whereas constructability needs to be reviewed on an ongoing basis throughout project development. More information on value engineering is available on the Federal Highway Administration (FHWA) Value Engineering web site at <http://www.fhwa.dot.gov/ve/index.htm>.

As work zone impacts assessment is performed progressively through the various program delivery stages, the three basic issues of safety, mobility, and constructability are addressed in an iterative manner. Information from one stage feeds into the next, with the level of detail of the assessment progressively increasing from stage to stage. The objective is to *achieve constructability without compromising safety and mobility*. Safety, mobility, and constructability are affected by the following types of issues, including:

- Project characteristics.
- Travel and traffic characteristics.
- Corridor, network, and community issues.
- Design, procurement, and construction options.
- Work zone design and safety issues.
- TTC strategies.
- Transportation operations (TO) strategies.
- Public information (PI) strategies.

Table 2.7 provides an overview of different work zone impacts considerations for each of these issues. Additional detail on these considerations is provided throughout this document at appropriate locations.

<p><b>Project Characteristics</b></p>	<ul style="list-style-type: none"> <li>■ Project type.</li> <li>■ Project size, extent, duration, and complexity.</li> <li>■ Roadway classification</li> <li>■ Area type (urban, suburban, rural).</li> </ul>
<p><b>Travel and Traffic Characteristics</b></p>	<ul style="list-style-type: none"> <li>■ Traffic demand and volumes.</li> <li>■ Seasonal and temporal variations in demand (hourly, daily, or weekly).</li> <li>■ Occurrence of special events.</li> <li>■ Percentages of different vehicular volumes (autos – Single-Occupancy Vehicle, High-Occupancy Vehicle; trucks; or buses).</li> <li>■ Type of travel (commuter or tourist), freight corridor, transit corridor.</li> <li>■ Public and private facility access issues.</li> <li>■ Potential impacts of weather.</li> <li>■ Other such similar characteristics.</li> </ul>
<p><b>Corridor, Network and Community Issues</b></p>	<ul style="list-style-type: none"> <li>■ Impacts of the project at both the corridor and network levels including parallel corridors, alternate routes, the transportation network, other modes of transportation, and impacts of other work zones in the vicinity of the project, either at the corridor level or the network level.</li> <li>■ Impacts on nearby transportation infrastructure such as key intersections and interchanges, railroad crossings, public transit junctions, and other junctions in the transportation network.</li> <li>■ Impacts on evacuation routes in the vicinity of critical transportation or other infrastructure.</li> <li>■ Impacts on affected public properties, including parks, recreational facilities, fire stations, police stations, and hospitals.</li> <li>■ Impacts of the project on affected private properties, including businesses and residences.</li> </ul>
<p><b>Design, Procurement and Construction Options</b></p>	<ul style="list-style-type: none"> <li>■ Temporal alternatives for work performance such as season, month, day of week (weekend versus weekday), and time of day (night time versus day, off-peak versus peak).</li> <li>■ Alternative lane closure strategies such as full closure, partial closure, crossovers, multiple lane closure, single lane closure, and impact of alternative traffic management strategies on lane-closure decisions.</li> <li>■ Alternative design solutions that address the durability and economy of maintenance of the roadway.</li> <li>■ Alternative design solutions and strategies that impact decision-making on right-of-way (ROW) acquisition.</li> <li>■ Alternative construction staging plans, and construction techniques and methodologies (e.g., accelerated construction techniques) that may have varying types and severity of work zone impacts.</li> <li>■ Alternative contracting methodologies such as design-build, A+B bidding, and incentive/disincentive contracting.</li> </ul>

**Table 2.7 Work Zone Impacts Considerations**

<p><b>Work Zone Design and Safety Issues</b></p>	<ul style="list-style-type: none"> <li>■ Cross-sectional issues such as lane widths, shoulder availability and widths, and number of lanes available for travel.</li> <li>■ Longitudinal issues such as taper widths, taper lengths, and stopping sight distance.</li> <li>■ Horizontal and vertical sight distance.</li> <li>■ Project signing and advance warning.</li> <li>■ Roadside devices and safety.</li> <li>■ Work area separation, channelization, and protection (e.g., positive separation, barrels, cones, clear zone considerations, construction zone intrusion detection).</li> <li>■ Work area and worker delineation (visibility, retroreflectivity, etc.).</li> <li>■ Work site access and access points.</li> <li>■ Visibility issues (e.g., night-time work, lighting, fog).</li> <li>■ Curvature and gradient – vertical and horizontal.</li> <li>■ Speed – posted speed limits, speed zoning, etc.</li> <li>■ Work zone enforcement (e.g., use of uniformed police officers and/or patrol cars, active enforcement using radar guns and/or automated enforcement).</li> </ul>
<p><b>TTC Strategies</b></p>	<ul style="list-style-type: none"> <li>■ Traffic safety and capacity requirements.</li> <li>■ Alternate route scenarios.</li> <li>■ Potential impacts on other corridors, nearby intersections/interchanges, and the larger transportation network.</li> <li>■ Project signing and advance warning.</li> <li>■ Lane closure types and strategies (full-closure, lane-width restrictions, cross-overs, positive separation, etc.).</li> <li>■ Work zone and work area configurations.</li> <li>■ Traffic safety and control checklists for developing a TMP.</li> </ul>
<p><b>TO Strategies</b></p>	<ul style="list-style-type: none"> <li>■ Deployment of ITS technologies for work zone traffic monitoring and management.</li> <li>■ Provision of real-time traveler information to the public, including web-based information.</li> <li>■ Application of transportation systems management (TSM) and corridor management strategies, including mitigation treatments for alternate routes (e.g., traffic signal timing adjustment on affected corridors), and alternate modes (e.g., public transit subsidies, incentives, and special programs).</li> <li>■ Coordination of transportation management with existing regional transportation management centers (TMCs).</li> <li>■ Conduct of mobility and safety reviews and audits.</li> <li>■ Speed enforcement and management in work zones using either police officers or automated techniques.</li> <li>■ Traffic incident management plans for work zones.</li> <li>■ Policies on work zone traffic management during emergencies (e.g., hurricane evacuations).</li> </ul>
<p><b>PI Strategies</b></p>	<ul style="list-style-type: none"> <li>■ Provision of project and work zone information prior to the commencement of the work in order to make the public aware of the expected work zone impacts and the State’s actions to mitigate the impacts.</li> <li>■ Recommendations to the public on commuter alternatives, such as information on alternate routes and/or modes.</li> <li>■ Provision of information on changing conditions on the project during implementation (e.g., changes in lane closure scenarios, construction staging, construction times, or alternate routing).</li> <li>■ Obtaining public input for the development of appropriate work zone impacts management strategies during the planning and design phases of the project; refinement of work zone management strategies during project implementation; and feedback on performance of the work zone and the project following the completion of the project.</li> <li>■ Dissemination of information through brochures, pamphlets, and media sources including newspapers, television, radio channels, and web sites.</li> <li>■ Public meetings and hearings.</li> <li>■ Coordination and cooperation with affected public and private parties.</li> </ul>

**Table 2.7 Work Zone Impacts Considerations (Continued)**

**Developing and Implementing Transportation Management Plans for Work Zones** provides a focused discussion on TTC, TO, and PI strategies along with overview discussions, applicability, advantages, and disadvantages. This Guide is available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).

Appendix A presents an example application of how the overall work zone impacts assessment process described in this Guide can be applied to a project. The appendix discusses the work zone impacts issues faced by the project and describes the strategies used for the project to mitigate work zone impacts.





## 3.0 Addressing Work Zone Impacts at the Policy-Level

### 3.1 What Happens at the Policy-Level?

At the policy-level, overall policies and program priorities are established and used for decision-making during the different program delivery stages. The policy is applied through policy provisions that address various aspects of transportation system planning, design, construction, maintenance, and operations. Policy provisions may be in the form of standard procedures, specific requirements, performance standards, and/or policy guidance. Examples of policy-level guidance and procedures include:

- Guidance on the type of work zone impacts assessment for different types of projects (e.g., qualitative, quantitative, or both).
- Guidance on the use of tools to assess and estimate impacts of projects (e.g., some agencies require the use of specific models or analytical methods to estimate the potential work zone impacts of projects).
- Standard processes and procedures for specific activities (e.g., developing standard traffic control plan sheets for shoulder and guard-rail work, or by specifying night-time work for certain categories of projects).
- Guidance on the type of contracting options that best suit different project types (e.g., traditional low-bid, design-build, incentive/disincentive, performance-based).
- Work zone performance monitoring requirements (e.g., requiring the measurement of travel times and the tracking of crashes for specific categories of projects).

Policy development and implementation is an ongoing and over-arching aspect of program delivery. Policies are periodically updated and revised to address new issues and to make their components concurrent with the state of the art and/or the state of the practice.

### 3.2 Why Consider Work Zone Impacts Issues at the Policy-Level?

Addressing work zone safety and mobility at the policy-level and applying the policy at the various stages of program delivery will facilitate streamlined decision-making and consistency. Policies can help standardize work zone practices that are known to work well, and serve as a guide for planning, designing, and constructing road projects. In addition, a policy-based approach to work zone safety and mobility facilitates buy-in and support from management for the effective assessment and management of work zone impacts. Such standardization and streamlining will in turn lead to good decision-making that results in safe and effective work zones, well-constructed projects, construction quality, improved agency operational and organizational efficiency, and cost effectiveness.

Recognizing the above, the updated Rule on Work Zone Safety and Mobility (the Rule) requires State Departments of Transportation and local transportation agencies<sup>1</sup> to implement a Work Zone Safety and Mobility Policy for the systematic consideration and management of work zone impacts. Many agencies have pre-existing work zone

<sup>1</sup> Hereinafter referred to as agencies.

policies, in which case, those policies may be updated and/or enhanced to incorporate the concepts and principles advocated by the Rule. For example, the former Rule required traffic control plans (TCPs)<sup>2</sup> for road projects while the updated Rule requires transportation management plans (TMPs)<sup>3</sup>. Pre-existing policies on TCPs may now be expanded to include provisions on TMP development and implementation. In the absence of a pre-existing overall policy, a new one may have to be developed and implemented.

Table 1.1 in Section 1.0 of this document presents excerpts of the provisions in the Rule that pertain to work zone impacts assessment and management. Section 630.1006 of the Rule addresses the Work Zone Safety and Mobility Policy.

More information on the Rule, including the Rule language, may be obtained in the Final Rule section of the FHWA work zone web site at [http://ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

Development and application of policy provisions for work zone impacts assessment may provide quick answers to questions such as:

- Do I need to perform an extensive work zone impacts assessment for my project?
- What project classification does my project fall under, and what are the corresponding work zone impacts assessment actions that I need to take?
- What management strategies should I consider in the Transportation Management Plan (TMP)?
- Are there any policy provisions that require maintenance of a certain number of lanes of traffic capacity during roadwork on a certain type of facility?
- What is the agency's policy guidance on how to account for road user costs in developing TMPs?
- What are the agency's policy provisions on traffic incident management strategies for work zones?
- Does the agency's policy allow performance-based contracting?
- Are there any policy provisions that require monitoring of work zone performance for my project?

## 3.3 Developing and Implementing a Work Zone Policy

### 3.3.1 Key Components of a Work Zone Policy

The key components that may be considered when developing or revising a work zone policy include a vision, goals, and objectives, and specific policy provisions for application during program delivery. Work zone impacts issues may be addressed in

<sup>2</sup> TCPs are the equivalent of temporary traffic control (TTC) plans.

<sup>3</sup> Section 630.1012(b) of the Rule addresses TMPs. A TMP expands work zone mitigation from a traffic control approach to a transportation management approach. According to the Rule, a TMP must always consist of a temporary traffic control (TTC) plan, and for significant projects, it must also address Transportation Operations (TO) and Public Information (PI) components.

these components by laying out a vision that facilitates assessment and management of work zone impacts, setting goals and objectives that aim to improve the safety and mobility of work zones, and including specific policy provisions that address various aspects of decision-making during work zone impacts assessment and management. The three components are briefly discussed as follows:

- **Vision.** This is an overall policy statement that supports the systematic consideration and management of work zone safety and mobility impacts on road projects, and lays out the agency's vision for providing safe and efficient travel for road users, worker safety, and quality of construction.



The California Department of Transportation's (Caltrans) commitment is to, "Minimize motorist delays for ALL activities on the State highway system without compromising public or worker safety, or the quality of the work being performed." Caltrans' aim is to achieve 100% compliance on all activities on the State highway system, including construction, special events, encroachment permits, and maintenance, but with varying levels of treatment.

Source: Transportation Management Plans Effectiveness Study, Robert Copp, Caltrans, TRB 2004 Annual Meeting, Session 526: Work Zone Impacts – A New Frontier

- **Goals and Objectives.** Strategic goals and performance objectives help agencies attain their work zone safety and mobility vision. Performance objectives can serve as the basis for developing and implementing actions designed to meet the goal(s) in a specified time frame. For example, an agency may have a goal of reducing work zone related fatalities by 50% within the next 5 years. One of the objectives that helps meet this goal may be to use enhanced traffic enforcement in all work zones to achieve greater compliance with speed limits and thereby reduce speed variability.



The Oregon Department of Transportation (ODOT) has a performance goal to design work zones for the regular posted speed limit rather than a reduced work zone speed limit. This is especially applicable to situations where traffic realignment is required (e.g., reverse curves and super-elevations). This design practice helps reduce unexpected curves and sharp curves and keep traffic flowing smoothly, thereby reducing rear-end, truck roll-over, and run-off-the-road accidents. This practice is most effective for high-volume/high-speed locations.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/16/05).

- **Specific Policy Provisions for Application During Project Delivery.** Specific policy provisions help implement and sustain the overall work zone policy, and provide for standardized decision-making at appropriate stages of program delivery. They may consist of processes, procedures, criteria, standards, and/or guidance for work zone related decision-making. Agencies may choose to implement policy provisions in the form of mandated requirements or in the form of policy guidance, as appropriate to their individual operating environments. More information on different types of specific policy provisions is provided in Section 3.4.

In addition to the above key components, the following may also be useful items to include in a work zone policy:

- Definitions and Explanation of Terms.
- Stakeholder and Team Information.
- Roles and Responsibilities.
- Contact Person(s).
- Policy Exemption Criteria and Process.

Additional information on the components that may be addressed in a work zone policy is available in Sections 3.2 and 3.3 of **Implementing the Rule on Work Zone Safety and Mobility**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

### 3.3.2 Who Develops and Implements the Policy?

Development and implementation of the work zone policy is the responsibility of management level agency staff from both executive and technical areas. They may be assisted by other technical and field staff. Agencies are encouraged to adopt a multi-disciplinary team<sup>4</sup> approach for policy development and implementation. The core team should consist of agency staff representing the agency's primary work zone-related functions, including planning, engineering/design, construction, maintenance, operations, and public information. This is reflective of the various issues involved in planning, designing, and building road projects, and the increasing complexity of managing work zone safety and mobility under current road and traffic conditions. Primary external members to consider include the FHWA, law enforcement, the contracting industry, and regional associations. Other external partners may also be included as appropriate. A multi-disciplinary team can infuse varying perspectives and a vast knowledge base into the policy. For example, traffic operations specialists can address issues related to work zone transportation operations, law enforcement personnel can contribute their field experience on most effective enforcement strategies, and contracting industry representatives can address the practicality of any new construction methods or contracting strategies.



The Florida DOT has instituted a multi-functional Maintenance of Traffic (MOT) committee through which all MOT policies, standards, specifications, new components, etc. are reviewed and approved. Members of this committee are from design, construction, maintenance, traffic operations, and the FHWA.

Source: Florida DOT comments in response to the FHWA Notice of Proposed Rulemaking on Work Zone Safety and Mobility, August 5, 2003, United States Department of Transportation online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf87/250607\\_web.pdf](http://dmses.dot.gov/docimages/pdf87/250607_web.pdf) (Accessed 09/08/05).

Over time there will likely be a need for the agency to update its policy as situations change, knowledge is gained, and new trends and issues are identified. Ongoing feedback and information from agency staff and other applicable external sources will serve as input for such updates.

The staff that may develop and implement the work zone policy, the inputs to the process and who is likely to provide the inputs, and the outputs and users of the output are presented in Table 3.1.

<ul style="list-style-type: none"> <li>■ The policy may be implemented by management-level staff – from both executive and technical areas.</li> <li>■ The management-level staff are assisted by technical staff from different disciplines including planning, engineering, design, construction, maintenance, and operations. They assess work zone policy issues and support management-level staff in decision-making on policy implementation.</li> </ul>	
Inputs	Input Providers and Participants
<p>There are two aspects to policy – initial implementation, and ongoing review and update. Therefore, there are two categories of inputs – initial and cyclical.</p> <p>Initial inputs include:</p> <ul style="list-style-type: none"> <li>■ Existing policy statements and policy provisions that the agency already has.</li> <li>■ Additional work zone safety and mobility issues on which the agency is considering the implementation of policy provisions.</li> <li>■ Other agency-level priorities and focus issues that drive the implementation of policy provisions (e.g., overall safety, mobility, and accessibility goals).</li> </ul> <p>The cyclical inputs include:</p> <ul style="list-style-type: none"> <li>■ Information, experiences, findings, and lessons learned from all other stages of program delivery.</li> <li>■ Public outreach and stakeholder feedback.</li> </ul>	<ul style="list-style-type: none"> <li>■ Agency staff representatives belonging to the following categories:             <ul style="list-style-type: none"> <li>- Management staff, representing the highest level of decision-making in the agency.</li> <li>- Technical staff including planners, designers, engineers; and technical specialists who are responsible for planning and designing road projects.</li> <li>- Field staff responsible for constructing projects, and monitoring and managing work zone impacts in the field. This includes construction engineers, project engineers, and field inspectors.</li> </ul> </li> <li>■ Primary non-agency staff representatives including the FHWA, law enforcement, the contracting industry<sup>3</sup>, and regional associations.</li> <li>■ Other non-agency staff representatives as applicable including:             <ul style="list-style-type: none"> <li>- Regional stakeholders such as other transportation agencies, transit providers, fire and emergency medical services, regional transportation management centers, local jurisdictions (county, city, village, township, etc.), and railroad agencies and operators.</li> <li>- Community and business representatives.</li> <li>- Industry and public safety associations such as trucking associations, the American Automobile Association, etc.</li> <li>- General public (through public outreach and feedback).</li> <li>- Media agencies including newspapers, television agencies, web sites, etc.</li> </ul> </li> </ul>
Outputs	Users of the Outputs
<p>Initial outputs include:</p> <ul style="list-style-type: none"> <li>■ The vision (overall work zone safety and mobility policy statement of the agency).</li> <li>■ Goals and objectives.</li> <li>■ Specific policy provisions that help work zone impacts related decision-making during program delivery.</li> </ul> <p>The cyclical outputs include:</p> <ul style="list-style-type: none"> <li>■ Applicable revisions to the overall work zone safety and mobility policy statement.</li> <li>■ Applicable revisions to specific policy provisions.</li> </ul>	<p>The users of the outputs included all categories of agency personnel (and applicable non-agency personnel) at various levels of decision-making as applicable to the different program delivery stages.</p> <p>This includes:</p> <ul style="list-style-type: none"> <li>■ Management level staff.</li> <li>■ Technical staff (planners, designers, engineers, etc.)</li> <li>■ Field staff (construction, inspection, etc.)</li> <li>■ Consultant/contractor staff responsible for project development and implementation.</li> </ul>

**Table 3.1 Policy Development and Implementation Participants**

More information on who develops and implements the policy is available in Section 3.4 of **Implementing the Rule on Work Zone Safety and Mobility**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

<sup>3</sup> The contracting industry includes members of organizations such as ATSSA – American Traffic Safety Services Association; ARTBA – American Road and Transportation Builders Association; AGC – Associated General Contractors of America. **3-5**

### 3.3.3 Policy Development and Implementation Process

The policy development and implementation process is illustrated in Figure 3.1. Input from and interaction with appropriate sources (as shown in Table 3.1) may be required during the process.

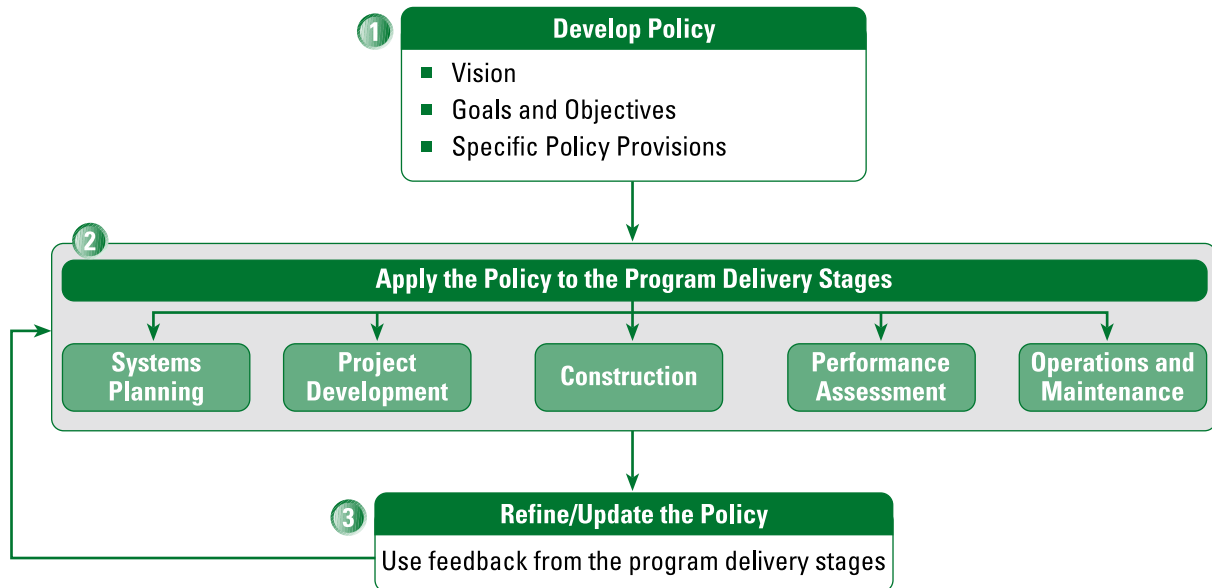


Figure 3.1 Policy Development and Implementation Process

The process is summarized as follows:

- **Step 1: Develop Policy.** Agencies that have pre-existing work zone policies may not need an entirely new policy, but rather a review and update of their existing policies as appropriate. In the absence of a pre-existing policy, a new work zone policy needs to be developed.
- **Step 2: Apply the Policy to the Program Delivery Stages.** This step represents the ongoing application of the overall policy and the associated policy provisions for decision-making during the program delivery stages (i.e., systems planning, project development, construction, performance assessment, and maintenance and operations).
- **Step 3: Refine/Update the Policy.** The final step in the policy implementation process entails using feedback from the different stages of program delivery to improve and refine the policy over time. The purpose is to improve work zone programs, processes, and practices, leading to effective management of work zone safety and mobility.

More information on the policy development and implementation process is available in Section 3.5 of **Implementing the Rule on Work Zone Safety and Mobility**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

## 3.4 Potential Policy Provisions for Application During Program Delivery

This section provides a general discussion and examples of some of the issues that may be considered in developing specific policy provisions. It presents agencies with some general ideas and options to consider in developing policy provisions that best suit their work zone impacts assessment and management needs.

Specific policy provisions help implement and sustain the agency's work zone policy. Provisions on key aspects of work zone impacts assessment and management can help improve decision-making and bring about consistency, efficiency, and standardization in the way projects are planned, designed, and built. Agencies may develop and implement policy provisions in the form of mandated requirements and/or in the form of policy guidance, as appropriate to their individual operating environments. Broadly stated, policy provisions help:

- Classify projects based on their expected work zone impacts.
- Apply work zone performance standards/requirements for different project types.
- Provide guidance on agency processes and procedures for work zone related decision-making during program delivery.

Many agencies may already have policy provisions that address specific aspects of decision-making during project delivery. For example, most agencies employ typical temporary traffic control (TTC) approaches for different types of projects. When agencies develop and/or update their respective work zone policies they should evaluate such pre-existing provisions for update and incorporation in the policy.

Agencies may also develop new policy provisions that help address additional aspects of work zone impacts assessment and management. For example, an agency may decide to develop policy guidance on performance-based contracts to respond to a lack of consistency in the application and usage of performance-based contracts. Such new policy provisions may be developed as part of periodic review and update of the agency's work zone policy. They may also be developed to respond to specific circumstances that necessitate an out-of-cycle action (e.g., to respond to changing industry trends, technological advancements, change in overall agency policy).

### 3.4.1 Classification of Projects Based on Expected Work Zone Impacts

A project classification system separates road projects into different types based on the severity of expected work zone impacts. Such classification enables agencies to apply policies and practices that are best suited to each type of project. It also helps address specific aspects of work zone related decision-making for different project types. For example, a project classification system may be used to identify the needed level of work zone impacts assessment for a project (i.e., high-level qualitative assessment or detailed quantitative analysis); preferred construction approaches; work zone design options and TMP strategies; and work zone monitoring and performance assessment requirements.

Some of the parameters that affect work zone impacts of projects and may be used for project classification include:

- Roadway functional classification – e.g., Interstate, expressway, principal arterial, major arterial, minor arterial, collector.
- Area type – e.g., urban, suburban, rural.
- Traffic demand and travel characteristics – e.g., lanes affected, average daily traffic (ADT), expected capacity reduction, level of service (LOS).
- Type of work – e.g., new construction, reconstruction, rehabilitation, maintenance, bridge work, equipment installation/repair.
- Complexity of work – e.g., duration, length, intensity.
- Level of traffic interference with construction activity.
- Potential impacts on local transportation network and businesses.
- Considerations specific to the region – e.g., tourism, special events, weather.

Classification systems will vary based on an agency's needs. They can range from a simple scheme (e.g., high, medium, and low work zone impact projects) to a multidimensional matrix of projects that recommends appropriate work zone management strategies for different project types. In general, a simple classification system that is practical and easy to adopt and apply is recommended.

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presents a table listing work zone impacts management strategies. The table presents some of the project characteristics that could lead an agency to consider specific work zone impacts management strategies. The table may be used as a starting point to identify management strategies that suit different project types. This Guide is available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).

Recognizing the variation in transportation management needs for different projects, the Rule requires the identification of significant projects<sup>6</sup>, and appropriate application of TMP components based on whether projects are classified as significant. This is a high-level approach that helps stratify the application of TMP components. Agencies may further hone this high-level approach by developing a scheme with additional levels of classification. One potential approach is the classification system used in the FHWA Work Zone Mobility and Safety Self Assessment Guide<sup>7</sup>. The guide categorizes work zones into four types based on their expected impact levels as shown in Table 3.2. These levels may not encompass all possible combinations or degrees of work zone categories; rather they are intended to serve as a general guide to help relate individual projects to some overall criteria.

<sup>6</sup> 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 based on the respective agency's policy and/or engineering judgment. This definition, provided in Section 630.1010 of the Rule, also specifies that all Interstate system projects within the boundaries of a Transportation Management Area that occupy a location for more than three days and have lane closures are significant.

<sup>7</sup> The FHWA Work Zone Self Assessment program is designed to help agencies assess their work zone programs, procedures, and practices against many of the good work zone practices in use today. FHWA Division Offices work together with transportation agency staff from their State partners to complete the assessment each year. More information is available at [http://www.ops.fhwa.dot.gov/wz/decision\\_support/self-assess.htm](http://www.ops.fhwa.dot.gov/wz/decision_support/self-assess.htm) (Accessed 12/16/05).



Type	Characteristics	Examples
<b>Type I</b>	<ul style="list-style-type: none"> <li>■ Affects the traveling public at the metropolitan, regional, intrastate, and possibly interstate level.</li> <li>■ Very high level of public interest.</li> <li>■ Directly affects a very large number of travelers.</li> <li>■ Significant user cost impacts.</li> <li>■ Very long duration.</li> </ul>	<ul style="list-style-type: none"> <li>■ Central Artery/Tunnel in Boston, Massachusetts.</li> <li>■ Woodrow Wilson Bridge in Maryland/Virginia/District of Columbia.</li> <li>■ Springfield Interchange “Mixing Bowl” in Springfield Virginia.</li> <li>■ I-15 reconstruction in Salt Lake City, Utah.</li> </ul>
<b>Type II</b>	<ul style="list-style-type: none"> <li>■ Affects the traveling public predominantly at the metropolitan and regional level.</li> <li>■ Moderate to high level of public interest.</li> <li>■ Directly affects a moderate to high number of travelers.</li> <li>■ Moderate to high user cost impacts.</li> <li>■ Duration is moderate to long.</li> </ul>	<ul style="list-style-type: none"> <li>■ Major corridor reconstruction.</li> <li>■ High-impact interchange improvements.</li> <li>■ Full closures on high-volume facilities.</li> <li>■ Major bridge repair.</li> <li>■ Repaving projects that require long term lane closures.</li> </ul>
<b>Type III</b>	<ul style="list-style-type: none"> <li>■ Affects the traveling public at the metropolitan or regional level.</li> <li>■ Low to moderate level of public interest.</li> <li>■ Directly affects a low to moderate level of travelers.</li> <li>■ Low to moderate user cost impacts.</li> <li>■ May include lane closures for a moderate duration.</li> </ul>	<ul style="list-style-type: none"> <li>■ Repaving work on roadways and the National Highway System (NHS) with moderate Average Daily Traffic (ADT).</li> <li>■ Minor bridge repair.</li> <li>■ Shoulder repair and construction.</li> <li>■ Minor interchange repairs.</li> </ul>
<b>Type IV</b>	<ul style="list-style-type: none"> <li>■ Affects the traveling public to a small degree.</li> <li>■ Low public interest.</li> <li>■ Duration is short to moderate.</li> <li>■ Work zones are usually mobile and typically recurring.</li> </ul>	<ul style="list-style-type: none"> <li>■ Certain low-impact striping work.</li> <li>■ Guardrail repair.</li> <li>■ Minor shoulder repair.</li> <li>■ Pothole patching.</li> <li>■ Very minor joint sealing.</li> <li>■ Minor bridge painting.</li> <li>■ Sign repair.</li> <li>■ Mowing.</li> </ul>

Table Source: FHWA Work Zone Self Assessment Guide.

**Table 3.2 FHWA Work Zone Self Assessment – Project Classification Scheme**



The British Columbia Ministry of Transportation classifies projects according to five categories based on the type of basic traffic control required. Project complexity increases progressively from Category 1 through Category 5. This scheme sets the basis for identifying work zone impact levels and appropriate transportation management strategies for different project categories. The Ministry’s guidelines contain specific requirements, standards, and step-by-step procedures for developing and implementing traffic management plans.

Source: British Columbia Ministry of Transportation, Traffic Management Guidelines for Work on Roadways, September 2001, URL: [http://www.th.gov.bc.ca/publications/eng\\_publications/geomt/traffic\\_mgmt\\_guidelines.pdf](http://www.th.gov.bc.ca/publications/eng_publications/geomt/traffic_mgmt_guidelines.pdf) (Accessed 07/12/05).

Agencies may also classify projects into different categories based on the type of TMPs that may be needed. **Implementing the Rule on Work Zone Safety and Mobility**<sup>8</sup> provides an example using three different categories of TMPs:

- **Basic TMP.** Basic TMPs are typically applied on construction or maintenance projects with minimal disruption to the traveling public and adjacent businesses and community. Such projects are not significant projects, and the TMPs typically consist of a TTC plan.
- **Intermediate TMP.** Intermediate TMPs are likely to be used for construction or maintenance projects that are anticipated to have more than minimal disruption, but have not been identified as significant projects. For example, these projects may be expected to impact a moderate number of travelers and have moderate public interest, such as single lane closures in urban areas or commercial business districts (CBDs). In addition to a TTC plan, intermediate TMPs would also include some elements of transportation operations (TO) and public information (PI) strategies.
- **Major TMP.** Major TMPs are intended for significant projects that typically have moderate to high impacts on traffic and the local area and generate a significant amount of public interest. Examples include projects involving multiple lane-closures or total closure of a vital corridor in an urban area or CBD. Major TMPs consist of a TTC plan, and also address TO and PI components.

Additional information on TMPs is available in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/15/05).



The California Department of Transportation (Caltrans) uses three categories of transportation management plans (TMPs) based on the expected work zone impacts of projects.

- The first category is a “**Blanket TMP.**” This applies to projects where work is done on low volume roads during off peak hours and no delays are expected. It also applies for moving lane closures. Typical TMP strategies for such projects include portable changeable message signs (CMS), freeway service patrols (FSP), travel management techniques (TMT), and work during off-peak hours.
- The second category is a “**Minor TMP.**” The majority of Caltrans road projects fall under this category. Generally such projects cause minimal impacts. Lane closure charts and some mitigation measures are required. Typical TMP strategies for such projects include night work, portable and fixed CMS, construction zone enhanced enforcement program (COZEEP), TMT, highway advisory radio (HAR), FSP, gawk screens, etc.
- The third category is a “**Major TMP.**” About 5% of Caltrans road projects fall under this category. Generally such projects cause significant work zone impacts, and may require multiple TMP strategies and multiple contracts. Typical TMP strategies for such projects include public awareness campaigns, fixed CMS, extended closures, moveable barriers, COZEEP, detours, reduced lane widths, a web site, helicopter traffic reports, etc.

Source: Transportation Management Plans Effectiveness Study, Robert Copp, Caltrans, TRB 2004 Annual Meeting, Session 526: Work Zone Impacts – A New Frontier.

### 3.4.2 Work Zone Performance Standards/Requirements

After a project classification system is setup, agencies may establish work zone safety and mobility performance requirements for different types of projects. Appropriate performance standards for different types of projects can drive decision-making on work zone design, construction, and management strategies that help achieve the desired performance. This facilitates consistent thinking across project development stages and helps minimize design alterations and change orders during construction. For example:

- Performance standards may be used in project planning and design to identify work zone transportation management strategies that help achieve the desired performance.
- During construction, the actual impacts of work zones may be monitored and managed so that they fall within a reasonable limit of the desired performance standards.
- During performance assessments, anticipated work zone impacts (i.e., modeled or predicted) may be compared with the actual impacts in the field (i.e., observed or measured).

Many agencies are increasingly using performance measures and performance goals for transportation decision-making. Performance standards can be implemented as specific performance objectives that address work zone safety, mobility, and constructability. For example, reduce work zone crashes or crash rates can be used as a safety performance objective. An example of a mobility performance objective is to maintain a specific average travel time through a work zone over a certain time-period. Performance-based contracts present another potential area where work zone performance standards may be incorporated.



The Wyoming Department of Transportation (WYDOT) has adopted a maximum motorist delay specification of 20 minutes for major construction projects in remote locations. Generally no reasonable detours are available on such projects and work must be performed under traffic. This specification permits the motorist to continue to use existing routes without unreasonable delays or detours.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/20/05).

Performance standards can also be implemented indirectly through work zone management requirements for specific project types. For example, a traffic management policy may drive decision-making on lane-closures (e.g., whether lanes may be closed, when they may be closed, how many lanes may be closed), delay and queue thresholds, and work hour restrictions. The traffic management policy may also include safety performance standards that address work zone related crashes.



An Oregon Department of Transportation (ODOT) policy requires that work zone lane and shoulder widths meet the minimum geometric standards specified in the ODOT Highway Design Manual. Internal policy also calls for 300-foot minimum acceleration lanes. Wider lanes and shoulders reduce the potential conflicts often associated with narrow lanes and shoulders, and thereby reduce side-swipe accidents and truck off-tracking. Safety of construction personnel is also improved because they are farther away from moving traffic. This practice is considered for every project but is most effective for high-volume/high-speed locations.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/20/05).



The Ohio Department of Transportation developed and adopted a policy that limits the number of lanes that may be closed for construction and maintenance activities on interstate highways and other freeways. The policy requires sufficient mainline capacity during construction and maintenance and provides for allowable queue thresholds.

Source: Ohio Department of Transportation policy on Traffic Management in Work Zones Interstate and Other Freeways, Policy No.: 516-003(P), July 18, 2000, URL: <http://www.dot.state.oh.us/Policy/516-003p.pdf> (Accessed 09/08/05).

Section 8.0 of this document discusses work zone performance assessment. Specifically, Table 8.4 presents examples of work zone performance measures. At the end of Section 8.0, a list of resources are presented that may be useful for incorporating performance measures and goals in work zone decision-making.

### 3.4.3 Policy Guidance and Agency Processes and Procedures

Policy guidance and agency processes and procedures help work zone related decision-making lead to achieving and/or maintaining a desired level of performance for different types of projects. They help institutionalize, streamline, and standardize work zone safety and mobility practices, make project delivery more efficient and effective, and ultimately result in better work zones. Agency-level guidance, processes, and procedures may be incorporated in the agency's policy, or be considered as an extension of the policy.

The Rule specifically addresses agency-level processes and procedures<sup>9</sup> for work zone assessment and management, use of work zone data, and work zone related training and process reviews.

Agency-level processes and procedures are discussed in Section 4.0 of **Implementing the Rule on Work Zone Safety and Mobility**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

Typically policy guidance, processes, and procedures provide recommendations on project options, work zone design, and impacts management strategies that suit different project types. The following are examples of topics that can be addressed in such guidance, policies, and procedures:

- **Examples of Overall Policy Issues.** Overall policy provisions have an over-arching influence and are not specific to any particular issue or activity. Examples include:
  - Establishment of a multi-disciplinary team to serve as a standing committee on work zones (as discussed in Section 3.3.2 of this document and Section 3.4 of **Implementing the Rule on Work Zone Safety and Mobility**<sup>10</sup>).
  - Agency organizational strategies (e.g., assigning a specific individual to serve as the agency’s work zone safety and mobility coordinator, establishing an agency office for work zone safety and mobility management)



The Ohio Department of Transportation (ODOT) uses a Full-Time Work Zone Traffic Control Person in Metro District Offices. This staff member makes sure that motorists have a safe and efficient means of travel through work zones. This person also takes measures to reduce delays and work zone crashes and to improve communication with motorists. The ODOT District 12 (Cleveland area) has used this position for 6 years. Similar positions are also used in the Columbus and Cincinnati areas.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).



The New Jersey Department of Transportation (NJDOT) established a new Office of Capital Project Safety (OCPS) to improve and enhance safety awareness in construction work zones. As problem areas are identified in work zones, the OCPS will evaluate and resolve the problem, and then develop a process to prevent it from recurring. A recent accomplishment of the OCPS was the development of a new safety program specification that requires all contractors to have a written safety program prior to starting work on a project.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

- Policy guidance on using the work zone impacts assessment guidance provided in this document.
- Development of memoranda of understanding (MOUs) with utility operators regarding schedule and work coordination.
- Acceptable or desired work zone performance levels such as crash, travel time, and queue thresholds.

<sup>3</sup> Available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm)

- Criteria for identifying significant projects (e.g., using a delay and/or queue threshold or by using qualitative criteria). The Rule requires the identification of significant projects and the development of appropriate TMPs. The required components of a TMP vary based on whether projects are classified as significant. Agencies may develop and implement specific policy guidance and criteria to guide their staff in identifying significant projects<sup>11</sup>.
- Exception criteria and procedures for significant projects.
- Provision of training for personnel involved in development, design, implementation, operation, inspection, and enforcement of work zones, particularly related to approaches to improve safety and mobility of work zones.
- **Examples of Policy Issues Related to Systems Planning.**
- Policy guidance on coordination (grouping and sequencing) of long-range corridor improvements within the project prioritization process of Long Range Plans (LRPs), Transportation Improvement Plans (TIPs), and other agency planning efforts.



The Michigan Department of Transportation (MDOT) is attempting to identify all needed construction work in a corridor and then let a contract to address all of it. The principle they are applying is “get in, get out, and stay out”. A typical implementation is for MDOT to allow a total weekend closure within a long-term contract project and invite road maintenance, utility, and survey forces to also work on their road interests during that time period. This concept is being used primarily on high-volume urban freeway projects where traffic distribution is a major issue.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

- Policy guidance on addressing work zone impacts related issues in alternatives evaluation for transportation improvements (e.g., addressing work zone impacts issues as part of Major Investment Studies (MISs) and Environmental Impact Statements (EISs)).
- Procedures for identification and cost estimation of work zone transportation management strategies as part of transportation planning and programming.
- Policy guidance on consideration of work zone related road-user costs and impacts to affected businesses and residents in corridor plans.
- Requiring the inclusion of work zone related intelligent transportation systems (ITS) components in regional ITS architectures. This will help system integration and interoperability.
- Requiring the assessment of work zone performance as part of Congestion Management Programs (CMPs) and Congestion Management Systems (CMS) as work zones are a significant source of congestion.

- **Examples of Policy Issues Related to Project Planning and Design.**

- Project development activities and analysis recommendations for different project types (e.g., if a project cost exceeds a certain dollar value, an agency may require assessment of its life-cycle cost implications).
- Recommendations on project design strategies that increase the overall life-cycle of the project and minimize the need for frequent maintenance over its life-cycle.



The California Department of Transportation (Caltrans) established a Long Life Pavement Rehabilitation Program (LLPRP) for Urban Freeways in April of 1997. Every pavement rehabilitated under the LLPRP will have a 30- to 40-year design life. Thus the program will pay dividends to the highway users and Caltrans in reducing the frequency of maintenance and rehabilitation treatments, thereby reducing the number of work zones, number of maintenance activities, and therefore worker exposure.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

- Policy guidance on collection of traffic and crash data to develop appropriate work zone transportation management strategies (e.g., for significant projects).
- Policy guidance on work zone options for different project types (e.g., reduced-lane widths, lane closures, night work, full closure, detours).



The Minnesota Department of Transportation has produced a document entitled, “A Guide to Establishing Speed Limits in Highway Work Zones.” This document outlines the guidelines, proper layouts, and procedures for implementing work zone speed limits.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

- Standard construction approaches for different project types (e.g., use of night-time work for pavement preservation/rehabilitation type projects in urban areas).
- Work zone traffic control standards/practices (e.g., delay and queuing thresholds, permitted lane/road closures and time, work hours, detours, temporary structures, positive separation).



The Washington State Department of Transportation uses work hour charts for typical types of maintenance work zones. Maintenance crews in individual regions use these charts to determine the most appropriate time to perform a certain activity on a corridor (or type of corridor). This is based on how much the work would impact traffic on a particular type of highway.

Source: Washington State Department of Transportation, Work Zone Traffic Control Guidelines, January 2005, M54-44, URL: <http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/Workzone.pdf> (Accessed 09/08/05).

- Use of project-specific lane closure policies, including an approval and notification process.
- Policy guidance on addressing work zone related user costs (e.g., guidelines on assessment of user costs and the extent to which they need to be mitigated).
- **Examples of Policy Issues Related to Work Zone Transportation Management Strategies.**
  - Procedures for determining TMP needs for different project types.



The Indiana Department of Transportation (INDOT) provides guidance on when the agency requires certain types of Transportation Management Plans (TMPs) for projects. It provides the following nine project characteristics to be considered: major reconstruction or new construction, high traffic volumes, urban/suburban areas, significant detrimental impacts on mobility, facility's capacity will be significantly reduced, alternate routing will be necessary, significant impacts on local communities and businesses, significant timing and seasonal impacts, and/or significant grade changes.

Source: Indiana Department of Transportation, Chapter 81 of the Indiana Design Manual, Transportation Management Plans, URL: <http://www.in.gov/dot/div/contracts/standards/dm/Part%208/Ch%2081/Ch81.pdf> (Accessed 12/21/05).

- Policy guidance on maintaining pre-existing roadside safety features<sup>12</sup> in developing the TTC plan.
- Policy guidance on TO strategies (e.g., travel demand management (TDM), ITS, operations planning, traveler information, real-time work zone monitoring, work zone traffic incident management, work zone traffic enforcement).
- Recommendations on specific TMP strategies for different project types (e.g., use of work zone traffic incident management plans for projects in urban areas where shoulders are unavailable during construction, use of an work zone incident and construction management coordinator for major projects)



The Colorado Department of Transportation has instituted guidelines for developing traffic incident management plans for work zones. This guidebook provides recommendations on the types of projects for which work zone traffic incident management plans will be developed.

Source: Colorado Department of Transportation, Guidelines for Developing Traffic Incident Management Plans for Work Zones, Safety and Traffic Engineering Branch, September 2003. URL: [http://www.dot.state.co.us/Traffic\\_Manuals\\_Guidelines/incident\\_management\\_guidelines/incident\\_management\\_guidelines\\_20030919.pdf](http://www.dot.state.co.us/Traffic_Manuals_Guidelines/incident_management_guidelines/incident_management_guidelines_20030919.pdf) (Accessed 09/08/05).

- Public information requirements for specific project types (e.g., use of standardized public information provided a certain number of days in advance of upcoming mobile and short-term road work.)



- **Examples of Policy Issues Related to Contracting.**

- Policy guidance on when to use different types of contracting strategies (e.g., low bid, design-build, lane rental, A+B bidding, incentives/ disincentives, performance-based contracting) based on project type. Innovative contracting mechanisms can be used to reduce project implementation delays, accelerate construction, and shorten overall construction duration, thereby reducing exposure and the resulting work zone impacts.



In 1996, the Florida Legislature authorized the Florida Department of Transportation (FDOT) to use accelerated contracting techniques on construction projects, and limits innovative contracting to \$60 million in contracts annually. Alternative contracting techniques include the following: A+B, Lane Rental, Design/Build, Warranty Clauses, No Excuse Bonus, Lump Sum, Liquidated Savings, and Incentive/Disincentive.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

- Development of standard specifications for incorporating work zone performance monitoring requirements in contract documents.

- **Examples of Policy Issues Related to Construction.**

- Policies on the use of value engineering (VE) and partnering, and on addressing any related work zone impacts issues (e.g., requiring the assessment of potential work zone impacts implications of any modifications proposed to the original TMP).
- Monitoring requirements for specific project types (e.g., monitoring travel times through work zones that are expected to have significant delays.)
- Work zone safety and mobility reporting and record-keeping procedures (e.g., requiring record-keeping on work zone related crashes).
- Policy guidance on collecting, reporting, synthesis, and storage of work zone crash and traffic operations data during construction.
- MOUs and policies with other public and private agencies for coordinating activities during construction (e.g., police agencies, TMCs, utility companies).



The Illinois State Toll and Highway Authority keeps close track of all lane closures on the tollways. One person maintains a list of all lane closures and coordinates these lane closures with the State police, public relations, construction, and project development. An updated list of lane closures is always available for public relations, the Authority, and the police. This also provides for better record keeping and analysis of incidents in work zones.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

- **Examples of Policy Issues Related to Performance Assessment.**

- Procedures for work zone reviews, process reviews, and work zone safety and mobility inspections/audits.
- Recommended strategies for use and analysis of any data and/or information collected during construction (e.g., recommending the cross-tabulation of work zone traffic incident data, mobility and operational data, and construction activity data for identifying potential project circumstances that trigger certain types of incidents).



The New York State Department of Transportation (NYSDOT) compiles work zone fatalities and injury accidents based on type, area within the work zone, driver characteristics, etc. The data is also categorized and analyzed by type of collision. This information is used to identify trends in driver behavior and work zone emphasis areas, develop countermeasures, and also for reporting purposes to the FHWA and NYSDOT in their annual report. The information is collected at the NYSDOT regional level and collected and analyzed by the main office.

Source: FHWA Work Zone Best Practices Guidebook, April 2000,  
<http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/21/05).

## 4.0 Work Zone Impacts Assessment During Systems Planning

### 4.1 What is Systems Planning?

Systems planning is the stage of program delivery where planning for the future is carried out by identifying transportation systems needs and deficiencies, developing and evaluating alternative improvement solutions, and compiling plans and programs for implementing the solutions. Systems planning is conducted at several levels including Statewide, regional, metropolitan, county, local, and corridor. The process is both interactive and iterative, with participation and feedback from concerned public and private organizations, other interested parties, and the general public.


#### 4.1.1 Key Activities Performed During Systems Planning

Two major groups of activities constitute systems planning – “Identification of Transportation Improvement Needs,” and “Development of Transportation Plans and Programs.”

Identification of transportation improvement needs includes:

- **Needs Assessment and Solution Development** (also referred to as scoping). This involves identifying transportation system needs and deficiencies, and developing alternative solutions (alternatives/potential projects) to meet the needs.
- **Alternatives Evaluation.** This involves the evaluation of the alternatives to determine how well they meet the need, assess their cost and benefit-cost effectiveness, and identify any undesirable impacts to the environment, society, and the respective communities. Typical activities include corridor/sub-area studies, environmental/ National Environmental Policy Act (NEPA) analyses, and air-quality conformity analyses.
- **Project Identification.** This involves the identification of projects by selecting the best alternatives, and developing the final project concepts, cost estimates, implementation timelines, and if required, impacts mitigation strategies. Funding sources are also identified for the respective projects.

The above activities are carried out either as part of ongoing system management, preservation, and upgrade, or through specific studies including corridor safety/mobility studies, regional/sub-area/district studies, congestion management plans or systems, and regional intelligent transportation systems (ITS) architectures. The rigor and level of effort of these activities depends upon the type, size, and scope of the identified needs and alternatives.



Development of transportation plans and programs involves the development of long-range transportation plans (LRTPs) and short-term Statewide Transportation Improvement Programs (STIPs) and regional Transportation Improvement Programs (TIPs). LRTPs lay out the long-range vision for the transportation system for a given horizon year, usually projected out 20 to 25 years. STIPs and TIPs are smaller packages of projects within long-range plans, and they outline five-to-six-year and/or two-year streams of projects. The following activities are performed during this process:

- **Project Prioritization.** This involves the prioritization of projects identified in the previous step based on the urgency of the needs, project costs, benefit-cost effectiveness, and the expected impacts of the projects.
- **Plan and Program Development.** This involves the assimilation, scheduling, and coordination of the prioritized projects to develop LRTPs, STIPs, and TIPs.

Systems planning is intricate, requires multi-agency participation, uses sophisticated modeling and analysis tools, and extends across multiple transportation disciplines and modes. An attempt has been made here to present systems planning in a simple format so that work zone impacts assessment may be discussed in the context of systems planning. The Federal Highway Administration's planning web site located at <http://www.fhwa.dot.gov/planning/index.htm> (Accessed 12/22/05) provides more information and resources on systems planning.

## 4.2 Why Assess Work Zone Impacts During Systems Planning?

Work zone impacts are not generally considered in systems planning. The primary reason cited for this is the lack of sufficient project-specific data during systems planning, such as how the project will be constructed, when exactly it will be built, how long it will last, etc. But many State Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and other transportation agencies recognize the potential value of assessing work zone impacts during systems planning. There is general thinking in the industry that advancing work zone considerations as early as possible in the program delivery process will lead to overall benefits in terms of better planned, budgeted, and implemented projects that minimize work zone impacts. This section provides a potential approach and general guidance on advancing the consideration of work zone impacts to the systems planning stage.

The following section summarizes the importance of work zone impacts in systems planning.

### 4.2.1 Importance of Work Zone Impacts Assessment in Systems Planning

The essential outputs of the systems planning process, irrespective of the type of plan or program are:

- A set of projects with respective implementation schedules, expected impacts, potential mitigation strategies, cost estimates and funding sources.
- An implementation plan/program that compiles and coordinates the identified projects.

If work zone impacts of projects are not considered in systems planning, work zone impacts of projects may not be understood sufficiently enough to identify the work zone management strategies that are needed for a project. As a result, the project cost estimates (that are programmed into transportation plans) may not reflect the complete costs of work zone management. This could lead to expensive change orders during design, thereby delaying project implementation and increasing total cost. It may also lead to unavailability of funds for implementing appropriate work zone impacts management strategies, potentially resulting in undesirable safety and mobility issues. Another potential effect is that the combined work zone impacts of multiple concurrent projects, either at the corridor or network level may not be accounted for, potentially resulting in additional delay to road users and prolonged work zone durations.

Therefore, considering work zone impacts in systems planning can result in better planned and programmed projects that:

- Account for potential work zone related impacts, management strategies, and cost estimates.
- Are coordinated and scheduled to minimize the combined work zone impacts of multiple concurrent projects.
- Are adequately funded and resourced for work zone impacts management, minimizing cost over-runs and/or project delays.
- Ultimately result in better managed work zones leading to improved safety and mobility.

Though the above discussion amplifies the need for work zone impacts assessment during systems planning, lack of sufficient project-specific data at this stage is still an issue. However, the assessment during systems planning does not have to be an elaborate analysis. A conceptual assessment using available information, appropriate rationale and reasoning, and engineering judgment can go a long way towards avoiding cost increases and schedule delays during the later stages of project development and implementation. For example, currently work zone temporary traffic control (TTC) costs are generally estimated as a percentage of the total project cost. This approach is generally accepted in the industry and works well in most cases. However, certain projects (e.g., significant projects<sup>1</sup>) require additional work zone management in the form of transportation operations (TO) and/or public information (PI) strategies. A conceptual assessment during systems planning can indicate whether projects will need additional management strategies in addition to a TTC plan. Such a conceptual assessment may not require extensive quantitative analyses; rather it may be performed qualitatively using engineering judgment. Once the need for TO and/or PI strategies is established, their costs may be estimated and appropriately budgeted into transportation plans and programs.

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<sup>1</sup> 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 based on the respective agency's policy and/or engineering judgment. This definition, provided in Section 630.1010 of the Work Zone Safety and Mobility Rule (the Rule), also specifies that all Interstate system projects within the boundaries of a Transportation Management Area that occupy a location for more than three days and have lane closures are significant.

## 4.3 When in Systems Planning Can Work Zone Impacts be Assessed?

Work zone impacts assessment during systems planning may help answer questions such as:

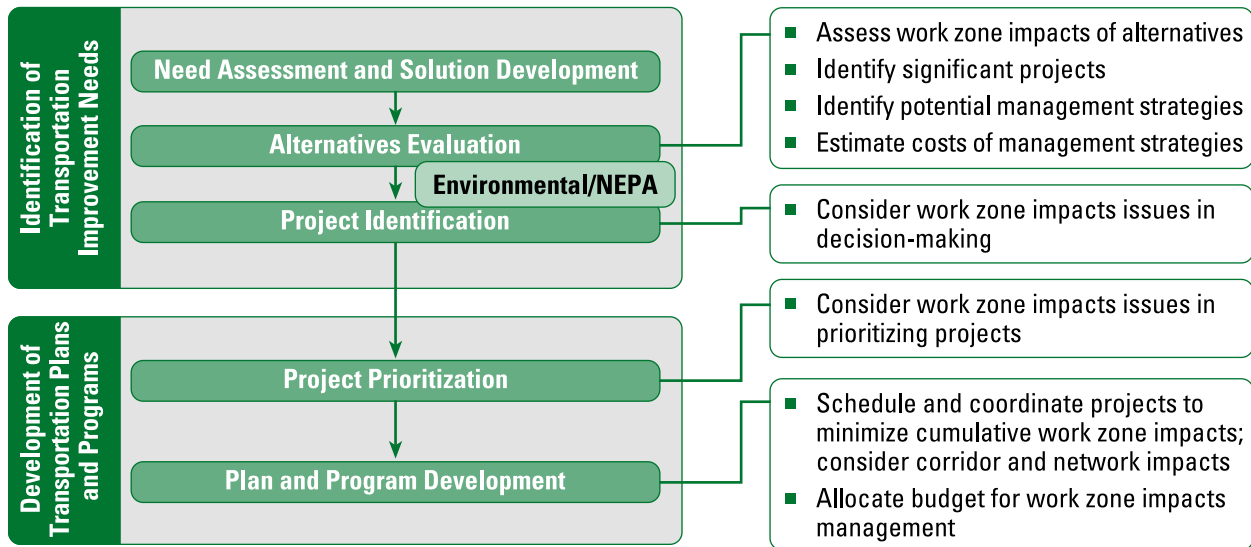
- What are the potential work zone impacts of identified projects?
- What are the combined impacts of multiple road projects taking place at the same time?
- What are the coordination issues, if any, that need to be accounted for in planning and scheduling multiple projects in the vicinity of each other?
- What can be done during this stage to manage the work zone impacts?
- What are the potential work zone management strategies that may be used for a project?
- How much money should be budgeted for work zone transportation management for a project?

Given that systems planning consists of many processes, participants, and products, when exactly should work zone impacts be assessed – during needs and project identification (scoping), during alternatives analysis and solution development, or during plan/program development? This is a very relevant question because systems planning activities do not always take place sequentially. Projects may be identified and programmed during any of the systems planning processes and by different entities. Further, the people who plan and manage work zone activities (i.e., engineers, designers, construction specialists, etc.) are not the people who are actively involved in systems planning. This is further exacerbated in situations where systems planning is conducted at the MPO or regional levels and not by road owner agencies<sup>2</sup>. In order to reflect these variations, it is important to make work zone impacts assessment an independent part of the systems planning process, and perform the assessment before projects are programmed and funded. This keeps work zone impacts assessment independent of the source of the potential project, and helps incorporate it into the regular flow of activities that take place for any potential project.



**TIP:** Ideally, work zone impacts assessment needs to be performed for potential projects identified through the various systems planning processes before they are programmed and funded into LRPs, TIPs, and STIPs. This helps account for expected work zone impacts, potential management strategies, costs of management strategies, and combined work zone impacts issues early in the process.

Figure 4.1 provides a high-level illustration of how work zone impacts assessment may be performed during systems planning. More details are provided in Section 4.5



**Figure 4.1 Incorporating Work Zone Impacts Assessment in Systems Planning**

## 4.4 Who are the Participants?

Systems planning constitutes many activities that span across multiple participants and stakeholders. The staff that may perform work zone impacts assessment during systems planning, the inputs and input providers, and the outputs and users of the output are shown in Table 4.1.

The staff that may assess work zone impacts during systems planning are presented according to the two basic categories of activities that take place:

- **Identification of transportation improvement needs.** Staff that are already responsible for scoping, needs identification, alternatives evaluation, and project identification may incorporate work zone impacts issues into these activities. This generally includes highway planners and engineers, safety engineers, and maintenance managers in State DOT districts/regions, counties, cities, and other road-owner agencies. Sometimes designers and program managers (e.g., pavement managers, bridge managers, traffic engineers/managers.) may also participate.
- **Development of transportation plans and programs.** Staff that are already responsible for project prioritization and plan/program development may incorporate work zone impacts issues into these activities. This generally includes community planners and systems-level planners belonging to MPOs, county-level planning commissions/organizations, and State DOT planning departments.

Inputs	Input Providers and Participants
<ul style="list-style-type: none"> <li>■ Applicable policies</li> <li>■ During the identification of transportation improvement needs:               <ul style="list-style-type: none"> <li>- List of identified transportation improvement needs, and potential solutions/alternatives.</li> <li>- Known constraints, work zone impacts, and other issues.</li> </ul> </li> <li>■ During the development of transportation plans and programs:               <ul style="list-style-type: none"> <li>- Set of identified projects from the previous stage, along with the final project concepts, cost estimates, implementation timelines, conceptual understanding of impacts, impacts mitigation strategies, and funding sources.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>■ Applicable managerial staff (executive and technical), agency manuals and publications (standards, policy guidance).</li> <li>■ All personnel responsible for the scoping, project needs identification, mitigation measures identification, and early cost estimation of individual projects will provide input. This includes designers, pavement managers, bridge managers, traffic engineers/managers, safety engineers, planners, and maintenance managers.</li> <li>■ Community planners and systems-level planners, belonging to county-level planning commissions/organizations, MPOs, and State DOT planning departments.</li> <li>■ Other stakeholder groups such as local community representatives, business representatives, trucking associations, American Automobile Association (AAA), public safety agencies, etc.</li> </ul>
Outputs	Users of the Outputs
<p>The output is a set of programmed projects with a conceptual planning-level work zone strategy for each project, consisting of:</p> <ul style="list-style-type: none"> <li>■ Project definition including purpose, location, schedule, and nature of work.</li> <li>■ Potential high-level construction and traffic control approach(es).</li> <li>■ Expected work zone impacts of the project and whether it is expected to be a significant project.</li> <li>■ Potential work zone transportation management strategies.</li> <li>■ Project scheduling and coordination recommendations and issues.</li> <li>■ High-level cost estimates for the work zone management strategies.</li> </ul>	<p>Users of this output include:</p> <ul style="list-style-type: none"> <li>■ Systems-level and project-level planners for programming projects and for coordinating with and planning for other projects.</li> <li>■ Executive-level managers including budget/finance staff for programming and funding.</li> <li>■ The project design/construction team (designers, technical specialists, construction/maintenance managers) for preliminary engineering and project development.</li> </ul>

NOTE: The level of participation from the input providers shown in Table 4.1 will depend on the scope and complexity of the project, and in many cases will be limited to the staff that perform the impacts assessment.

**Table 4.1 Systems Planning Assessment Participants**



## 4.5 Assessment Process

Figure 4.2 illustrates the steps involved in work zone impacts assessment during systems planning. Some notes pertaining to the figure are presented in Table 4.2.

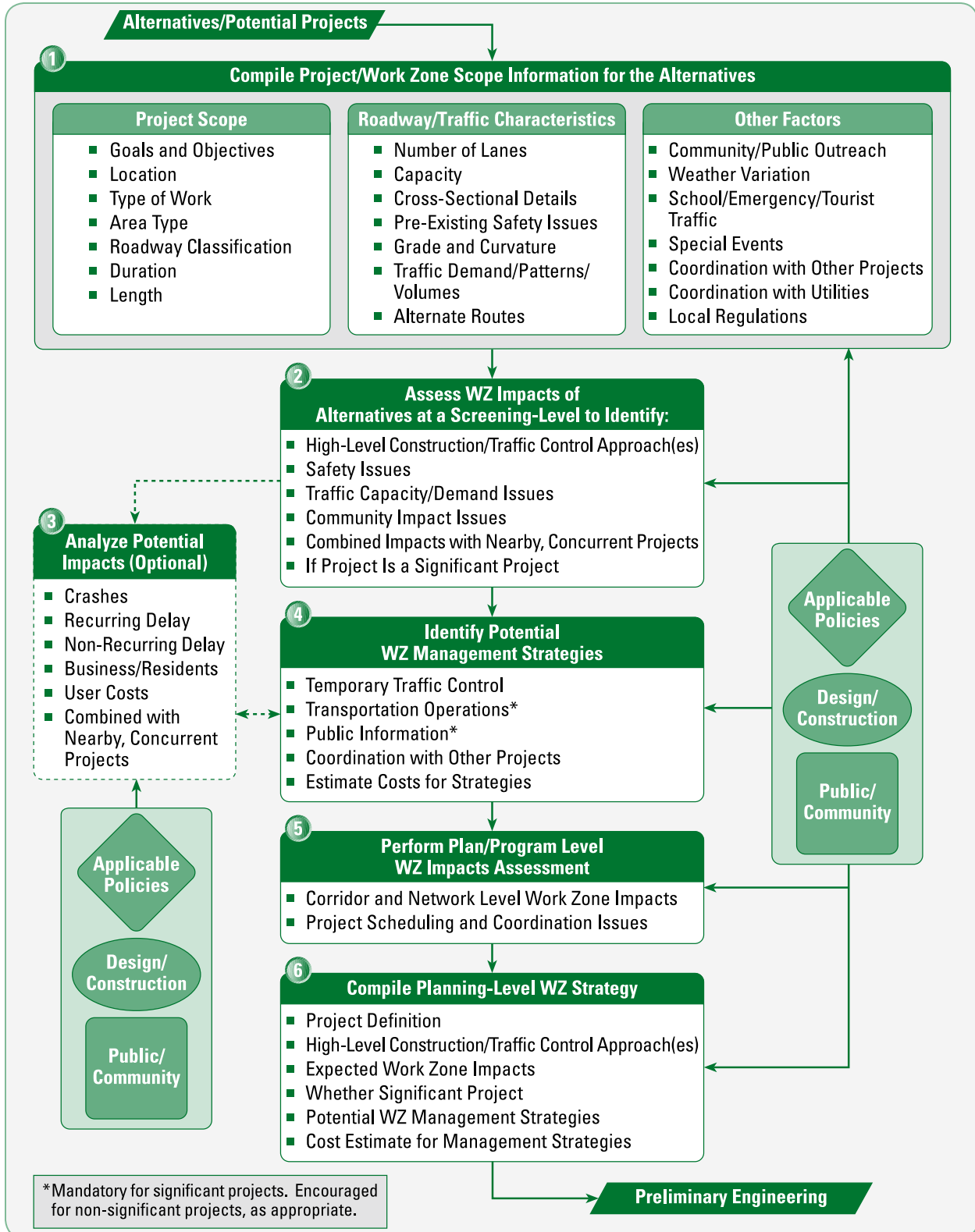


Figure 4.2 Systems Planning-Work Zone Impacts Assessment Process

## Process Notes for Systems Planning

**Steps 1 through 4** in Figure 4.2 represent the work zone impacts assessment activities that may be performed during the identification of transportation improvement needs. The assessment may be conducted for each alternative solution or potential project being evaluated. The purpose is to consider work zone impacts issues also in selecting the best alternative(s). The idea of conducting a work zone impacts assessment for every alternative/project may seem daunting. However, the assessment will always be proportional to the type, size, and complexity of the project. For many projects a qualitative assessment may be sufficient, with a quick identification and documentation of work zone impacts issues. The screening of small projects or those likely to have minimal impacts could be done with templates or simplified tools/rules so that analysts can concentrate efforts on projects that are likely to cause greater impacts.

**Step 5** represents the assessment that may be performed during project prioritization and plan/program development. Issues such as project scheduling and coordination, and corridor and network impacts are addressed during this step. The staff who perform these activities may include community planners, systems-level planners, highway planners and engineers belonging to county-level planning commissions/organizations, MPOs, and State DOT planning/engineering departments.

**Step 6** represents the compilation of information from the assessments to develop the conceptual planning-level work zone strategy for each project. This may then be carried over to the preliminary engineering stage for subsequent assessments.

**Input from and interaction with appropriate sources** (as shown in Figure 4.2) may be required during the assessment as follows:

- **Applicable Policies**, shown as a green diamond in the diagram, represents the agency's policies and related policy provisions (i.e., policy requirements, standards, and/or guidance) and appropriate processes, procedures, and practices that apply to the particular activity. They help with decision-making on specific issues during the process, such as the level of impacts assessment and the type of management strategies needed for different projects. For example, an agency's policy may recommend the establishment of a regional inter-agency roadwork coordination committee for assessing and managing corridor and regional work zone impacts of multiple projects. Section 3.4 of this document provides a brief discussion on potential policy provisions for application during project delivery.
- **Design/Construction**, shown as a green ellipse in the diagram, represents input from design engineers, traffic engineers, and construction engineers who have a better understanding of project design and construction issues. Sometimes input from technical specialists from specific disciplines may also be required, including highway engineers, pavement specialists, structural engineers, environmental specialists, and right-of-way (ROW) specialists. Participation of such staff in the systems planning work zone impacts assessment may lead to decisions that carry over to subsequent project phases without significant alteration.
- **Public/Community**, shown as a green square in the diagram, represents input from the general public including motorists, other highway users, businesses, residents, neighborhood groups, etc. This input may be provided through public involvement processes, customer feedback efforts, surveys, focus groups, etc.

**Though systems planning may be separated into distinct activities, the interface between the different activities is fluid.** Decision-making and actions from one activity may overlap with or extend into other activities. For some projects, systems planning activities may also overlap with preliminary engineering and/or design (e.g., large regionally significant projects that require multi-year planning, preliminary engineering and design studies).

**Agencies may combine work zone impacts assessment with environmental/NEPA assessments.** Generally, agencies prepare three types of environmental reviews under NEPA: Categorical Exclusions (CE) for small, routine projects with insignificant environmental impacts; Environmental Assessments (EA) for projects with no significant environmental impacts; and Environmental Impact Statements (EIS) for projects with significant environmental impacts. The opportunity exists to combine work zone impacts assessment with the environmental/NEPA assessments. Sometimes the NEPA process can be a primary source of work zone related constraints or inputs for the project. More information on NEPA is available at <http://www.environment.fhwa.dot.gov/projdev/index.asp> (Accessed 12/22/05)

**Table 4.2 Process Notes**

The following discussion provides an explanation of the individual steps shown in Figure 4.2.

In the following discussion, the terms “alternatives” and “potential projects” are used interchangeably. They refer to the different alternative solutions or potential projects that are being evaluated as options to serve a particular transportation improvement need. Sometimes there may be only one alternative to serve a particular need, in which case the work zone impacts assessment needs to be performed only for that alternative.

### □ **Step 1 of 6: Compile Project/Work Zone Scope Information for the Alternatives**

This step involves the compilation of available information (also referred to as project scoping information) on the alternatives/potential projects. Work zone impacts assessment may be performed by the same staff who assess needs and identify alternative solutions / potential projects. Therefore, the project and work zone scope information may be readily available to them. The purpose of the information collection is to obtain some contextual information on the project so that its work zone impacts may be assessed. If it is clearly evident that a project will not have major work zone impacts, that assertion may be noted, and much data or information need not be collected.



**TIP:** This step is a good check-point to determine if there are any policy provisions that apply to the project. For example, the agency may have a policy on regional coordination when planning for road projects, in which case, the participation of appropriate stakeholders may need to be facilitated.

The major categories of information that may be needed include the following:

- **Project Scope**, including goals and objectives, location, type of work, area type, roadway classification, duration, and length.
- **Roadway/Traffic Characteristics**, including number of lanes, roadway capacity, cross-sectional details, pre-existing safety issues, grade, curvature, and traffic demand/patterns/volumes, available alternate routes.
- **Other Influencing Factors**, including community and public outreach information, weather variation, school-zone issues, emergency vehicle traffic issues, whether project is located in a Central Business District (CBD), presence of other nearby transportation junctions (e.g., railroad crossings, transit junctions), availability of alternate modes, tourist traffic issues, upcoming and planned special events, coordination issues with other projects, utility coordination issues, and local regulations (e.g., noise restrictions).

The types of information listed above are intended to serve as a guide for the different factors that may influence work zone impacts. All of the above information may not be needed – it may be sufficient to just take note of major issues that are apparent or readily identifiable. For example, if there are no viable alternate routes for a project, that information needs to be noted and recognized, so that it may be accounted for when identifying work zone traffic control and management strategies in subsequent steps.

Hard data (e.g., traffic counts, crash records) may not be required at this point. It may be sufficient to qualitatively identify issues, (e.g., whether there are any pre-existing safety issues, whether there is a history of weekend congestion at the location). Such information, if noted at this early stage, will help in the selection of a suitable work zone strategy for the project. For example, if there is a major event that occurs every Memorial Day at a location nearby, construction starting before June may not be a good option for the project. If hard data is readily available it may be useful to note the availability of data.

## □ **Step 2 of 6: Assess Work Zone Impacts of Alternatives at a Screening-Level**

This is the first time that the alternatives/potential projects are looked at from a work zone impacts perspective to get an idea of what it may take to develop, design, and build a project with minimum disruption. The objective of this step is to get a first-cut understanding of the potential work zone impacts of each alternative/potential project. The assessment is generally qualitative and relies upon engineering judgment and available information from the previous step. Screening of small projects or those likely to have minimal impacts could be done with templates or simplified tools/rules so that more detailed analyses can focus on projects that are likely to cause greater impacts. The result of this screening level assessment will be a summary-level list of the work zone impacts and related issues for the project.

This step is also a good checkpoint to identify the potential impact area<sup>3</sup> of a project. Work zone impacts of some projects may be restricted to the immediate vicinity of the work zone (e.g., a small queue leading up to the work zone), or may be felt on the corridor on which the work is being performed (e.g., sizeable queuing and impacts to a nearby interchange/intersection). However, the work zone impacts of some projects may be felt on a good portion of the corridor and roadway network, affecting other roadways, interchanges, intersections, and/or multi-modal junctions in the transportation network. This is especially true for work zones in urban/suburban settings (e.g., commercial business districts (CBDs), arterial grid networks). In conducting the screening level work zone impacts assessment the potential extent of the impacts (e.g., immediate vicinity only, corridor impacts, network impacts) should also be identified where applicable.

The following discussion provides an overview of the activities that may be performed as part of the screening-level assessment. Table 2.7 – Work Zone Impacts Considerations in Section 2.0 provides a list of the different work zone impacts issues and considerations that may be addressed.

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<sup>3</sup> Section 630.1004 of the Rule defines work zone impacts as work zone-induced deviations from the normal range of transportation system safety and mobility. These impacts may extend beyond the physical location of the work zone itself, and may occur on the roadway on which the work is being performed, as well as other highway corridors, other modes of transportation, and/or the regional transportation network. The extent of the work zone impacts may vary based on factors such as road classification, area type (urban, suburban, and rural), traffic and travel characteristics, type of work being performed, time of day/night, and complexity of the project.

Screening level work zone impacts assessment of alternatives/potential projects may include the following activities:

- **Identification of High-level Construction/Traffic Control Approach(es) for the Project.**

The types of issues to be considered include:

- *Potential construction approach(es).* Examples include phased construction, design-build, asphalt pavement vs. concrete pavement, and pre-cast concrete members vs. cast-in-place concrete members.
- *Potential traffic control and management approach.* Examples include lane closure, total roadway closure, shoulder closure, use of shoulder for travel during construction, cross-over, and use of detour routes.
- *Potential time of construction.* Examples include off-peak, night work, weekend work, and intermittent closures.



The New York State Department of Transportation (NYSDOT) recognizes that mobility and safety impacts should be considered in initial phases of project development (called scoping). The scoping process should identify mobility needs, which may influence the selection of a preferred design alternative. However, “construction details” will always be a relatively minor consideration in this phase.

Source: NYSDOT comments in response to the FHWA Notice of Proposed Rulemaking (NPRM) on Work Zone Safety and Mobility, August 5, 2003, United States Department of Transportation (U.S.DOT) online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf81/175976\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/175976_web.pdf) (Accessed 12/29/05).

More information on different construction/traffic control approach(es), where and when they are likely to be suitable, and their pros and cons are discussed in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).



**TIP:** Design/construction personnel can provide valuable input towards identifying the potential construction/traffic control approach(es) for a project.

- **Identification of Safety Issues.** Issues to be considered include:

- *Pre-existing safety issues.* Examples include high crash history at the project location, obvious safety issues known to staff or the public, curve and gradient issues, line of sight issues, weather related safety issues, lack of adequate shoulder width, and prevailing speeds.
- *Safety implications of potential construction approach(es).* Examples include implications of night work, lane width issues, lane-closure related safety issues, channelization and work area separation issues, construction staging areas, construction traffic access issues, and management/enforcement of speed in advance of and through the work zone.

- **Identification of Traffic Capacity/Demand Issues.** Issues to be considered include:
  - *Traffic and travel characteristics at the project location.* Examples include heavy traffic volumes, congested urban/suburban corridor, rural corridor with heavy truck traffic, and recreational or seasonal traffic issues.
  - *Recurring congestion issues.* Examples include capacity and level of service (LOS) issues, uni-directional peak hour congestion, heavily congested urban/suburban corridor, high-volume interchange(s), and pre-existing bottlenecks and choke-points in the vicinity of the project.
  - *Non-recurring congestion issues.* Examples include high potential for incident related traffic congestion, special event traffic issues, and weather related traffic delays.
  - *Mobility implications of potential construction approach(es).* For example, lack of shoulders during construction may require a work zone traffic incident management plan. Doing work at night may preclude the need for an elaborate TMP. Traffic capacity and management issues may exist on a detour route.
- **Identification of Community Impacts and Related Issues.** This involves the identification of the work zone impacts on the community, businesses, and residents likely to be affected by the project. Types of issues to be considered include:
  - *Accessibility issues.* Examples include business access relocation, ramp-closure related access issues, and detour related mobility impacts on communities.
  - *ROW related issues.* Examples include property relocation, easement, and realignment of property lines.
  - *Other coordination issues.* Examples include utility related issues, and construction noise issues.
- **Identification of Combined Impacts and Coordination Issues with Nearby, Concurrent Projects.** This involves the identification of nearby and/or concurrent projects, and assessing whether the projects may have an impact on the project under consideration, or vice-versa. It also involves the assessment of potential combined impacts of multiple projects at the corridor/network level. This assessment may be performed using a qualitative fatal-flaw type approach to identify potential conflicts and coordination opportunities. The process may be informal (e.g., based on any readily available information), or formal (e.g., through a coordination process for identifying district/region-level project coordination issues.)



In Oklahoma, an effort is made to coordinate all State Department of Transportation and local government utility construction and maintenance work. This minimizes concurrent rehabilitation of adjacent and alternate routes and instances of digging up the same road twice (e.g., installation of a new utility crossing shortly after an overlay/rehabilitation job). In addition to reducing motorist delay, this practice provides a forum to discuss formal agreements to detour traffic from State to local routes or vice versa; funding to improve local highways that serve as alternate routes for State highway projects; and traffic management through partnerships and networking.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 12/16/05).

- **Identification of Whether the Project is a Significant Project.** Some projects are likely to have greater work zone impacts than other projects (e.g., greater congestion, more effects on road safety, or greatly reduce access to businesses or event venues). Such projects may warrant additional attention during project delivery and additional funding for work zone transportation management strategies. Recognizing this, the updated Rule (the Rule) establishes a category of projects called *significant projects*. Simply stated, a significant project is one that an agency expects to cause a relatively high level of work zone related disruption. Classification of certain projects as significant helps stratify<sup>4</sup> the application of TMP components. Agencies can then allocate resources more effectively to those projects that are likely to have greater impacts.

Since decisions on project budgets, high-level design issues, and sequencing of projects are generally made early in the program delivery process, the identification of significant projects should be made as early as possible when the most options are available. Alternatives/potential projects are assessed for their work zone impacts for the first time in this step. Therefore, this is a good juncture to do an early assessment of whether a potential project will be a significant project. Once a project is identified as significant, appropriate resources may be set aside to plan, design, and build the project, and appropriate TO and PI strategies may be identified and funds set aside for those strategies. This helps set the basis for TMP development in future stages.

The work zone impacts issues identified (as discussed in the previous bullet points) may be used to identify whether a given project is a significant project. If an agency's work zone policy has provisions on significant projects, those policy provisions will govern the decision-making. Often it is obvious that a project will not likely have major work zone impacts, in which case that project will probably not be a significant project (e.g., a repaving project in a low-volume corridor). It may also be the case that certain projects are obviously significant (e.g., a major freeway interchange reconfiguration project in a congested CBD setting). In some cases it may not be apparent whether a project is significant or not, in which case it may be noted that further examination and/or analysis may be required (discussed in Step 3).

More information on identifying significant projects, including possible criteria, is provided in Section 5.0 of Implementing the Rule on Work Zone Safety and Mobility, available at [http://ops.fhwa.dot.gov/wz/rule\\_guide/rule\\_guide.pdf](http://ops.fhwa.dot.gov/wz/rule_guide/rule_guide.pdf) (Accessed 11/18/05).

### **Step 3 of 6: Analyze Potential Impacts (Optional)**

This is an optional step to further investigate and analyze the potential work zone impacts of a project/alternative using appropriate analysis tools. At this stage of project delivery, quantitative analysis may be needed only for longer-duration projects that are expected to have major impacts (corridor, network, or regional levels), and may represent a small percentage (e.g., 5%) of all projects that an agency is involved in. For many projects the screening-level qualitative assessment (in Step 2) may be sufficient.

The following are some examples of scenarios under which an agency may find it helpful to quantitatively analyze impacts:

- **The screening-level assessment in Step 2 may indicate that the project is a significant project,** and the agency may desire to obtain a better (quantitative) understanding of what the impacts may be so that appropriate work zone management strategies and their costs can be identified.

<sup>4</sup> As stated in Section 630.1012(b) of the Rule, TMPs for significant projects must consist of a TTC plan, and must also address TO and PI strategies. TMPs for all other projects must consist of a TTC plan, and may also address TO and PI as needed for the project.

- **It may not be very obvious during the screening-level assessment in Step 2 whether or not a project is significant.** So the agency may decide to further analyze the potential work zone impacts. For example, an agency may identify in Step 2 that a particular project would have significant sustained work zone impacts if performed during daytime hours, but likely would not if performed at night. So, in this step the agency may conduct a queuing and delay analysis to determine if it would be feasible to conduct the project at night without an extensive TMP.
- **To help the agency choose between multiple traffic control and management approaches.** Examples include night work vs. daytime work, weekend vs. weekday, lane closure vs. no closure, and full closure vs. partial closure.
- **To justify additional funds for work zone transportation management for a particular project or to justify as to why a particular project will not have major impacts.** Analyses may help provide hard numbers for the potential work zone impacts, the resulting user-costs, and the amount of user-cost savings that the recommended management strategies may yield.



The following is a summary of how the Washington State Department of Transportation (WSDOT) considers work zone issues during scoping:

- Prior to 1996-97, most of the scoping was performed by groups of about ten staff members who would conduct field tours to identify deficiencies. This was then followed by cost estimation using rules of thumb, for example, the cost for a certain activity on a 5-mile highway section at \$1 million per mile would amount to a total of \$5 million.
- In 1995, there was a re-engineering of the scoping process to increase cross-functional involvement, and resources, time, and money for scoping. This paid-off significantly in project delivery. For the first time, WSDOT incorporated the concept of work zones into scoping. They started thinking about work zones at the earliest possible stage to develop a “work zone strategy.” For smaller projects, the work zone strategies document may be relatively short and typically refer to a section of the Manual on Uniform Traffic Control Devices (MUTCD). For larger projects (e.g., a bridge project or a major repaving project through downtown Tacoma) the work zone strategies document may be more involved and require a structured assessment and documentation of work zone traffic control and transportation management issues.
- Scoping now constitutes 1.5% to 3% of the total engineering for the construction program, but prior to 1996-97, it was only 0.3%. WSDOT practice is to over scope by 30% - 50% of the approximate budget allocation. This over scoping is done for both preservation and improvement projects. The identification of studies such as EISs and feasibility studies is also part of the scoping process. For a major project an EIS normally constitutes 30% of the engineering/design for the project.

Source: FHWA Work Zone Workshop conducted at WSDOT, December 12, 2002.



**TIP:** Quantitative analysis of work zone impacts may not be possible during systems planning due to inadequate project detail and lack of data. In such cases, the particular issue under investigation may be noted so that the staff that conduct assessments in subsequent phases are made aware of the issue.



The following are some issues to be considered in conducting the quantitative analysis:

- **High-level tools such as sketch-planning, travel demand modeling, and deterministic tools may be most appropriate for this level of analysis.** Any quantitative analysis conducted during this step is intended to provide a quick understanding of work zone impacts related issues (e.g., whether a project may be a significant project, choice of construction/traffic control approach, early identification and cost estimation of work zone management strategies). For example, an agency may want to evaluate the feasibility of closing one lane in each direction for a future Interstate project. The agency may contact the region's MPO to perform a quick analysis of potential travel impacts of such a construction scenario. The MPO may then use the region's travel demand model to conduct this analysis and determine if the construction scenario would be feasible. If the project complexity and the desired level of accuracy for the work zone impacts estimation warrant a more detailed analysis (e.g., simulation), the agency can choose to do so using appropriate analysis tools.

More information on different analysis tools is provided in **APPENDIX B – Overview of Work Zone Impacts Analysis Tools**. The appendix also has links to additional resources on analysis tools.

- **The analysis may be performed at the work zone, corridor, and/or network levels.** Work zone impacts issues and measures that may be considered in the analysis include:
  - *Work zone related safety impacts induced by the project* (e.g., expected crashes, crash rate). It may not be possible to perform an accurate estimation of transportation safety impacts because of the various factors that influence crash occurrence, especially in and around work zones. However, analysis tools are capable of providing order-of-magnitude estimates based on several factors including highway capacity, traffic demand, trip distribution and attraction patterns, quality of highway safety features, and the presence of special safety improvement strategies/technologies. For example, a lane-closure for road construction may change the traffic dynamics on a particular corridor. Analysis tools may be useful for assessing the safety impacts of various project options.
  - *Work zone related mobility impacts induced by the project* (e.g., traffic volumes, travel time, delay, travel time reliability/variability, vehicle miles traveled (VMT))
  - *Work zone related societal impacts* (e.g., additional fuel consumption, air-quality, and other environmental impacts.)
  - *User-costs of the above work zone impacts* (i.e., dollar value of the safety, mobility, and societal impacts using average dollar figures for parameters such as cost of crashes, value of time, cost of fuel, cost of emissions, etc.)

The conversion of safety, mobility, environmental, fuel consumption, and other impacts into equivalent dollar values is an accepted practice in the transportation profession to estimate benefits and costs of proposed investments, as well as to justify the need for the investments. The same rationale may be applied here, wherein, the user costs of work zone impacts and the monetized benefits of the work zone management strategies may be used to justify the additional funds required to reduce and manage the user costs. More information on user-costs and user-cost calculations is available online at the following web sites:

- FHWA's QuickZone web site, located at <http://www.tfhrc.gov/its/quickzon.htm> (Accessed 01/06/06)
- FHWA's ITS Benefits and Costs databases, located at <http://www.itsbenefits.its.dot.gov/> and <http://www.itscosts.its.dot.gov/> (Accessed 08/23/06)
- FHWA Office of Planning web site, located at <http://www.fhwa.dot.gov/planning/> (Accessed 01/06/06)
- The IDAS web site located at <http://idas.camsys.com/> (Accessed 01/06/06)

- *Life-cycle cost implications* (i.e., taking into account the work zone impacts of building the project, as well as the work zone impacts of performing periodic maintenance on the facility over the life of the project.)
- *Benefits that may be attained by using specific work zone management strategies* (e.g., the IDAS model predicts that traffic incident management systems can reduce incident duration by about 51%, fatality rates by about 21%, and fuel consumption and major pollutant emissions by 42%<sup>5</sup>).



The Michigan Department of Transportation (MDOT) conducted an evaluation of its construction mitigation for the reconstruction of I-496 in Lansing, Michigan. The IDAS model was used for the analysis. It was estimated that the construction project would have resulted in negative impacts to user mobility, safety, fuel consumption, and emissions amounting to about \$13 million over the life of the construction. MDOT's construction mitigation included a public outreach campaign, a temporary ITS system for construction traffic management, and upgrades to arterial operations on alternate routes. The analysis estimated that these efforts resulted in user mobility, safety, fuel, and emissions savings of about \$11 million, mitigating a good portion of the estimated \$13 million negative impact of the construction that would otherwise have occurred. The overall benefit-cost ratio was estimated at approximately 3:1. In this case, the analysis was conducted after the project was completed. However, the same methodology may be used to conduct analysis during systems planning and/or future project development activities, to estimate potential benefits of an agency's construction mitigation efforts, and also to justify the need for specific management strategies.

Source: Federal Highway Administration, ITS Deployment Analysis System Case Study 2: Michigan Department of Transportation Evaluation of the Temporary ITS for the Reconstruction of I-496 in Lansing, Michigan, April 2002. URL: <http://www.camsys.com/idas/CaseStudies/CaseStudy2/caseStudyFrame.htm> (Accessed 09/13/05).

- **The analysis may be combined with an ongoing project study such as a corridor/sub-area study, EIS, MIS, etc.** Generally, the mitigation measures discussed in an EIS must cover the range of impacts of the proposal and address issues such as design alternatives that would decrease pollution emissions, construction impacts, esthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. For example, corridor analyses and environmental impacts assessments for major new facilities or reconstruction are likely to require detailed corridor traffic management plans to address the traffic disruption caused by potentially years of construction and work zones that affect the capacity of the corridor to meet its travel demand. This may be reflected in the need to expand capacity and improve facilities along alternate travel paths in the short term, or provide travel alternatives such as increased transit service or High Occupancy Vehicle (HOV) use should also be reflected in the TIP.



The Colorado Department of Transportation (CDOT) prepared a Preliminary Environmental Impact Statement (PEIS) for the I-70 Mountain Corridor project. One specific aspect of the PEIS is a technical report on Construction Traffic Impact Mitigation Strategies, which addresses the potential impacts that may be caused during construction, and presents a set of strategies that may be used to mitigate those impacts. It also consists of a list of resources on construction impacts mitigation, as well as a brief overview of how construction impacts were addressed in different EISs conducted by other agencies.

Source: I-70 Mountain Corridor PEIS Construction Traffic Impact Mitigation Strategies, April 13, 2005.  
URL: [http://www.i70mtncorridor.com/documents/12%7EConstruction\\_Mitigation.pdf](http://www.i70mtncorridor.com/documents/12%7EConstruction_Mitigation.pdf) (Accessed 01/04/06).

Once work zone impacts analysis is complete, appropriate work zone transportation management strategies may then be identified in Step 4. The link between Steps 3 and 4 is bi-directional as it represents an iterative process to conduct the work zone impacts analysis in conjunction with the work zone management strategies. For example, an agency may want to analyze whether the use of a work zone traffic incident management system would mitigate the work zone impacts sufficiently enough for work to be performed during the day instead of night.



**TIP:** Design/construction personnel can provide valuable input regarding the influence of design and construction issues in analyzing the work zone impacts of a project.

## □ Step 4 of 6: Identify Potential Work Zone Management Strategies

This step involves the conceptual identification of potential work zone management strategies based on the impact assessments conducted in the previous steps. This conceptual identification needs to be sufficient enough to estimate the costs of the management strategies for future programming into transportation plans. Agencies may arrive at this step directly after the screening-level assessment in Step 2, or after conducting further quantitative analysis in Step 3. In either case, at this point enough information should be available on the potential work zone impacts of the project/ alternative, so that decisions can be made on the work zone management strategies that may be needed for the TMP. At this stage of assessment, the purpose is to identify the management strategies and estimate their costs at a high-level – not to develop the TMP. So, the level of effort is expected to be minimal compared to that required for actual design and development. Often, it may just involve a compilation of the work zone impacts issues from the previous steps, quick identification of appropriate management strategies, and estimation of their costs based on simplistic procedures and available data.

The following provides a general idea about the issues that need to be addressed in identifying work zone management strategies:

- **TTC Strategies.** The Rule requires TMPs for all projects to consist at least of a TTC plan. Therefore, TTC strategies need to be identified for all projects. This involves conceptual decisions on issues such as potential construction approaches, traffic control and management approaches, and time of construction.
- **TO and PI Strategies.** As per the Rule, TMPs for significant projects must address TO and PI components. TO and PI components are encouraged for all other projects as appropriate. For example, a project may be expected to have moderate work zone impacts. For such a project an extensive TMP may not be required, but some elements of TO (e.g., work zone traffic incident management) and PI (e.g., use of a web site for information dissemination) may be needed. In this step conceptual decisions need to be made on what TO and PI strategies may be needed.
- **Coordination Strategies with Other Projects.** This includes the identification of issues such as project inter-dependencies, schedule coordination, aggregation of multiple projects, corridor-level and network-level coordination, etc.
- **Costs for the Management Strategies.**
  - Generally, costs for TTC strategies are estimated as a percentage of total construction costs. Agencies have been following this approach for many years, and are generally equipped with the necessary data to perform this estimation.
  - Costs for TO and PI strategies may have to be estimated based on the agency's past experience in deploying TO and PI strategies for both work zone and non-work zone related activities. Information from prior implementations by other agencies may also be used as appropriate.

The Intelligent Transportation Systems (ITS) Benefits Database and Costs Database, maintained and updated by the FHWA's Joint Program Office (JPO), provide several resources for benefit and cost estimation for a range of TO and PI strategies.

The databases are available at <http://www.itsbenefits.its.dot.gov> and <http://www.itscosts.its.dot.gov> (Accessed 08/23/06).

More detailed information about the different work zone management strategies is provided in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).

Step 4 is the culmination of the work zone impacts assessment during the alternatives evaluation stage. After the assessments in Steps 1 through 4, the work zone impacts issues, management strategies and costs that have been identified for the respective alternatives should be included in selecting the best alternative to serve a particular transportation improvement need. Work zone impacts issues may also be officially noted in the record-of-decision (ROD) for a project. In choosing alternatives, agencies are encouraged to consider the maintenance of the alternative over its life-cycle as a decision-making factor. For example, if an alternative has a longer life-cycle and/or requires less maintenance, it may be preferred over other alternatives. Examples of features that facilitate more efficient maintenance and operations include wider shoulders, designated pullouts, and wider bridges. The selected projects are then passed on to the next stage for plan/program level assessment.

#### □ **Step 5 of 6: Perform Plan/Program Level Work Zone Impacts Assessment**

This step represents the assessment that may be performed during project prioritization and plan/program development. Here, the work zone impacts of individual projects (from the previous steps) are used to assess work zone impacts that apply at the plan/program level. Examples include corridor/network, sub-area, regional impacts, and project scheduling and coordination issues. The staff who perform these activities generally include community planners and systems-level planners belonging to State DOT Planning departments, MPOs, and county-level planning commissions/organizations. Once this assessment is performed, individual projects can then be programmed into appropriate transportation plans/programs (i.e., STIP, TIP, etc.) along with a line item budget for work zone transportation management and a note of any coordination issues that may be needed.

The objective of the assessment at this stage is to identify and address the combined and/or inter-relational work zone impacts of projects identified in a transportation plan/program. The assessment may be performed by coordinating and consulting with appropriate regional stakeholders, including MPOs, local jurisdictions, regional TMCs, emergency services, business representatives, community representatives, contractor associations, and AAA. The types of issues that may be addressed during this assessment include:

- **Combined work zone impacts of multiple concurrent projects on an influence area (corridor, network/subarea, regional, and/or Statewide).** Concurrently active projects may be geographically spaced such that they are likely to impact each other. In other cases the key alternate route for a particular project might also be under construction at the same time, thereby posing a conflict and leaving the alternate route incapable of handling diverting traffic. An early understanding of the combined impacts of concurrent projects on an influence area at this stage of systems planning can help an agency take appropriate actions to minimize and/or eliminate those impacts. Examples of such actions include:

- **Aggregating projects.** For example, if multiple projects are identified for the same corridor, they may be combined into one project, provided the project purposes are reasonably similar and justify such combination through reduced construction time and/or overall cost. Generally, such aggregation is done to combine multiple contracts and reduce construction time and cost. The distance between multiple work zones along the same corridor is an important traffic flow and mobility consideration. Inadequate spacing between work zones can hinder traffic flow recovery between work zones. Consolidation of work zones can help solve this problem, and also reduce the number of approach/merge areas, resulting in smoother traffic flow.
- **Identifying project interdependencies.** For example, a particular arterial route may have been identified as an alternate route for a repaving project on a freeway corridor. However, the arterial route itself may need certain upgrades (e.g., traffic signal system upgrades, addition of turn lanes) to be able to handle the diverted freeway traffic. The early identification of this issue during the plan/program level work zone impacts assessment may lead to the programming and scheduling of the arterial route improvements before the freeway project.
- **Adjusting project schedules.** For example, if two different projects are scheduled for the same location at different times (e.g., the first project in year 1 and the second in year 2), it may be feasible to combine the two projects to reduce the number of times that a work zone will have to be setup at the same location. In other cases, it may be desirable to stagger the schedule for two nearby projects that would otherwise have occurred concurrently. If the two projects are done at the same time, it may be difficult for the local transportation network to handle the travel demand. Accelerating or delaying one of the projects to a different time or construction season can be considered to lessen the severity of impacts at any one time.
- **Coordinating the management strategies for multiple projects.** This opportunity may be used to identify common management strategies for multiple projects, potentially resulting in cost savings (e.g., use of the same public relations/information contract for concurrent projects along a corridor). Another example is the sharing of work zone traffic incident management resources across projects that are in the vicinity of each other.
- **Work zone impacts on other transportation infrastructure and junctions.** Examples include increased mass transit demand during construction and impacts in and around train stations and bus stops.
- **Other regional issues.** Examples include the impacts of work zones on known special events, tourist traffic, and holiday traffic, and the effects these factors have on work zones.

This assessment may be performed either qualitatively or quantitatively. Qualitative assessment may be done by examining all concurrent projects in the plan/program to identify potential conflicts, combined impacts, alternate route issues, etc. The use of a fatal-flaw analysis technique is very applicable in this situation to identify any fatal flaws that may lead to future work zone issues during implementation. Quantitative analysis may be performed using an approach similar to that described in Step 3, the only difference being that in this case, the analysis is more focused on combined impacts of multiple projects. The analysis tools presented in Step 3 are also applicable for this analysis. Upon completion of the assessment, the plan/program may then be adjusted and modified accordingly to minimize and/or eliminate the combined and inter-relational work zone impacts of concurrent projects.



At the California Department of Transportation (Caltrans), impacts to road users are first identified during long range planning at the District level in the Transportation Corridor Study (TCR), the District System Management Plan (DSMP) and in the Transportation System Development Program (TSDP). In these documents, future planned and programmed projects are discussed along with any issues associated with them. These documents are part of the basis for short range planning for Project Study Reports (PSR) or Project Scope and Summary Reports (PSSR). These plans are circulated to the local agencies affected in the region, which allows for further discussion regarding particular impacts of the various proposed and programmed projects.

Source: Caltrans comments in response to the FHWA Advance Notice of Proposed Rulemaking (ANPRM) on Work Zone Safety, June 6, 2002, United States Department of Transportation (U.S.DOT) online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf81/176155\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/176155_web.pdf) (Accessed 01/04/06).

## □ Step 6 of 6: Compile Planning-Level Work Zone Strategy

This step represents the culmination of the systems planning level work zone impacts assessment, and involves the compilation of the information from the prior five steps into a planning-level work zone strategy. The information that comprises the planning-level work zone strategy may be retained by both the road-owner agency and the regional planning entity, as appropriate. The road-owner agency may then use that information for further assessments during preliminary engineering and design, while the regional planning entity may use the information for budgeting and financing and to track projects and update plans/programs.

The planning-level work zone strategy may generally consist of the following information:

- **Project Definition.** This includes the location, type, expected duration, length, and other details that pertain to where the roadwork will be performed and the type of work. This information can be grouped under three categories, namely – Project Scope, Traffic/Roadway Characteristics, and Other Influencing Factors.
- **Potential High-Level Construction/Traffic Control Approach(es).** These represent the potential alternative(s) to construct the project, based on information available at the planning stage. For example, it may be apparent at the planning stage that a particular project will need to be performed at night, or that, the project will likely require full-closure over multiple weekends. This may also include a conceptual definition of the construction approach(es), such as whether to use asphalt pavement or concrete pavement, or whether to use pre-cast concrete members or cast-in-place concrete members.
- **Expected Work Zone Impacts.** This includes documentation of the anticipated work zone impacts of the project, based on the planning-level impacts assessment performed for that project. It may be a qualitative assertion of the anticipated impacts or a quantitative summary of the anticipated impacts, depending on agency policies and/or procedures and the type and complexity of the project.

- **Significant Project Status.** This identifies whether the project is a significant project.
- **Potential Transportation Management Strategies for the Work Zone.** This documents the potential transportation management strategies that have been identified as part of the planning-level impacts assessment for the project. Documentation of the expected benefits of the strategies or how they will mitigate the work zone impacts of the project will also be useful to understand the impacts of the project with and without the strategies. This may be a good selling point to obtain the required funding for the strategies. This information may be presented qualitatively or quantitatively as appropriate.
- **Planning-Level Cost Estimate for the Identified Transportation Management Strategies.** Planning-level cost estimates are typically based on previously available information and/or thumb-rule methods that help estimate costs of work zone transportation management strategies (e.g., as a percentage of total project cost). The identification of specific potential transportation management strategies for a project will help perform this cost estimation in a more structured manner, and will also help ensure that sufficient funds for work zone mitigation are allocated when the projects are being programmed into long-range and short-term transportation plans.

Agencies may not be able to identify all of these components that constitute the planning-level work zone strategy, and the level of detail available on these components may also be limited. This need not be a deterrent to performing work zone impacts assessment during systems planning. The idea is to identify as much information as possible to conceptually define the work zone. This will help provide a rational link between systems planning and project development, allow engineers and designers to design projects better, and potentially avoid under-allocation of funds for work zone mitigation and management.



When developing transportation plans, the Wisconsin Department of Transportation (WisDOT) considers impacts on road users by doing the following: 1) coordinating project schedules to avoid construction on alternate routes simultaneously, 2) avoiding construction activities during peak travel periods, and 3) planning and funding congestion mitigation measures. To support better decisions on project scheduling and staging, more documentation of the costs of nighttime work compared to daytime work is needed.

Source: WisDOT comments in response to the FHWA Advance Notice of Proposed Rulemaking (ANPRM) on Work Zone Safety, May 31, 2002, United States Department of Transportation (U.S.DOT) online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf81/176160\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/176160_web.pdf) (Accessed 01/04/06).



**TIP:** The application of the work zone impacts assessment process to a project in the systems planning stage may result in more than one planning-level work zone strategy, in which case, each of the options may be carried over to the programming stage.



## 5.0 Work Zone Impacts Assessment During Preliminary Engineering

### 5.1 What Happens During Preliminary Engineering?

Preliminary engineering is the first stage in project development. This is the stage when designers and project planners conduct early project-level planning and develop an overall design concept of what the new facility would look like. At this stage, projects that are identified in systems planning are handed over to the respective project planners and designers to further develop the project. The main objective is to identify ways to implement the project, and develop appropriate plans and design concepts. Therefore, during preliminary engineering more project-specific information is collected and synthesized.

The key difference between systems planning and preliminary engineering is that, in systems planning transportation improvement needs are identified, potential alternative solutions are developed and evaluated, and the best alternatives are chosen for further development and implementation. Therefore, the focus of systems planning is to identify projects. In preliminary engineering, planning is done at the project-level to identify and develop ways to implement the solution, identify potential issues/obstacles, and develop an implementation concept for the project. The focus of preliminary engineering is to identify ways to implement projects.

Preliminary engineering is also referred to as the first stage of design. Project design is an iterative process with several design stages. Some States refer to these stages as the 30% (preliminary engineering), 60%, 90%, and final design stages. Preliminary engineering and the subsequent design stages are generally performed by similar staff, i.e., project planners and designers belonging to the design/engineering departments of transportation agencies, either at the central office or the region/district level. Their primary responsibility is to plan, develop, and design specific projects. Often preliminary engineering and design take place in tandem without a clear-cut distinction between the stages. This document however discusses work zone impacts assessment for preliminary engineering and design in separate chapters. This was done to emphasize the importance and potential benefits of specifically advancing work zone considerations to the preliminary engineering stage, and to highlight some of the early work zone impacts assessment activities that may be performed during preliminary engineering. Such advancement of work zone considerations could make project development and work zone impacts assessments more systematic. The discussion of work zone impacts assessment separately for preliminary engineering and design is not intended to imply that decision-making by transportation agencies is highly compartmentalized.

Major preliminary engineering activities include:

- Conducting early project-level planning activities (e.g., collecting data, reassessing the project purpose and definition, conducting site visits and site investigations).
- Further defining project needs (e.g., identifying the type of pavement, identifying the required thickness for the overlay).

- Identifying build options for the project (e.g., rebuild on existing right-of-way (ROW), realign roadway, use of multiple contracts vs. a single contract).
- Identifying other impacts and coordination issues (e.g., environmental, utility, ROW).
- Identifying potential construction and traffic control approach(es) (e.g., reduced width construction, night work, cross-over construction, weekend closures).
- Developing preliminary design concept(s) based on the above activities; and
- Developing a preliminary cost estimate for the project.

For some projects preliminary engineering activities may overlap with systems planning and/or design (e.g., large regionally significant projects that require multi-year planning, preliminary engineering and design studies).

## 5.2 Objectives of Work Zone Impacts Assessment During Preliminary Engineering

The bulk of work zone impacts assessment has typically taken place during the later design stages of project development. This can be a problem if work zone issues identified during the later design stages lead to changes in overall project approach. Often times, designers and construction staff express frustration when they encounter issues that could delay project development and/or implementation. For example during design if it is identified that an alternate route chosen for a particular project will also be under construction at the same time, the entire transportation management approach for the project may have to be changed, potentially resulting in project delays and increased costs. If such issues are identified just prior to, or during construction, it could be even more problematic because construction may have to be stopped on the project. As a result, sometimes in order to keep the project moving, decisions may be made that may not best address the work zone safety and mobility needs of the project.

In light of the above, agencies are increasingly trying to address and at least identify more of the work zone impacts issues during preliminary engineering.



The Washington State Department of Transportation (WSDOT) develops a Work Zone Traffic Control Strategy early in project development during a required project design conference attended by traffic engineers, law enforcement officials, and construction engineers. The strategy addresses issues such as the number of lanes that can be closed, hours of the day and days of the week when work can occur, level of service (LOS) to be provided during construction, and the need for night operations. The development of such an overall work zone strategy early in project development ensures that the identified issues are considered in design, and later in developing the traffic control plan (TCP). A checklist has been developed to alert people to the various strategies available. This approach also helps earmark funds early in project design to cover the cost of providing adequate safety and mobility.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/05/06).

The key to work zone impacts assessment during preliminary engineering lies in advancing work zone considerations as early as possible in project development; identifying the potential work zone impacts of the project early enough so that work zone related project delays or costs are not incurred in later design stages; and identifying and developing work zone management strategies in a more streamlined manner.

The following are the objectives of work zone impacts assessment during preliminary engineering:

- Using the preliminary engineering development information (e.g., concept plans, preliminary designs, location and design documents, environmental/NEPA assessments) to further incorporate work zone impacts considerations in choosing build options for the project and identifying potential construction staging approach(es).
- Reassessment/identification of the potential work zone impacts of the project.
- Reassessment/confirmation of significant project<sup>1</sup> designations.
- Reassessment/identification of potential work zone management strategies.
- Further identification of coordination issues with other projects, and other coordination issues (e.g., utilities, enforcement, environmental, ROW, community impacts).
- Reassessment/estimation of the cost of the identified work zone management strategies, and development of high-level implementation plans for the strategies.

Assessing work zone impacts during preliminary engineering may answer questions such as:

- Is the project definition any different than what was identified during systems planning and are there additional work zone impacts issues that need to be addressed?
- Given the concept design for the project, what are the possible construction staging and traffic control approaches that I can use for the project?
- What are the work zone impacts implications of the potential construction staging and traffic control approaches?
- Given that the project strategy has changed from what was originally assumed during systems planning (e.g., decision is made to build the project at night), are the work zone impacts any different now, and are there additional issues that I should address?
- Based on the concept design and potential construction and work zone traffic control strategies, is the originally assumed designation of significant project still valid for my project, and should I re-examine the work zone management strategies that were identified during systems planning?
- Are there any other concurrent projects nearby that were not identified during systems planning and may have an impact on my project or vice-versa (e.g., based on an updated version of the transportation plan/program for the region)?
- Based on site visits, are there any other coordination issues such as utilities, environmental, ROW, and community?

<sup>1</sup> 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 based on the respective agency's policy and/or engineering judgment. This definition, provided in Section 630.1010 of the Work Zone Safety and Mobility Rule (the Rule), also specifies that all Interstate system projects within the boundaries of a Transportation Management Area that occupy a location for more than three days and have lane closures are significant.

## 5.3 Who are the Participants?

The staff that may perform the work zone impacts assessment during preliminary engineering, the inputs and input providers, and the outputs and users of the outputs are shown in Table 5.1.

<p>Preliminary engineering assessments are generally performed by the project design and construction team. This includes:</p> <ul style="list-style-type: none"> <li>■ Project planners and designers.</li> <li>■ Highway engineers and safety engineers.</li> <li>■ Construction engineers, traffic engineers, and intelligent transportation systems (ITS) and operations engineers.</li> <li>■ The environmental bureau of the agency.</li> </ul>	
Inputs	Input Providers
<ul style="list-style-type: none"> <li>■ Applicable policies.</li> <li>■ Systems planning outputs, to include the conceptual planning level work zone strategy.</li> <li>■ Project specific definition information that becomes available during preliminary engineering (location, project limits, duration, type of work, known constraints, etc.).</li> <li>■ Preliminary engineering development information (concept designs, base plans, identified structural needs, ROW issues, potential environmental issues identified in early assessments, utility and sub-surface information, soil and hydraulic investigations, etc.).</li> </ul>	<ul style="list-style-type: none"> <li>■ All personnel responsible for the scoping, project need identification, mitigation measures identification, and early cost estimation of individual projects will provide input. This includes designers, pavement managers, bridge managers, traffic engineers/managers, safety engineers, planners, and maintenance managers. Specifically, these staff will have to determine what exactly needs to be done on the project (e.g., for a repaving job, whether a 2-inch overlay will be sufficient or something more complex is needed).</li> <li>■ Technical specialists such as pavement experts, soil experts, hydraulics engineers, environmental experts, construction engineers (at a high level of participation), utility coordination personnel (i.e., water, sewage, power, gas, telecom infrastructure), and those working on ROW issues.</li> <li>■ Other stakeholder groups such as local community and business representatives, trucking associations, American Automobile Association (AAA), public safety agencies, and contractor representatives.</li> </ul>
Outputs	Users of the Outputs
<p>The output is the preliminary work zone strategy, which consists of:</p> <ul style="list-style-type: none"> <li>■ Refined project definition.</li> <li>■ Potential work zone impacts of the project.</li> <li>■ Reassessment/confirmation of whether significant project.</li> <li>■ Potential construction staging and traffic control approach(es).</li> <li>■ Potential work zone transportation management strategies.</li> <li>■ Coordination and scheduling issues with other projects.</li> <li>■ Other coordination issues (utilities, environmental, ROW, community impacts, etc.).</li> <li>■ Cost estimates and high-level implementation plans for the work zone management strategies.</li> </ul>	<p>The users of the output constitute the project design and construction team, including:</p> <ul style="list-style-type: none"> <li>■ Project planners.</li> <li>■ Designers.</li> <li>■ Highway engineers.</li> <li>■ Traffic engineers, ITS engineers, and operations staff.</li> <li>■ Safety engineers.</li> <li>■ Construction engineers.</li> </ul>

**Table 5.1 Preliminary Engineering Assessment Participants**

## 5.4 Assessment Process

Figure 5.1 illustrates the steps involved in work zone impacts assessment during preliminary engineering. Some notes pertaining to the figure are presented in Table 5.2.

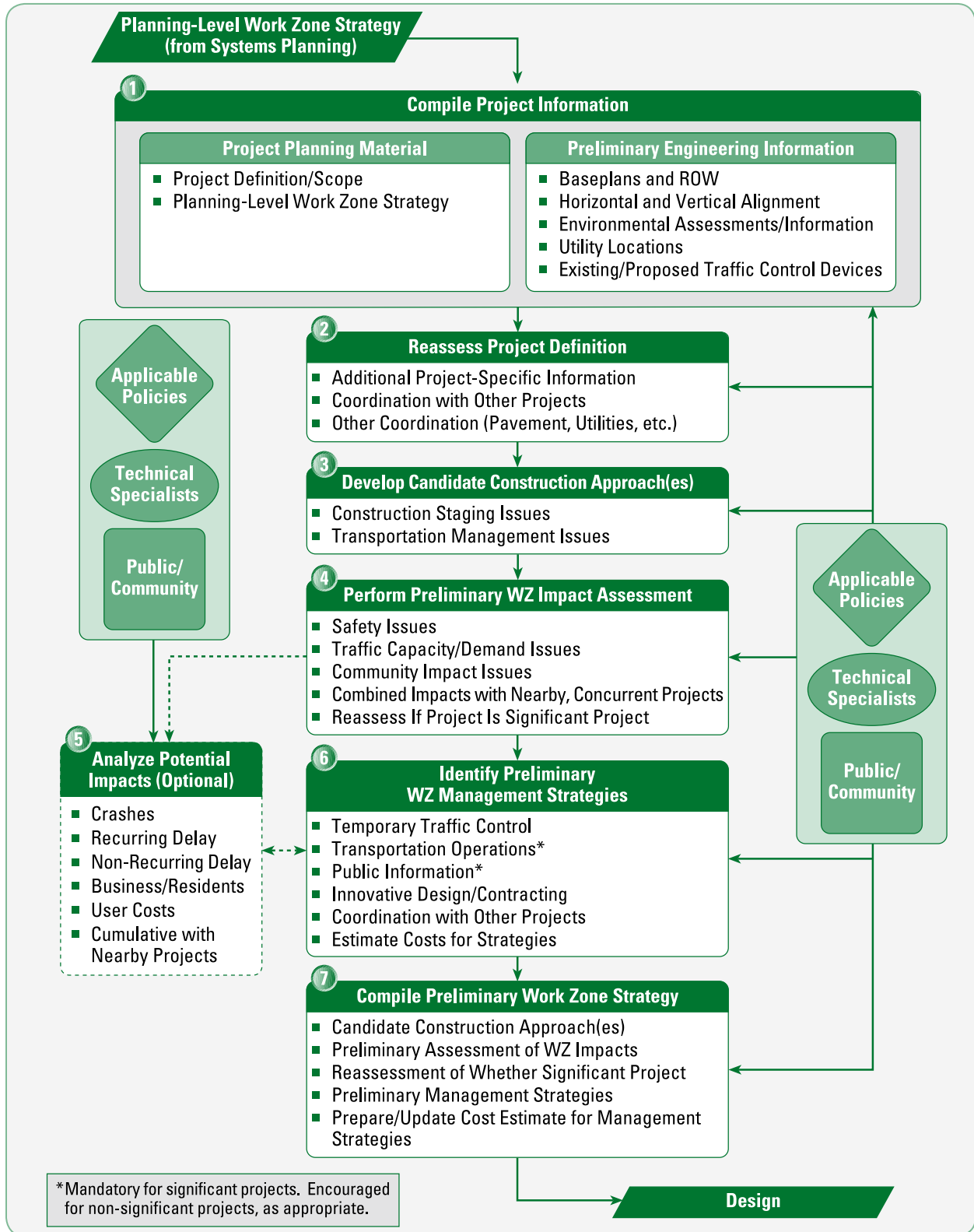


Figure 5.1 Preliminary Engineering — Work Zone Impacts Assessment Process

## Process Notes for Preliminary Engineering

**At a glance, the preliminary engineering process diagram (Figure 5.1) may resemble the systems planning process diagram (Figure 4.2).** Though the process steps, the types of issues, and the outputs of the assessment may seem similar, the key difference is the extent to which those issues are addressed. More project-specific information becomes available in preliminary engineering, and the work zone impacts assessment needs to reflect that. For example, preliminary engineering site visits and surveys may indicate the need for utility relocation prior to construction. The time needed for the utility relocation could extend the project schedule into a heavy travel weekend (e.g., holiday weekend). As a result, the project strategy may have to be revised to either adjust the schedule to avoid the holiday weekend, or include appropriate traffic management strategies to accommodate holiday traffic during that weekend.

**Input from and interaction with appropriate sources** (as shown in Figure 5.1) may be required during the assessment as follows:

- **Applicable Policies**, shown as a green diamond in the diagram, represents the agency's policies and related policy provisions (i.e., policy requirements, standards, and/or guidance) and appropriate processes, procedures, and practices that apply to the particular activity. They help with decision-making on specific issues during the process, such as the level of impacts assessment and the type of management strategies needed for different projects. For example, an agency's policy may recommend that any utility related coordination and/or relocation issues need to be addressed during early project planning and site visits, so that appropriate actions can be taken to resolve the issues. Section 3.4 of this document provides a brief discussion on potential policy provisions for application during project delivery.
- **Technical Specialists**, shown as a green ellipse in the diagram, represents input from specialists in specific disciplines including highway engineers, construction engineers, traffic engineers, structural engineers, pavement specialists, environmental specialists, ROW specialists, and hydraulics engineers. Participation of such staff in the preliminary engineering work zone impacts assessment may lead to decisions that carry over to subsequent project phases without significant alteration.
- **Public/Community**, shown as a green square in the diagram, represents input from the general public including motorists, other highway users, businesses, residents, neighborhood groups, etc. This input may be provided through public involvement processes, customer feedback efforts, surveys, focus groups, etc.

**The interface between preliminary engineering, systems planning, and design may be fluid.** Decision-making and activities from one phase may overlap with or extend into the other. Further for some projects, systems planning, preliminary engineering, and/or design activities may be conducted as part of the same study (e.g., large regionally significant projects that require multi-year studies).

**Agencies may combine work zone impacts assessment with environmental/NEPA assessments.** Generally, agencies prepare three types of environmental reviews under NEPA: Categorical Exclusions (CE) for small, routine projects with insignificant environmental impacts; Environmental Assessments (EA) for projects with no significant environmental impacts; and Environmental Impact Statements (EIS) for projects with significant environmental impacts. The opportunity exists to combine work zone impacts assessment with the environmental/NEPA assessments. Sometimes the NEPA process can be a primary source of work zone related constraints or inputs for the project. Example of issues that may be addressed include how work zone impacts tie into the project location and design process and how work zone impacts are weighed against other socio-economic/environmental impacts and other project considerations. More information on NEPA is available at <http://www.environment.fhwa.dot.gov/projdev/index.asp> (Accessed 12/22/05)

**Preliminary engineering work zone impacts assessment may result in more than one preliminary work zone strategy,** in which case multiple options may be carried over to the design stage for further investigation and analysis.

Table 5.2 Process Notes

The following sections provide a brief explanation of the process.

## □ Step 1 of 7: Compile Project Information

Compilation of available project information includes:

- **Project planning material from the systems planning phase.** This material includes the project definition and scope and the systems planning level work zone strategy. In essence, the systems planning-level work zone strategy will now be refined based on more project-specific information to develop the “Preliminary Work Zone Strategy.” This preliminary work zone strategy will have more project-specific detail and will serve as a foundation for the subsequent design stage. If the planning level work zone strategy is not available, information on the project definition/scope, roadway/traffic characteristics, and other contributing factors (public/community issues, weather considerations, special events, etc.) should be compiled as described in Step 1 of the Systems Planning process.
- **Preliminary engineering development information.** This is the concept design for the project, and consists of preliminary decisions on roadway alignment and ROW, cross-sectional details, elevation and super-structure details, and other information necessary to initially depict what the new facility will look like after it is built. In the case of preservation projects, the new facility may not be very different from the current facility. For rehabilitation, reconfiguration, and new projects, the vision of the new facility may be drastically different from the present state. The information that is collected in this stage is essential to be able to perform work zone impacts assessment in later steps and at later stages. The following are some examples of information that need to be collected and/or developed:
  - Engineering plans, documents, and supporting information that define the project environment in detail.
  - Information from available or ongoing studies and environmental/NEPA assessments (e.g., project constraints, impact mitigation requirements, recommended assessments and/or analyses).
  - Topographical, soil, and hydraulics information.
  - Existing and future roadway and traffic characteristics.
  - Base plans showing existing and planned roadway alignment, existing and planned ROW, existing and proposed traffic control devices (e.g., signs, signals, pavement markings), and existing and proposed overhead/underground utilities.
  - Information on other nearby transportation facilities and/or junctions (e.g., adjacent routes, highway interchanges/intersections, railroad crossings, rail stations, bus stops).
  - Coordination issues with other ongoing or planned projects.
  - Any other relevant information specific to the project location (weather, special events, etc.).



**TIP:** This step is a good checkpoint to reassess/identify if there are any policy provisions that apply to the project. For example, the agency may provide policy guidance on the different work zone impacts issues that need to be addressed during preliminary engineering.



The Texas Department of Transportation (TxDOT) provides guidelines on data collection/preliminary design in its Project Development Process Manual. Guidance is provided on obtaining the data necessary for making engineering and environmental decisions related to project design. TxDOT recommends that data collection be as complete as possible so that project solutions that provide the most benefit are selected. The activities that comprise data collection/preliminary design include: early coordination with stakeholders; preparation and execution of additional agreements; review of traffic data; obtaining right of entry; obtaining related data, plans, studies, and reports; conduct of a site visit; obtaining information on existing utilities; obtaining traffic accident data; obtaining hydraulic studies; obtaining aerial photography/planimetrics/digital terrain maps (DTMs)/digital orthophotography; and conduct of topographic and other surveys.

Source: TxDOT Project Development Process Manual, August 1, 2003. URL: [http://manuals.dot.state.tx.us/dynaweb/coldesig/pdp/@Generic\\_BookView](http://manuals.dot.state.tx.us/dynaweb/coldesig/pdp/@Generic_BookView) (Accessed 01/05/06).

## □ Step 2 of 7: Reassess Project Definition

This step involves performing a reality check as to whether the previously developed project definition (during systems planning) still holds true, given that there is more detail available on the project. Additional data may be collected in this phase in order to provide a more complete set of information with which to complete the assessment and evaluation of project and work zone issues. Examples of the types of additional data that may be required to reassess the project definition are:

- Additional traffic counts.
- Information from other projects and studies.
- Information related to project specific issues and concerns, such as:
  - Pedestrian counts in residential areas.
  - School bus schedules.
  - Existing incident response times from accidents in the project area.
- Coordination issues with other projects (within the impactable vicinity).

All data elements may not be required for all projects. The required data elements and the level of effort will depend on agency policy/procedures and on the type, duration, complexity, and expected work zone impacts of the project.

The following are examples of issues that may be considered in reassessing the project definition:

- Project purpose, location, extent, duration, nature of work, and type of work zone.
- Roadway alignment and ROW issues.
- Cross-sectional details, elevation and super-structure details.
- Related pavement and structural needs.
- Soil, hydraulics, and environmental needs.
- Utility related infrastructure and coordination issues.
- Design parameters.



### □ **Step 3 of 7: Reassess Project Definition**

This is where a preliminary decision as to how the project will be built is made and an overall strategy for the construction (e.g., phased construction, design-build) and the work zone type (e.g., night work, lane-closure, cross-over, full-closure) is developed. Until this step, most of the effort involved collecting systems planning level information, collecting preliminary design information, and verifying and re-examining prior assumptions. Given the information available at this juncture, the designer may now consider and develop candidate construction approach(es). The planning-level construction staging and traffic control approaches are revisited and potentially modified, and other alternatives are developed. Transportation management issues related to the project and candidate construction, staging, and traffic control approaches are also identified.

The types of issues to be considered in developing the candidate construction approaches are discussed in Step 2 of the systems planning process description in Section 4.5.

More information on different construction/traffic control approach(es) is available in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).



**TIP:** Construction personnel and/or contractor representatives (if allowable) can provide valuable input towards identifying the potential construction/traffic control approach(es) for a project.

### □ **Step 4 of 7: Perform Preliminary Work Zone Impacts Assessment**

Preliminary engineering is accomplished by conducting field investigations, surveys, and public/community outreach using the principles of highway and traffic engineering. This is also the phase where potential ROW acquisition issues; environmental impact/NEPA issues, including impact of the new facility and the construction project on the environment; and community impact issues, including impact of the new facility and the construction project on the community, are addressed. Therefore, this is a very suitable time to incorporate work zone impacts issues into the investigations and assessments that are already being performed. The information obtained from the assessments can help the agency take further action, such as establish the requisite teams, involve appropriate personnel, contact stakeholders, and take necessary actions to facilitate the availability and use of transportation management strategies for construction. For example, if it is determined that a work zone traffic incident management system/strategy will be necessary for the construction project, the agency may delegate that to their traffic operations staff who may begin assessing the traffic incident management needs for the project, in conjunction with the project design/construction team, and other appropriate stakeholders.

This step is expected to be a qualitative assessment involving a quick identification of work zone impacts issues, re-confirmation whether a project is a significant project (discussed in Table 1.1 and in Section 4.5 under Step 2 of 6), identification of potential work zone management strategies, and determination of whether more detailed (quantitative) work zone impacts analysis is needed. The assessment will be based on the candidate construction staging, traffic control approaches, and transportation management issues identified in Step 3, and will help flush out and identify potential concerns prior to the completion of partial design (e.g., 30% design plans). In later stages of design, designers may use the work zone issues and impacts identified in this step to “design their way out of” any potential problems or obstacles.

It is important at this stage to re-confirm whether a project is significant because more detailed project specific information is now available, which may change previous assertions/assumptions. For example, during preliminary engineering the project approach may be modified to construct the project at night as opposed to the planning level assumption of constructing the project during the day. As a result, the work zone impacts of the project may be lower than what was anticipated in the systems planning assessment, resulting in a re-classification of the project to a non-significant project. Conversely, an assumption may have been made during systems planning that designated a project as non-significant. Additional preliminary engineering data during this step may void that assumption, leading to a re-classification of the project as significant.

The activities that need to be performed in this step are similar to those of Step 2 of the systems planning process, where a screening-level work zone impacts assessment of alternatives is performed. The key difference between the systems planning and the preliminary engineering assessments is that in preliminary engineering the objective is to develop the best way to plan, design, and build a given project; whereas in systems planning, the objective is to identify alternatives that best meet a given need and have the least impacts from an environmental, work zone, and societal perspective. Extensive and well thought-out preliminary engineering and investigation leads to a better understanding of the project needs and potential impacts, and eventually leads to a better project design. The following are some examples of issues to consider. Refer to Step 2 of systems planning for more information.

- Is the project definition any different than what was identified during systems planning?
- If the project strategy has changed from what was originally assumed during systems planning (e.g., decision is made to build the project at night), are the work zone impacts any different now, and are there additional issues that I should address? Does the potential impact area (discussed in Step 2 of systems planning) of the project need to be reassessed or identified?
- Do ongoing (or completed) environmental/NEPA or other studies provide any constraints and information that may limit project location, design, and construction options?
- What are the safety implications (e.g., lane width issues, lane/shoulder closure issues, line-of-sight issues, horizontal and vertical curvature, ramp-closure issues) of the potential construction approaches?
- What are the traffic/mobility implications of the potential construction approaches? (e.g., lane closure restrictions, potential choke points, whether delays are expected, need for detour routes, potential impact on detour routes, potential impact on other transportation infrastructure such as railroad crossings and interchanges).

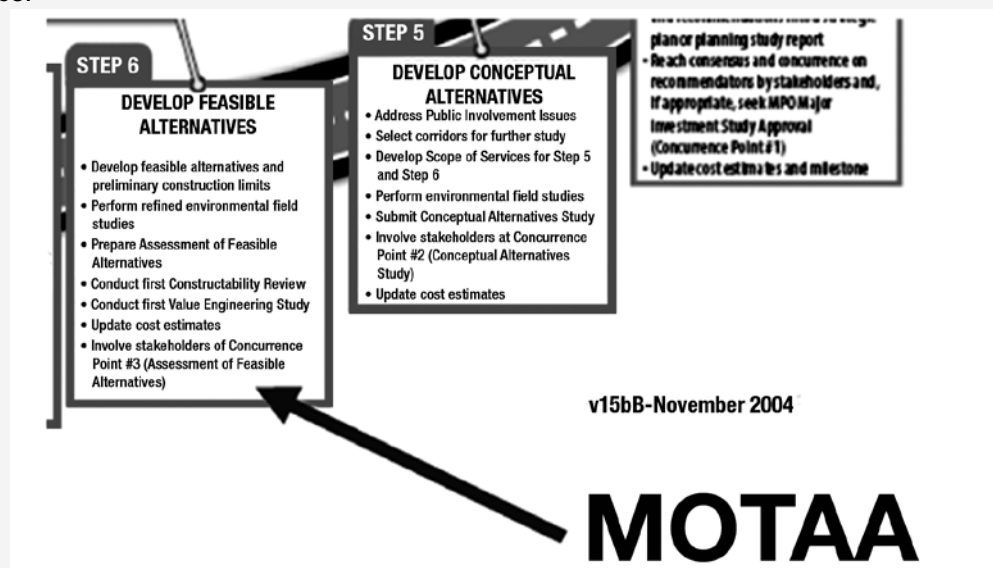
- Identify and list out major impacts (safety and mobility) of the project and possible mitigation strategies, including project/work zone design options, contracting strategies, and other mitigation measures.
- Based on the concept design and potential construction and work zone strategies, is the originally assumed designation of significant project still valid for my project?
- Based on site visits, are there any other coordination issues such as utilities, environmental, ROW, and community?
- Are there any obvious issues that can be addressed right away and noted down so that they need not be addressed in later design stages (e.g., history of high weekend traffic volumes at the project location due to tourist traffic as a result of which weekend lane closures may not be a good option)?
- The level of work zone impacts assessment needed for the project: Is a high-level (qualitative) assessment sufficient or will a more detailed (qualitative) analysis be needed?



The Ohio Department of Transportation (ODOT) has established a Maintenance of Traffic Alternatives Analysis (MOTAA) process. It involves the analysis of potential work zone impacts “constraints” and occurs prior to the first detail plan submissions. It occurs early enough so that MOTAA can be used to:

- Pick between feasible project alternatives;
- Size structure widths; and
- Highlight work zone right-of-way and environmental impacts early enough to do something about them.

The following illustrates how early in project development the ODOT MOTAA takes place:



Source: Transportation Research Board 84th Annual Meeting, Session 476: Work Zone Impacts and Mitigation Efforts, How One State DOT is Addressing Work Zone Impacts, Dave Holstein, Ohio Department of Transportation, January 11, 2005, URL: <http://webboard.trb.org/file.asp?file=David+Holstein%2Epdf> (Requires Login. Accessed May 30, 2006).

## □ Step 5 of 7: Analyze Potential Impacts (Optional)

Typically, work zone impacts assessment is not a major focus of preliminary engineering activities. Many agencies qualitatively identify the potential work zone impacts of the construction project, but do not necessarily analyze the impacts to any degree of detail. However, quantitative analysis does have its benefits, especially because more project-specific information is available during preliminary engineering, and any analysis conducted with this information can help the agency better understand the potential work zone impacts of the project. For example, preliminary engineering site visits, investigations, and conceptual design activities may yield more detailed (project-specific) information on aspects such as the exact scope of work for the project, design concepts, ROW issues, utility issues, environmental issues, traffic data and studies, and base plans. This kind of information is a big step-up from what is normally available in systems planning, and can be very useful to quantitatively understand the work zone impacts of a project before any major design work is accomplished.

In the process diagram (Figure 5.1), this step is shown as a box with dashed lines, which means that this step is optional. It is up to individual agencies to determine (in Step 4) whether or not quantitative analysis is needed, based on the type, complexity, and expected work zone impacts of the project. If it is determined (in Step 4) that further quantitative analysis is not needed, the agency would skip this step and proceed directly to Step 6. At this stage of project development, quantitative impacts analysis may generally be done for significant projects that are expected to have major impacts at the corridor, network, or regional levels, but this does not mean that it will not be needed for other projects. Any decision to analyze or not to analyze should be made on a project-by-project basis.



**TIP:** Sometimes, quantitative work zone impacts analysis during preliminary engineering may not be possible due to inadequate project detail and lack of data to perform the analysis. In such cases, the particular issue under investigation may be noted so that the staff that conduct assessments in subsequent phases are made aware of the issue.

The following are some examples of scenarios under which an agency may find it helpful to quantitatively analyze impacts during preliminary engineering:

- **The preliminary assessment in Step 4 may indicate that the project is a significant project,** and the agency may desire to obtain a better (quantitative) understanding of what the impacts may be so that appropriate work zone management strategies and their costs can be identified. This does not automatically mean that quantitative analysis is needed in this step if a project is identified as significant in Step 4; any decision should be made on agency policy and individual project needs.
- **It may not be very obvious during the preliminary assessment in Step 4 whether or not a project is significant.** So the agency may decide to further analyze the potential work zone impacts. For example, an agency may identify in Step 4 that a particular project would have significant sustained work zone impacts if performed during daytime hours, but likely would not if performed at night. So, in this step the agency may conduct a queuing and delay analysis to determine if it would be feasible to conduct the project at night without an extensive TMP.

- **To help the agency choose between multiple project design and construction options.** Examples include asphalt pavement vs. concrete pavement, white top vs. black top, narrow shoulders vs. wide shoulders (life-cycle costs), and cast in place concrete vs. pre-fabricated concrete.



The Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS) is a computer model intended to estimate the maximum amount (distance) of highway that can be rehabilitated or reconstructed within various closure timeframes. This model integrates pavement, construction, and traffic-related decision-making by balancing numerous constraints such as scheduling interfaces, pavement materials and design, contractor logistics and resources, and traffic operations. When combined with a traffic model, the CA4PRS software can help determine which pavement structures and rehabilitation strategies maximize on-schedule construction production without creating unacceptable traffic delays.

Source: A Computer Simulation Model: Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS), Report Prepared for California Department of Transportation (Caltrans), E. B. Lee, John Harvey, and C.W. Ibbs, February 2004, University of California at Berkeley, Institute of Transportation Studies, Pavement Research Center. URL: [http://www.ce.berkeley.edu/~eblee/CA4PRSMModel\\_Tech\\_021204.pdf](http://www.ce.berkeley.edu/~eblee/CA4PRSMModel_Tech_021204.pdf) (Accessed 01/06/06).

More information on CA4PRS is available at <http://www.dot.ca.gov/newtech/roadway/ca4prs/ca4prs.htm> (Accessed 01/06/06), and <http://www.ce.berkeley.edu/~eblee/CA4PRS.htm> (Accessed 01/06/06).

- **To help the agency choose between multiple traffic control and management approaches.** Examples include night work vs. daytime work, weekend vs. weekday, lane closure vs. no closure, and full closure vs. partial closure.
- **To justify additional funds for work zone transportation management for a particular project or to justify as to why a particular project will not have major impacts.** Analyses may help provide hard numbers for the potential work zone impacts, the resulting user-costs, and the amount of user-cost savings that the recommended management strategies may yield.

The following are some issues to be considered in conducting quantitative work zone impacts analysis during preliminary engineering:

- **Sketch-planning tools and deterministic tools may be most appropriate for this level of analysis.** Quantitative analysis at this stage is generally aimed at estimating the work zone impacts of the project (at a high-level) in and around the work zone, and/or the immediate transportation network within the impactable vicinity of the work zone. Therefore, sketch-planning tools and deterministic tools may be most suitable. Travel demand modeling tools may also be used, but they are generally intended for regional and/or metropolitan level analysis, and may not provide the desired level of analysis clarity. For example, some deterministic tools are capable of replicating and analyzing the impacts of the traffic control plan (TCP) for a project, including taper lengths, number of lanes, lane widths, shoulder widths, turning lanes, traffic signal information; and the use of different management strategies (e.g., ITS, demand management, real-time information.). However, travel demand modeling tools do not have this level of clarity and may not serve the purpose. Also, if agencies are interested in estimates of queue lengths, travel time, and delay, in addition to volume,

volume/capacity (V/C) ratios, vehicle miles traveled (VMT), and vehicle hours traveled (VHT), travel demand models may not serve the purpose. This does not mean that travel demand models cannot be used. This decision needs to be made based upon individual project needs and the types of information that the agency is interested in. Using travel demand models for the analysis may be better than conducting no analysis at all. Examples of tools that may be most appropriate for conducting quantitative work zone impacts analysis during preliminary engineering are:

- *Work Zone Specific Sketch-Planning Tools* such as MicroBENCOST, QuickZone, QUEWZ, and CA4PRS.
- *Deterministic/Highway Capacity Manual (HCM) Based Tools* such as Highway Capacity Software (HCS 2000), Assessment of Roundabout Capacity and Delay (ARCADY), Freeway Delay Calculation Program (FREWAY), and Dynamic Toll Plaza Queuing Analysis Program (Dqueue).
- *Generic Sketch-Planning Tools* such as the ITS Deployment Analysis System (IDAS), Screening for ITS (SCRITS), and IMPACTS.

If the project complexity and the desired level of accuracy for the work zone impacts estimation warrant a more detailed analysis (e.g., simulation), the agency may choose to do so depending on the availability of the data needed to conduct a low-level analysis. A traffic simulation tool like CORSIM would require additional information including trip tables, origin-destination patterns, and more details on the traffic control parameters. At the preliminary engineering stage, such detail may not always be available, and therefore simulation tools may not be suitable for this analysis. They may however be appropriate for use on larger projects where both preliminary engineering and design may take place in tandem.



QuickZone is a work zone delay estimation model developed by the Federal Highway Administration's (FHWA) Research, Development and Technology (RD&T) program. QuickZone helps project planners and engineers estimate delay, queuing and user costs associated with alternate work zone design and mitigation strategies. The kind of input data required include basic network definition data, traffic counts, high level work zone configuration (e.g., lane-closure details), and construction times. The user may add specific transportation management strategies, e.g., ITS, public information, and demand management strategies to estimate the benefits that may be obtained. Based on this information, the user may then run multiple scenario analyses to estimate delay, queuing, and user-costs of different potential construction and management strategies. More information on QuickZone is available at <http://www.tfrc.gov/its/quickzon.htm> (Accessed 01/06/06).

More information on analysis tools is provided in **APPENDIX B – Impacts Analysis Tools**.

- **The analysis may be performed at the work zone, corridor, and/or network levels.** Appropriate measures may be considered in the analysis for safety, mobility, societal impacts, road user-costs, life-cycle cost implications, and benefits of the work zone management strategies. Examples of different work zone impacts issues and measures are provided in the systems planning process description, under Step 3 of 6, in Section 4.5.
- **The analysis may be combined with an ongoing project study such as corridor/sub-area study, EIS, etc.** Environmental/NEPA assessments must cover the range of impacts of the project, and address issues such as design alternatives that would decrease pollution emissions, construction impacts, esthetic intrusion, relocation assistance, possible land use controls that could be enacted, and other possible efforts. Any work zone impacts analysis that is conducted during preliminary engineering may be combined with other such project assessments, can provide information towards effective completion of other assessments, and can use information and constraints that come out of the other assessments.



The New York State Thruway Authority (NYSTA) is studying the reconstruction of the NYS Thruway between Interchanges 23 and 24 to improve deteriorating conditions on the underlying roadway. Construction is expected to begin sometime in 2007, and the project is currently in the environmental study and review phase. An environmental assessment conducted by the NYSTA indicated potential impacts to wetlands, noise levels, increased storm water discharge, and archeological sites. Therefore a positive declaration was made to prepare an Environmental Impact Statement (EIS). Preliminary assessments indicate that if the proposed project goes forward an additional temporary lane may be required to maintain traffic during construction. The temporary lane may be converted to a permanent lane if the study concludes that this is the preferred alternative. The EIS scope identifies the need to examine the impacts of construction activities in and adjacent to the project area and identify appropriate mitigation strategies. The types of construction impacts to be considered include accidental spills including fuel spills; temporarily increased noise levels; temporarily degraded air quality; temporarily increased levels of dust in the air; erosion and sediment control; and traffic congestion.

Source: New York State Thruway Authority's web site for the Thruway Reconstruction Project between Interchanges 23 and 24. URL: <http://www.thruway.state.ny.us/projectsandstudies/projects/i23-i24/index.html> (Accessed 01/06/06).

Once the work zone impacts analysis is complete, appropriate work zone transportation management strategies may then be identified in Step 6. The link between Steps 5 and 6 is bi-directional as it represents an iterative process to conduct the work zone impacts analysis in conjunction with the work zone management strategies. For example, if a work zone traffic incident management plan is chosen as a strategy, the agency may perform a scenario analysis to estimate its benefits in terms of mitigating the work zone impacts of the project.

## □ Step 6 of 7: Identify Preliminary Work Zone Management Strategies

This step involves the preliminary identification of potential work zone management strategies based on the impact assessments conducted in the previous steps. Agencies may arrive at this step directly after the preliminary assessment in Step 4, or after conducting further quantitative analysis in Step 5. In either case, at this point enough information should be available on the project with regards to the potential design, construction/staging, overall work zone/traffic control approach, environmental issues, other coordination issues (utility, ROW, community/business impacts, etc.), and the resultant work zone impacts of the project. This information will be used to identify the management strategies and estimate their costs sufficiently enough to initiate the implementation plans for those management strategies.

The objective of this step is not to develop the TMP but to identify the potential management strategies that could constitute the TMP and take the necessary actions that set the basis for TMP development in subsequent design stages. So, the level of effort is expected to be minimal compared to that required for actual design and development. Often, it may just involve a compilation of the work zone impacts issues, quick identification of appropriate management strategies, estimation of their costs based on simplistic procedures and available data, and identifying resources and means to implement them. The discussion on identification of management strategies provided under Step 4 of 6 of the systems planning process in Section 4.5 can be used as a framework for identifying the management strategies.

This step may seem identical to the Step 4 of the systems planning process – and appropriately so, because the objective of this step and that of Step 4 of systems planning is essentially the same, which is to identify work zone management strategies for the project. The biggest difference is in the level of work zone impacts assessment. In systems planning the focus is on getting a conceptual understanding; whereas in preliminary engineering, the focus is on using more project-specific information to conduct the preliminary activities that help set the tone for actual design in subsequent stages. Another aspect to note in preliminary engineering is that in addition to identifying management strategies and estimating their costs, implementation plans for the management strategies are also initiated. For example, the management strategies that are identified in this step may include a work zone traffic monitoring system, work zone traffic incident management program, and a public information campaign including a web-based traveler information program. As part of initiating the implementation plan for the management strategies, the agency may investigate the possibility of using pre-existing traffic surveillance and detection devices for work zone traffic monitoring, initiate contacts with the agency's traffic operations group to develop concepts for the work zone traffic incident management program, and initiate discussions with the agency's information systems group to setup a web site for the project.

More detailed information about the different work zone management strategies is provided in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).



## □ **Step 7 of 7: Compile Preliminary Work Zone Strategy**

In this step, the information from the impact assessment conducted in the previous steps is compiled to develop a “Preliminary Work Zone Strategy” which consists of:

- The project definition.
- Candidate construction/staging and traffic control approaches.
- Anticipated/estimated work zone impacts.
- Preliminary transportation management strategies.
- Cost estimate for the transportation management strategies (may be one or multiple sets of strategies, depending upon whether there is more than one construction/staging alternative).
- High-level identification of implementation resources, challenges, and opportunities, and initiation of appropriate action items for the management strategies.

Potential coordination and/or conflicts with other projects may also be addressed. The alternative(s) that best suits the needs of constructability, safety, and mobility should be selected. In some instances, it may not be clearly evident that one particular alternative is most appropriate, in which case, multiple alternatives may be carried over to the design phase where more detailed investigation and analyses may be performed.



## 6.0 Work Zone Impacts Assessment During Design

### 6.1 What Happens During Design?

Design represents the stage in program delivery where the final design is conducted for the project and appropriate plan documents, specifications, and cost estimates are developed. These documents lay out exactly how the project will be built, what the issues are, and how the work zone will be implemented and managed. Design is an iterative process that consists of different stages, sometimes referred to by different percentages such as the 30% stage (preliminary engineering), the 60% and 90% stages, and then the final design for the project. Through the course of these design stages, final decisions are made on the best options for all the aspects of the project. Based on these decisions the final plans, specifications, and estimates (PS&Es) and the bid package are developed, followed by bidding and contract award.

The following is a summary of the activities that are performed during design:

- Conducting further analysis and design.
- Choosing the best build option.
- Choosing project design and contracting strategy.
- Addressing right-of-way (ROW) and other issues (e.g., utility relocation, coordination).
- Choosing specific design elements (e.g., structural, pavement, geometry).
- Developing construction staging plan(s).
- Developing plans for work zone traffic control and management.
- Developing final cost estimates.
- Developing PS&Es.
- Bidding and contract award.

Preliminary engineering and the subsequent design stages are generally performed by similar staff, i.e., project planners and designers belonging to the design/engineering departments of transportation agencies, either at the central office or the region/district level. Their primary responsibility is to plan, develop, and design specific projects. Often preliminary engineering and design take place in tandem without a clear-cut distinction between the stages. However, this document discusses work zone impacts assessment for preliminary engineering and design in separate chapters. This was done to emphasize the importance and potential benefits of specifically advancing work zone considerations to the preliminary engineering stage, and to highlight some of the early work zone impacts assessment activities that may be performed during preliminary engineering. Such advancement of work zone considerations could make project development and work zone impacts assessments more systematic. The discussion of work zone impacts assessment separately for preliminary engineering and design is not intended to imply that decision-making by transportation agencies is highly compartmentalized.

## 6.2 Objectives of Work Zone Impacts Assessment During Design

Design is the stage where the final work zone impacts assessment is conducted so as to choose the best construction/staging option(s), the most suitable design and contracting approach, and the most appropriate work zone transportation management strategies. The impacts assessment during design is an iterative process progressing through the various stages of design, and addressing the basic issues of safety, mobility, and constructability. Basic assumptions are re-examined and appropriate changes are made. Consensus of all involved parties is sought, and performance objectives for the work zone are developed.

Most agencies have extensive design manuals, customized versions of the Manual on Uniform Traffic Control Devices (MUTCD)<sup>1</sup>, and standards that help assess work zone impacts and develop appropriate work zone strategies. Typically these work zone strategies are limited to traffic safety and control strategies within the work zone or just adjacent to it. Transportation management strategies are not always included. However, there is an increasing recognition that traffic management efforts beyond temporary traffic control (TTC) plans are needed to deal with the increasing traffic volumes using the same roads on which agencies need to perform maintenance and rehabilitation<sup>2</sup>. Therefore, the focus of this guidance is to enhance design-level work zone impacts assessment by considering and addressing work zone impacts from a broader transportation management perspective, rather than solely a traffic safety and control perspective. This broader approach leads to the development of a transportation management plan (TMP) for the project that includes a TTC plan, as well as other appropriate strategies.

The objectives of work zone impacts assessment during design are to:

- Perform a detailed project-level work zone impacts assessment progressively and comprehensively through the various design iterations.
- Reassess and confirm whether the project is a significant project<sup>3</sup>.
- Develop recommendations for final construction approach and construction staging.
- Identify final design and contracting strategies – consider innovative design and contracting approaches.
- Develop final recommendations and plans for work zone management strategies.
- Estimate the final costs for the chosen work zone management strategies.
- Identify performance requirements<sup>4</sup> for the work zone.
- Develop the TMP, appropriate PS&Es, and other documents that are required to implement the TMP.
- Develop contracting documents.

The TMP may be developed by the agency itself – either in-house or by using a consultant. Alternatively, the agency may choose to allow the contractor to develop a TMP prior to start

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<sup>1</sup> The MUTCD is available at <http://mutcd.fhwa.dot.gov>.

<sup>2</sup> Recognizing the growing complexities in performing road work today, in September 2004 the Federal Highway Administration (FHWA) updated the work zone regulation at 23 CFR 630 Subpart J and renamed it the Work Zone Safety and Mobility Rule (the Rule). The former Rule required the development of traffic control plans (TCPs) for all road projects. The updated Rule expands the former TCP requirement to now require the development and implementation of transportation management plans (TMPs) for all projects. More information on developing TMPs is available in *Developing and Implementing Transportation Management Plans for Work Zones*, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm).

<sup>3</sup> 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 based on the respective agency's policy and/or engineering judgment. This definition, provided in Section 630.1010 of the Rule, also specifies that all Interstate system projects within the boundaries of a Transportation Management Area that occupy a location for more than three days and have lane closures are significant.

<sup>4</sup> Performance requirements/guidelines that are identified during design may be useful to monitor the actual performance of the work zone during construction. Section 7.0 of this document discusses work zone impacts assessment during construction.

of work, and/or use performance-based specifications. If the agency chooses to use a contractor developed TMP (instead of an agency developed TMP), appropriate specifications for the TMP are developed, rather than the TMP itself. In either case, TMP development will be governed by agency-developed recommendations and/or performance specifications. All TMPs that are developed by a non-agency entity (e.g., contractor, consultant) must to be approved by the agency. The agency may also have the TMP reviewed, stamped, and approved by a licensed Professional Engineer.

Work zone impacts assessment during design may provide answers to specific work zone impacts related questions such as:

- Now that I know how I am going to build the project, what are the specific traffic safety and control requirements for the project?
  - e.g., taper lengths, type of separation, number of barrels/cones, work site access points, signage requirements for the work zone, detour signs.
- Now that I know my chosen work zone type, what are the additional traffic safety features that I need to incorporate?
  - e.g., for night work the issues that need to be addressed include lighting and visibility needs, advance warning to motorists, reflectorized separation, reflectorized clothing for workers, presence of law enforcement in advance of and through the work zone, etc.
- Now that I know that I am going to deploy a work zone traffic incident management system using advanced intelligent transportation systems (ITS) technology as part of the Transportation Operations (TO) component for the TMP, what are the requirements for that system?
  - e.g., detector requirements, coordination with pre-existing regional transportation management center (TMC), information communication and dissemination requirements, number of tow-trucks needed for incident response and management, work zone traffic incident management policies, etc.
- Now that I know that I am going to deploy a real-time work zone traveler information system as part of the Public Information (PI) component of the TMP, what are the needs of the system?
  - e.g., whether portable dynamic message sign(s) (DMS) will be needed or pre-existing stationary DMS can serve the purpose, other en-route information dissemination methods, project web site, project telephone hotline, E-mail alerts, media contacts, etc.
- Now that I know the construction/staging approach, the chosen design, and the TMP for the project, what are the expected work zone impacts of the project and how effective are the TMP strategies expected to be?
  - e.g., expected queue lengths and delays, expected crashes/crash rate, analysis/estimation of the work zone impacts of the project, analysis/estimation of how well the TMP mitigates those impacts (i.e., analysis of work zone impacts with and without TMP strategies), etc.
- Now that I know the specific components of the TMP, what are the individual items that constitute them, what are the estimated costs, and can I save some money by utilizing pre-existing resources or by combining resources?
  - e.g., given that the project needs a TO component, what are the actual TO strategies that I need, such as a work zone traffic incident management system, enhanced work zone enforcement, real-time work zone monitoring and management, work zone speed advisory system, transit subsidies, etc.
  - What is the implementation plan for the TMP components? Are there any components that need to be implemented much ahead of the projected start date for the project (e.g., the PI plan), or are there any components that need to be implemented prior to implementing other components?

## 6.3 Who are the Participants?

The staff that may perform the work zone impacts assessment during design, the inputs and input providers, and the outputs and users of the outputs are shown in Table 6.1.

<p>The primary participants are the project design and construction team:</p> <ul style="list-style-type: none"> <li>■ Project planners.</li> <li>■ Designers.</li> <li>■ Highway Engineers.</li> <li>■ Traffic Engineers, ITS and operations engineers.</li> <li>■ Safety Engineers.</li> <li>■ Construction Engineers.</li> </ul>	
Inputs	Input Providers
<ul style="list-style-type: none"> <li>■ Applicable policies.</li> <li>■ Outputs from preliminary engineering (the preliminary work zone definition).</li> <li>■ Any other project specific information that is identified during the design processes (project constraints, identified structural needs, ROW issues, environmental issues, utility and sub-surface information, soil and hydraulic information, construction methods and needs, traffic control and management information, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>■ Designers, pavement managers, bridge managers, traffic engineers/managers, safety engineers, planners, maintenance managers.</li> <li>■ Technical specialists such as pavement experts, soil experts, hydraulics engineers, environmental experts, construction engineers, utility coordination personnel (water, sewage, power, gas, telecom infrastructure), traffic management specialists (traffic operations/ITS), marketing/public relations staff, law enforcement personnel.</li> <li>■ Contractors and contractor associations such as the American Road and Transportation Builders Association (ARTBA), Associated General Contractors of America (AGC), and American Traffic Safety Services Association (ATSSA).</li> <li>■ Other stakeholder groups, such as local community representatives, business representatives, other public safety agencies, trucking associations, American Automobile Association (AAA).</li> </ul>
Outputs	Users of the Outputs
<p>The outputs may be the actual plan documents, and/or recommendations or specifications for developing the plan documents. These include:</p> <ul style="list-style-type: none"> <li>■ Analysis reports and other associated documentation (traffic studies, impact studies, benefit/cost analysis, modeling/simulation results, etc.).</li> <li>■ Any performance requirements or guidelines for the work zone.</li> <li>■ TMP with detailed components to include the TTC plan, and TO and PI components as applicable.</li> <li>■ PS&amp;E package.</li> <li>■ Contracting method, and letting and award information.</li> </ul>	<ul style="list-style-type: none"> <li>■ The project design and construction team, including designers, traffic engineers, safety engineers, construction management and contracting personnel, and construction and safety inspectors.</li> <li>■ Other related staff with specific responsibilities for project implementation, such as traffic operations and ITS staff, marketing/public relations staff, law enforcement coordination staff, and law enforcement officers.</li> <li>■ Executive level managers.</li> <li>■ Other stakeholders – regional transportation agencies, public safety and emergency services, community associations, etc.</li> <li>■ Contractor and contractor staff.</li> </ul>

**Table 6.1 Design-Level Work Zone Impacts Assessment Participants**

## 6.4 Assessing Work Zone Impacts During Design

Figure 6.1 illustrates the steps involved in work zone impacts assessment during design. Some notes pertaining to the figure are presented in Table 6.2.

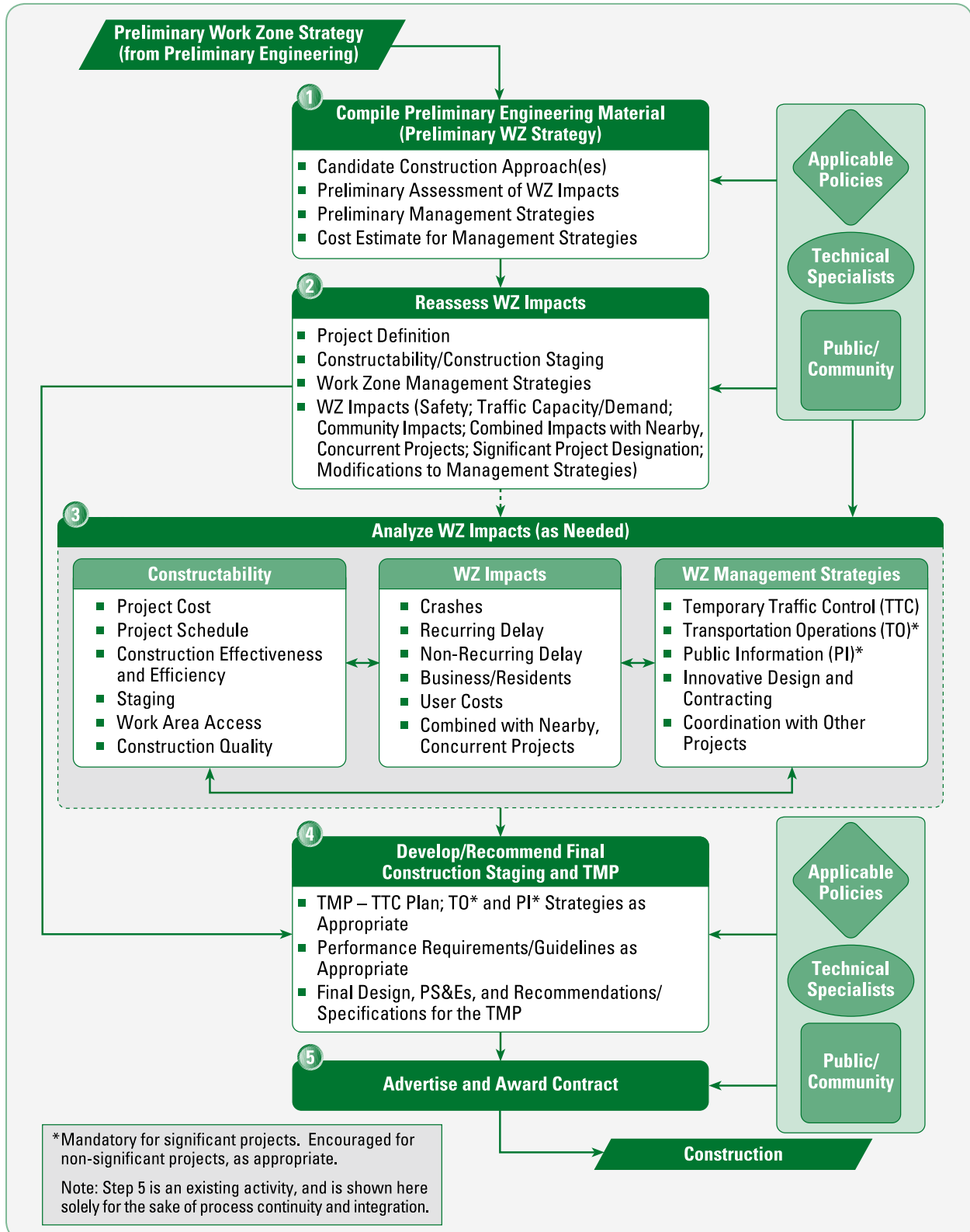


Figure 6.1 Design – Work Zone Impacts Assessment Process

## Process Notes for Design

**Much of work zone impacts assessment, to the degree it is done, currently takes place during design** and is focused on developing TCPs for projects. This guidance is intended to enhance and supplement existing practices towards adopting a broader work zone transportation management approach.

**Work zone impacts assessment during design is an iterative process** progressing through the different design stages, leading to the final design, TMP, performance requirements/criteria, and PS&Es for the project. Each design stage consists of specific activities, milestones, and concurrence points. Work zone impacts assessment is not intended to be a separate activity, rather it should be included in the ongoing design activities, with work zone impacts issues being accounted for at each concurrence/decision point. The process shown in Figure 6.1 may not always be a one-shot process; sometimes it may take several iterations of the process to develop the final design, TMP, and PS&Es.

**Input from and interaction with appropriate sources** (as shown in Figure 6.1) may be required during the assessment:

- **Applicable Policies**, shown as a green diamond in the diagram, represents the agency's policies and related policy provisions (i.e., policy requirements, standards, and/or guidance) and appropriate processes, procedures, and practices that apply to the particular activity. They help with decision-making on specific issues during the process, such as the level of impacts assessment and the type of management strategies needed for different projects. For example, for a work zone that is expected to cause a delay of 20 minutes or more, an agency's policy may require the TMP to incorporate management strategies that can help minimize and manage that delay, and a quantitative analysis of the expected delay and the potential delay reduction that can be attained by implementing the management strategies. Section 3.4 of this document provides a brief discussion on potential policy provisions for application during project delivery.
- **Technical Specialists**, shown as a green ellipse in the diagram, represents input from specialists in specific disciplines including highway engineers, construction engineers, traffic engineers, structural engineers, pavement specialists, environmental specialists, ROW specialists, and hydraulics engineers. Participation of such staff throughout the work zone impacts assessment may lead to decisions that carry over to subsequent project phases without significant alteration.
- **Public/Community**, shown as a green square in the diagram, represents input from the general public including motorists, other highway users, businesses, residents, neighborhood groups, etc. This input may be provided through public involvement processes, customer feedback efforts, surveys, focus groups, etc. Public involvement during design may not be as extensive as the public input and feedback processes that occur during systems planning and preliminary engineering.

**The interface between design, systems planning, and preliminary engineering may be fluid.** Decision-making and activities from one phase may overlap with or extend into the other. For some projects, systems planning, preliminary engineering, and/or design activities may be conducted as part of the same study (e.g., large regionally significant projects that require multi-year studies).

**Agencies may combine work zone impacts assessment with environmental/NEPA assessments.** Generally, agencies prepare three types of environmental reviews under NEPA: Categorical Exclusions (CE) for small, routine projects with insignificant environmental impacts; Environmental Assessments (EA) for projects with no significant environmental impacts; and Environmental Impact Statements (EIS) for projects with significant environmental impacts. The opportunity exists to combine work zone impacts assessment with the environmental/NEPA assessments. Sometimes the NEPA process can be a primary source of work zone related constraints or inputs for the project. Example of issues that may be addressed include how work zone impacts tie in to the project location and design process, how are work zone impacts weighed against other socio-economic/environmental impacts and other project considerations, etc. More information on NEPA is available at <http://www.environment.fhwa.dot.gov/projedev/index.asp> (Accessed 12/22/05)

**Table 6.2 Process Notes**



The following sections provide a discussion of the steps shown in Figure 6.1.

### □ **Step 1 of 5: Compile Preliminary Engineering Material**

This step involves the compilation of the preliminary engineering material (i.e., the preliminary work zone strategy), which should include:

- The project definition.
- Candidate construction/staging approach(es).
- Preliminary assessment of work zone impacts.
- Significant project designation.
- Preliminary work zone transportation management strategies.
- Preliminary cost estimates for the management strategies and the candidate construction/staging approach(es).
- Available information on implementation resources, challenges, and opportunities for the management strategies.
- Available project coordination/conflict information.

If the preliminary engineering work zone strategy has not been developed yet, the agency can follow a process like the one described in Section 5.4 to perform the preliminary engineering work zone impact assessment, and develop a preliminary work zone strategy for the project. For larger projects, preliminary engineering and design may take place as part of one study effort.



The Texas Department of Transportation (TxDOT) provides guidance on the activities that should be performed during the early stages of design. The guidance states that this period of project development requires a substantial amount of the project manager's experience and attention. Decisions made during this time will directly affect the project schedule and quality. Input from the project manager's peers and supervisor should be sought for quality assurance. The design field survey, stream crossing hydraulics, and pavement design should be completed before detailed plan development. Traffic control and permits/agreements may delay the project if not handled properly at the beginning of detailed design. Design Division approval of geometric schematics for new location or added capacity projects should be obtained before beginning detailed design. The activities that may be performed at this juncture include the following groups of tasks (which may be performed concurrently):

- Traffic Control – plan the sequence of construction, develop conceptual detour/road closure plan;
- Permits and Agreements – obtain miscellaneous permits, design environmental mitigation details;
- Design Data Collection – review data collection needs;
- Stream Crossing Hydraulics – refine hydrologic study, prepare stream crossing hydraulics, prepare hydraulic report; and
- Pavement Design – prepare pavement design report.

Source: TxDOT Project Development Process Manual, August 1, 2003. URL: [http://manuals.dot.state.tx.us/dynaweb/coldesig/pdp/@Generic\\_BookView](http://manuals.dot.state.tx.us/dynaweb/coldesig/pdp/@Generic_BookView) (Accessed 01/05/06).

## □ Step 2 of 5: Reassess Work Zone Impacts

The purpose of this step is to reassess the work zone impacts of the project so that any issues are identified and addressed before the final design is completed. Reassessment of work zone impacts starts with the preliminary work zone strategy and progresses through the various design stages. As design progresses, more detailed project information becomes available and project-related decisions are finalized (e.g., pavement choice may be finalized, which will influence the total duration of construction). Decisions may be made during later design stages that may change the project parameters, potentially changing the work zone impacts implications of the project. Therefore, the reassessment of work zone impacts should be conducted along with the ongoing design activities, with work zone impacts issues being accounted for at each concurrence/decision point. For example, any design-level constructability reviews<sup>5</sup> and value engineering (VE)<sup>6</sup> studies should be encouraged to look at the potential for work zone impact reductions. Such reassessment can help avoid the propagation of errors to the final design, and potentially avoid costly changes later during construction.

Reassessment of work zone impacts is expected to be a qualitative process to double-check the validity of the assessments and assumptions that were made in earlier stages, as more design decisions are finalized and more information becomes available. If the assessment indicates that the work zone impacts may be different from what was expected, further investigation and analysis may be needed. If not the agency may proceed to final design. Depending on the complexity of the project, the agency may conduct additional quantitative analysis of work zone impacts in Step 3. General guidance is provided in Step 3 on the types of projects for which additional quantitative analysis may be required.

The reassessment of work zone impacts can be done in a manner similar to that described in Step 2 of 6 of the systems planning process (Section 4.5), and Step 4 of 7 of the preliminary engineering process (Section 5.4). The key difference in design is that the assessment is more detailed and specific, and the issues that are identified will lead to the final TMP strategies and design recommendations for the project.

The following are some issues to consider in reassessing work zone impacts during design:

- **Project Definition.** As design progresses, final decisions are made on various aspects related to the project definition. These include decisions on the exact nature of work to be performed, location, extent, and duration; roadway alignment and ROW; cross-sectional, elevation and super-structure details; pavement and structural needs; soil, hydraulics, and environmental needs; utility related infrastructure and coordination issues; and design parameters. When such decisions are finalized, an assessment should be made to determine if those decisions influence the work zone impacts of the project. Project design options should be chosen with consideration for minimizing their life-cycle work zone impacts (e.g., choosing long-life pavements, designing wider shoulders to facilitate easier maintenance, incorporating other features that reduce the work zone impacts of maintenance/rehabilitation). Project Definition is also discussed in Step 2 of 7 of the preliminary engineering process (Section 5.4).

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<sup>5</sup> Design-level constructability reviews are aimed at using construction knowledge and experience (field knowledge) to design projects that are practical to construct, facilitate rational bids, and minimize problems/delays during construction. Examples of State DOT constructability review processes are available in the FHWA Work Zone Best Practices Guidebook. URL: <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/6/05).

<sup>6</sup> Value engineering (VE) is an organized application of common sense and technical knowledge to find and eliminate unnecessary costs in a project. VE can be performed either during design or construction. VE is briefly discussed in Section 7.4 under Step 2 of 7. More information is available on the FHWA VE web site at <http://www.fhwa.dot.gov/ve/index.htm> (Accessed 11/15/05).



At the New York State Department of Transportation (NYSDOT), materials and life cycle costing are key design issues. NYSDOT has incorporated design features to accommodate future work zone mobility needs (e.g., wider bridges to facilitate use of the shoulder as a travel lane during construction, avoiding piers in medians).

Source: NYSDOT comments in response to the FHWA Advance Notice of Proposed Rulemaking (ANPRM) on Work Zone Safety, June 6, 2002, United States Department of Transportation (U.S.DOT) online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf81/175976\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/175976_web.pdf) (Accessed 01/18/06).

The FHWA Highways for LIFE program focuses on how to build a highway safer, longer lasting, at a lower cost, and faster. More information on this program is available at <http://www.fhwa.dot.gov/hfl> (Accessed 01/18/06).

- Constructability/Construction Staging Approach(es).** During preliminary engineering and early design, it may not be possible to finalize the construction/staging approach for the project. In design, further investigation is performed and decisions are made on the most suitable construction/staging approach for the project, and constructability issues are identified and addressed. The choice of construction/staging approach directly influences the potential work zone impacts of the project. Therefore, as design progresses and decisions are made, any variations from prior decisions/assumptions should be noted and assessed for their work zone impacts implications. In choosing the construction/staging approach and in conducting constructability reviews, work zone impacts issues should be considered and the selection of construction/staging approach(es) should seek to minimize work zone impacts. Construction staging approach is also discussed in Step 3 of 7 of the preliminary engineering process (Section 5.4), and Step 2 of 6 of the systems planning process (Section 4.5).



Many agencies have successfully used full road closures for accelerating road construction and minimizing overall impacts to road users. The FHWA developed a series of case studies to provide examples of projects using full road closure for work zone operations. The case studies are available at [http://www.ops.fhwa.dot.gov/wz/construction/full\\_rd\\_closures.htm](http://www.ops.fhwa.dot.gov/wz/construction/full_rd_closures.htm) (Accessed 01/18/06).

The National Cooperative Highway Research Program (NCHRP) Report 476 contains Guidelines for Design and Operation of Nighttime Traffic Control for Highway Maintenance and Construction. This report is available at [http://trb.org/publications/nchrp/nchrp\\_rpt\\_476.pdf](http://trb.org/publications/nchrp/nchrp_rpt_476.pdf) (Accessed 01/18/06).

A Traffic Control Handbook for Mobile Operations at Night is available from the FHWA Office of Safety (<http://safety.fhwa.dot.gov> — Accessed 8/25/06).

- **Work Zone Management Strategies.** Design-level decisions can influence the choice of work zone management strategies. As specific decisions are made and milestones are attained, the work zone management strategies should also be reassessed to determine if they still apply and whether they adequately serve the purpose of mitigating the work zone impacts of the project. If not, additional management strategies need to be identified. This reassessment is a quick review as to whether the prior assumptions (from preliminary engineering or other design stages) still apply, or whether the previously identified management strategies need to be modified. For example, the preliminary engineering assessments may result in the identification of two alternative “construction and work zone management approaches” – the first being a night work option with a basic TMP (i.e., TTC plan only), and the second being a daytime work option with a complete TMP (i.e., TTC, TO, and PI included). As design progresses, more information may become available on the feasibility of each of the construction approaches, leading to the elimination of the night work option. Therefore, the second option would be chosen and further developed. Step 6 of 7 of the preliminary engineering process in Section 5.4, and Step 4 of 6 of the systems planning process in Section 4.5 discuss the initial identification of work zone management strategies.

More detailed information on the different work zone management strategies is provided in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).

- **Work Zone Impacts.** Work zone impacts should be reassessed when decisions are made on the construction/staging approach(es) and the accompanying work zone management strategies. The reassessment is expected to be an iterative process that progresses along with the ongoing design activities, with checks and balances being made at the respective design milestones and concurrence points. Work zone impacts issues to address include safety; traffic capacity/demand; community impacts; combined impacts with nearby, concurrent projects; significant project designation; modifications to management strategies; and work zone performance requirements (either policy-level or project-specific). If the reassessment indicates that the chosen work zone management strategies will be effective and help attain the performance requirements/goals for the work zone, the agency would proceed to Step 4 (final design). If not, the management strategies may need to be modified, or additional management strategies may need to be identified as appropriate. For smaller (less complex) projects, the reassessment can be based on simplified tools and rules and/or engineering judgment. For larger (more complex) projects a more detailed (quantitative) analysis may be needed, which is discussed in Step 3. In general, a quick reassessment can indicate whether or not a project would need additional quantitative analysis. General guidance is provided in Step 3 on the types of projects for which additional quantitative analysis may be needed. Table 2.7 – Work Zone Impacts Considerations in Section 2.0 provides a detailed list of the different work zone impacts issues and considerations that may be addressed.

### □ Step 3 of 5: Reassess Work Zone Impacts (As Needed)

This step may be considered as an extension of the work zone impacts reassessment discussed in Step 2. The purpose of this step is to conduct a more detailed (quantitative) investigation and analysis of the work zone impacts. Similar to Step 2, this quantitative analysis should also be performed iteratively, progressing along with the design activities, with the design milestones and concurrence points being used as junctures for work zone related checks.

In the process diagram (Figure 6.1), this step is shown as a box with dashed lines, indicating that this step would be performed on an as-needed basis. It is up to individual agencies to determine whether or not quantitative analysis is needed, based on the type, complexity, and expected work zone impacts of the project. If it is determined that further quantitative analysis is not needed, the agency would skip this step and proceed directly to Step 4.



**TIP:** Though this step may not be performed for all projects, detailed quantitative analysis during design may be the best way to get a clear understanding of the expected work zone impacts of a project. Most project decisions are finalized during design and this is when the project design/construction team may have the best understanding of how exactly the project will be built. A quantitative analysis conducted during design will probably yield the best estimation of the magnitude, location, duration, and costs of the work zone impacts, and help identify the management strategies that best mitigate these impacts. Further, detailed analysis may potentially avoid omission or oversight of work zone safety and mobility issues prior to final design. It may also help identify and address issues that may lead to a work stoppage during the construction stage (e.g., queue lengths or delays in excess of agency policy).

Quantitative analysis may be used to:

- Confirm and re-examine whether the project is a significant project.
- Choose between alternative project design, construction/staging, and traffic control and management approaches.



The Massachusetts Highway Department (MHD) routinely performs quantitative analysis to compare the construction time for maintaining traffic through the work zone versus closing the highway and diverting traffic. The objective is to maintain pre-existing levels of vehicular and pedestrian mobility and minimize construction cost and schedule.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/18/06).

- Estimate the life-cycle costs of the project, taking into account the cost of maintaining and rehabilitating the facility over its life-cycle.



The Ohio Department of Transportation (ODOT) uses Life Cycle Costing to select the type of pavement to be used. In the past, pavements were selected for reasons such as supply, personal choice, and maintenance. These reasons were not quantified, were generally subjective, and sometimes did not yield a long pavement life. Life-cycle cost analysis provides quantitative information about the pavement type to use, helps justify decisions, and maximizes pavement cost and life.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/18/06).

- Choose between alternative work zone transportation management strategies.
- Understand specific aspects of work zone impacts of the project (e.g., choke points, bottlenecks, diversion patterns, queue lengths, queue build-up and dissipation rates).



DYNASMART-P is a tool developed by FHWA to model the impacts of operational aspects on the transportation network, including work zones and incidents. The user can represent work zones on the network, and run dynamic simulations to estimate impacts such as traffic backup and queuing, queue length, delay, and the effects of using management strategies (e.g., using DMS to divert traffic to alternate routes). More information on DYNASMART-P is available at <http://www.dynasmart.com> (Accessed 01/18/06).

- Understand the work zone impacts implications of any value engineering proposals that recommend the removal of certain project elements for cost-cutting purposes.
- Understand the combined impacts and coordination issues with other nearby, concurrent projects.
- Identify the work zone performance requirements/goals for the project (e.g., by analyzing the work zone impacts under different scenarios and developing a range of potential impacts, which can then serve as the basis for the performance goals).
- Set the parameters for any innovative/alternative contracting approach (e.g., in the case of A+B bidding, the objective is to minimize construction duration by getting contractors to bid on the actual work items (Part A), and the total number of days to complete the project multiplied by the daily road user cost stipulated in the contract (Part B). The combined values of A and B determine the winning bid. The agency may need to conduct a quantitative analysis of the work zone impacts to estimate the associated daily road user costs that it needs to stipulate in the contract).



The Indiana Department of Transportation (INDOT) uses the QUEWZ software to predict congestion and associated user costs. The user cost information is used to establish incentives on A+B Contracts and as criteria for the best alternative for maintaining traffic. The version of QUEWZ used by INDOT has the ability to account for the traffic that will divert from the route. It has been calibrated by INDOT and found to be reasonably accurate in user cost and delay estimation, resulting in more efficient construction phasing and maintenance of traffic planning.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/18/06).

- Justify additional funds for work zone management strategies, or to justify why a project will not have major work zone impacts. (e.g., by quantifying the work zone impacts, the associated user-costs, and the benefits and costs of the work zone management strategies).
- Determine and design the specific aspects of the management strategies.
  - *TTC Plan* – quantify expected queue length and incorporate that information in designing the taper for the project; design the lane-widths; set the work zone speed limits; estimate costs of TTC strategies; etc.
  - *TO Component* – determine the communications and detector requirements for a work zone traffic monitoring and incident management system; estimate traffic diversion patterns and rates to determine potential impacts on the alternate route(s) and appropriately improve operations on the alternate route (e.g., signal timing adjustments); evaluate the positioning of dynamic message signs (DMS) which may affect the diversion patterns; estimate the number of people who would switch to transit so as to structure the transit incentive program; estimate the costs of the TO strategies; etc.
  - *PI Component* – estimate the volume of traffic that would be affected by the project to determine the PI needs; determine the types of PI strategies to use (e.g., real-time updates through email, telephone based information); coordinate with stakeholders to initiate the PI program; estimate the costs of the PI strategies; etc.

Quantitative impacts analysis may generally be needed for significant projects that are expected to have major impacts at the corridor, network, or regional levels, but this does not mean that it will not be needed for other projects. A decision to analyze or not to analyze should be made on a project-by-project basis. The following provides some general guidance to help agencies determine the types of projects for which detailed quantitative analysis may be appropriate:

- Section 3.4.1 discusses the classification of projects according to their expected work zone impacts. Table 3.2 in that section presents the project classification scheme used in the FHWA Work Zone Self Assessment program<sup>7</sup>, which classifies projects into four types. The project complexity and expected work zone impacts is highest for Type I projects, followed by Types II, III, and IV, respectively. In general, quantitative analysis of work zone impacts may be appropriate for *all* Type I and Type II projects; may be needed for *some* Type III projects; and may not be needed for *most* Type IV projects.

<sup>7</sup> The FHWA Work Zone Self Assessment program is designed to help agencies assess their work zone programs, procedures, and practices against many of the good work zone practices in use today. FHWA Division Offices work together with transportation agency staff from their State partners to complete the assessment each year. More information is available at [http://www.ops.fhwa.dot.gov/wz/decision\\_support/self-assess.htm](http://www.ops.fhwa.dot.gov/wz/decision_support/self-assess.htm) (Accessed 12/16/05).

- Section 3.4.1 also presents a classification scheme based on the type of TMP that may be needed for projects. The example classification scheme uses three types of TMPs – Basic TMP, Intermediate TMP, and Major TMP. Using this classification scheme, quantitative analysis may not be needed for *most* Basic TMP projects; may be needed for *some* Intermediate TMP projects; and may be needed for *most* Major TMP projects.

Quantitative analysis can be performed at the work zone, corridor, and/or network levels. Appropriate measures may be considered in the analysis for safety, mobility, societal impacts, road user-costs, life-cycle cost implications, and benefits of the work zone management strategies. Examples of different work zone impacts issues and measures are provided in Step 3 of 6 in Section 4.5 (Systems Planning Process) and under Step 5 of 7 in section 5.4 (Preliminary Engineering Process). The key difference in design is that the analysis is more detailed and will lead to the development of the final design and TMP for the project. The level of detail and clarity of analysis is expected to be higher. For example, early work zone impacts analysis performed during preliminary engineering (e.g., using a sketch-planning tool) for a particular project may indicate that traffic diversion to the designated alternate route for the project would be significant, leading to a preliminary decision to upgrade and re-time the traffic signals on the alternate route. In design, a more detailed analysis (e.g., using a micro-simulation tool) may be conducted to determine the actual diversion patterns, the volume of traffic expected to divert to the alternate route, and the actual intersections that would be affected. This analysis may then be used to identify the number of traffic signals that need to be upgraded and the exact nature of the upgrades, and to develop the signal timing plans and estimate the costs for the same.

In addition to the measures in Section 4.5 and Section 5.4, agencies may be interested in understanding some more specific operational issues during the design level analysis. Examples include queue build-up and dissipation patterns/durations, queue lengths, traffic diversion patterns/volumes, effects of slight modifications in work duration (i.e., changes in start and stop time), vehicle trajectory analysis (e.g., to understand the impacts of tight curves and lane shifts), benefits of specific management strategies (e.g., travel time savings that may be attained by deploying a work zone traffic monitoring and incident management system, speed and crash reduction that may be attained through a speed advisory and enforcement program, overall mobility savings that can be attained through a work zone traveler information program).

Key technical issues to be addressed in the analysis include:

- **Constructability** (project cost, schedule, construction effectiveness and efficiency, construction staging, work area access, construction quality, environmental constraints, utilities, noise, weather interference, project coordination and interdependencies, any interference with/to ongoing maintenance activities, etc.).
- **Work Zone Impacts** (crashes; queues; recurring delay; non-recurring delay; traffic diversion; nearby railroad crossings; transit junctions; interchanges/intersections; impacts to businesses/residents; combined impacts with nearby, concurrent projects; user-costs of the impacts; etc.). Table 2.7 – Work Zone Impacts Considerations in Chapter 2.0 provides a detailed list of the different work zone impacts issues and considerations that may be addressed.
- **Work Zone Management Strategies** (TTC, TO, PI, innovative design and contracting, advanced construction technologies, coordination with other projects, combining multiple projects, etc.).



More detailed information on the different work zone management strategies is provided in **Developing and Implementing Transportation Management Plans for Work Zones**, available at [www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 1/18/06).

The three technical issues presented above are briefly explained in Steps 2, 3, 4, and 5 of the systems planning process in Section 4.5; and Steps 3, 4, 5, and 6 of the preliminary engineering process in Section 5.4. The key difference in design is the level of detail in analyzing and addressing individual issues.

Deterministic/Highway Capacity Manual (HCM) based tools, traffic simulation models, and other tools that can help perform a detailed analysis may be most appropriate for this level of analysis. The objective of quantitative analysis during design is to analyze and address specific issues in detail, and make final decisions and recommendations towards development of the final design and TMP for the project. Detailed analysis tools such as deterministic tools and traffic simulation models may be most suitable. Higher-level travel demand models and sketch planning tools may also be used if the project situation warrants their use (e.g., budgetary constraints, regional impacts, readily available model from the agency's planning division). Sometimes a combination of different levels of tools may be needed to appropriately analyze the impacts. Many agencies also use tools that are developed in-house and are customized according to their respective policies and program priorities.

Deterministic tools are capable of providing accurate results for specific locations or small roadway sections provided there is adequate information on traffic volume, roadway geometrics, traffic control and management features, and any roadside friction that may exist. For example, an HCM-based deterministic tool can replicate the TTC plan for a project (i.e., taper lengths, number of lanes, lane widths, shoulder widths, turning lanes, traffic signal information), and predict the delay and queue length for the corridor on which the work zone is setup. A tool such as QuickZone (which uses both deterministic and sketch-planning methods) can estimate queues and delays on the mainline corridor and diversion to the adjoining network. It also provides a high-level estimate of the benefits of different management strategies (e.g., ITS, demand management, real-time information). However, if agencies are interested in simulating the effect of the work zone on a dynamic basis<sup>8</sup> (e.g., determine the roadways to which traffic may divert, estimate queue development and/or discharge rates, estimate queue durations, identify traffic overflow/spillback, estimate the operating effects and benefits of management strategies) simulation models may be most suitable.

<sup>8</sup> In dynamic analysis or dynamic traffic assignment (DTA), vehicles are simulated such that they arrive at a particular point on the network (e.g., the starting point of the corridor) in time slices rather than all at one time. Some tools exclusively use DTA (e.g., micro-simulation tools) while others use a combination of DTA and static assignment.



The Wisconsin Department of Transportation (WisDOT), Facilities Development Manual provides a Traffic Volume Analysis Example, based on deterministic equations. The objective is to estimate the Design Hour Volume (DHV) for the work zone, using both Average Annual Daily Traffic (AADT) and Seasonal Average Daily Traffic (ADT), and decide the construction time and allowable work hours. The example shows that the estimated DHV based on AADT appears to indicate no problem with 1-lane in each direction, but the estimated DHV for the seasonal peak ADT indicates otherwise. The high weekend travel hours exceed the capacity for 1-lane in the northbound direction on Friday afternoon, and in the southbound direction on Sunday afternoon. If the project is an asphalt overlay, the contractor can complete the work during the week (before the weekend traffic arrives). However for reconstruction, one side of the highway may be closed and a median crossover needed to allow traffic on the other side. This scenario may also need bridge/highway widening to accommodate heavy weekend traffic with 2-lanes in each direction.

Source: Wisconsin Department of Transportation, Facilities Development Manual, Procedure 11-50-22, Chapter 11 Design, Section 50 General Design Considerations, Subject 22 Work Zone Traffic Congestion and Mitigation, February 2003.

Examples of tools that may be most appropriate for conducting the design-level quantitative work zone impacts analysis are:

- **Work Zone Specific Sketch-Planning Tools** such as MicroBENCOST, QuickZone, QUEWZ, and CA4PRS.
- **Deterministic/Highway Capacity Manual (HCM) Based Tools** such as Highway Capacity Software (HCS 2000), Assessment of Roundabout Capacity and Delay (ARCADY), Freeway Delay Calculation Program (FREWAY), and Dynamic Toll Plaza Queuing Analysis Program (Dqueue).
- **Traffic Simulation Tools** such as:
  - Macroscopic Simulation Models such as Bottleneck Traffic Simulator (BTS), CORFLO, and NETCELL.
  - Mesoscopic Simulation Models such as DYNASMART-P, DYNAMIT-P, etc. Microscopic Simulation Models such as TSIS/CORSIM, PARAMICS, and VISSIM.

More information on available software tools that support work zone impacts analysis can be found in APPENDIX B – Overview of Work Zone Impacts Analysis Tools, and on the following web sites:

- Work Zone & Traffic Analysis/Management section of the FHWA work zone web site, available at [http://ops.fhwa.dot.gov/wz/traffic\\_analysis.htm](http://ops.fhwa.dot.gov/wz/traffic_analysis.htm) (Accessed 08/19/05).
- FHWA Traffic Analysis Tools web site, available at <http://ops.fhwa.dot.gov/trafficanalysistools/index.htm> (Accessed 08/19/05).

The quantitative analysis may be combined with an ongoing project study such as corridor/sub-area study, EIS, etc. Environmental/NEPA assessments must cover the range of impacts of the project, and address issues such as design alternatives that would decrease pollution emissions, construction impacts, esthetic intrusion, relocation assistance, possible land use controls that could be enacted, and other possible efforts. Any work zone impacts analysis that is conducted during design may be combined with other such project assessments, can provide information towards effective completion of other assessments, and can use information and constraints that come out of the other assessments. This applies especially to large projects for which planning, preliminary engineering, and design are performed as part of the same study.

Based on the results of the analysis, the agency may choose to either revise the management strategies and/or the construction/staging approach for the project. This represents the iterative aspect of the work zone impacts assessment process. Decision-making at this juncture is driven by the required level of performance for the work zone (as determined by the agency and/or design team, or as defined by applicable policies and standards).

#### □ **Step 4 of 5: Develop/Recommend Final Construction Staging and TMP**

In this step, information from the previous steps is used to complete the final design, the construction staging, the TMP, and the cost estimates for the project. These are then compiled into the PS&E package. Agencies may arrive at this step directly after the reassessment in Step 2, or after conducting further quantitative analysis in Step 3. In some agencies and/or for some projects, these plans and documents may not be finalized until the construction stage. Also, TMP development responsibility and sequencing may vary according to the chosen design approach and contracting strategy.

- **Traditional Design-Bid-Build process.** In this case, the final plans, TMP, PS&E and bid package are developed by the agency (or consultant as appropriate).
- **Design-Build.** This involves a stage-by-stage approach to designing and building the project, where design and construction take place in tandem. When construction is taking place on one phase, the subsequent phase is designed. This generally saves project time and money. This approach is more often adopted for major infrastructure reconstruction or rehabilitation projects and is performed by a team of engineering consultants and contractors.
- **Contractor Developed TMP.** In this case, the agency includes basic TMP requirements and recommendations in the bid package, rather than the agency developing the TMP itself. Contractors may then include appropriate TMPs in their bids.
- **Performance Based TMP.** In this case, work zone performance requirements are established by the agency. Contractors may then include TMPs that help meet those performance requirements in their bids.

All TMPs that are developed by a non-agency entity (e.g., contractor, consultant) must be approved by the agency. The agency may also have the TMP reviewed, stamped, and approved by a licensed Professional Engineer.

As stated in the updated Rule<sup>9</sup> (the Rule), the TMP for a significant project must consist of a TTC plan, and also address TO and PI components. TMPs for all other projects must consist of a TTC plan, with the consideration of TO and PI components being encouraged as appropriate.

<sup>9</sup> Section 630.1012 of the Rule addresses TMPs.

The following provides some general guidance and resources for TMP development, based on information provided in **Implementing the Rule on Work Zone Safety and Mobility**<sup>10</sup>:

- **A TTC plan** describes TTC measures to be used for facilitating road users through a work zone or an incident area. The TTC plan plays a vital role in providing continuity of reasonably safe and efficient road user flow and highway worker safety when a work zone, incident, or other event temporarily disrupts normal road user flow. The TTC plan must be consistent with the provisions under Part 6 of the MUTCD and with the work zone hardware recommendations in Chapter 9 of the American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide. In developing and implementing the TTC plan, pre-existing roadside safety hardware must be maintained at an equivalent or better level than existed prior to project implementation. The scope of the TTC plan is determined by the project characteristics, and the traffic safety and control requirements identified by the agency for that project. The TTC plan must either be a reference to specific TTC elements in the MUTCD, approved standard TTC plans, agency TTC manual, or be designed specifically for the project.

Chapter 9 of the AASHTO Roadside Design Guide is entitled, "Traffic Barriers, Traffic Control Devices, and Other Safety Features for Work Zones." The entire document is available for purchase from the American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, NW., Suite 249, Washington, DC 20001 or at the URL: <http://bookstore.transportation.org> (Accessed 01/18/06). It is available for inspection from FHWA Headquarters and Division Offices.

- **The TO component** of the TMP includes 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. Typical TO strategies may include but are not limited to demand management, corridor/network management, safety management and enforcement, and work zone traffic management. The scope of the TO component should be determined by the project characteristics, and the transportation operations and safety strategies identified by the agency.



The FHWA conducted a cross-cutting study on several deployments of ITS in work zones. This report, "Intelligent Transportation Systems in Work Zones: A Cross-Cutting Study," showcases four examples and is available at <http://www.ops.fhwa.dot.gov/wz/its/index.htm> (Accessed 01/18/06).

- **The PI component** of the TMP includes communications strategies that seek to inform affected road users, the general public, area residences and businesses, and appropriate public entities about the project, the expected work zone impacts, and the changing conditions on the project. This may include traveler information strategies. The scope of the PI component should be determined by the project characteristics and the public information and outreach strategies identified by the agency. Public information should be provided through methods best suited for the project, and may include information such as the project characteristics, expected impacts, lane closure details, and commuter alternatives.



The Virginia Department of Transportation (VDOT) uses special management and operations plans on selected, high traffic volume projects (usually Interstate projects). These include the use of incentive and disincentive clauses to expedite the work, A + B type bidding taking both project cost and user delay into consideration, using public input in determining the construction strategy and least impact to the business community, and extensive public awareness campaigns.

Source: VDOT comments in response to the FHWA Advance Notice of Proposed Rulemaking (ANPRM) on Work Zone Safety, June 6, 2002, United States Department of Transportation (U.S.DOT) online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf81/176059\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/176059_web.pdf) (Accessed 01/18/06).

More specific guidance on designing a public information and outreach campaign for work zones is provided in **Work Zone Public Information and Outreach Strategies**, available at [http://ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

- **Agencies should develop and implement the TMP in sustained consultation with stakeholders** (e.g., other transportation agencies, railroad agencies/operators, transit providers, freight movers, utility suppliers, police, fire, emergency medical services, schools, business communities, and regional transportation management centers).
- **The PS&Es must include either a TMP or provisions for contractors to develop a TMP** at the most appropriate project phase as applicable to the agency's chosen contracting methodology for the project. A contractor developed TMP must not be implemented before it is approved by the agency.
- **The PS&Es must include appropriate pay item provisions for implementing the TMP, either through method or performance based specifications.** For method-based specifications individual pay items, lump sum payment, or a combination thereof may be used. For performance based specifications, applicable performance criteria and standards may be used (e.g., safety performance criteria such as number of crashes within the work zone; mobility performance criteria such as travel time through the work zone, delay, queue length, traffic volume; incident response and clearance criteria; work duration criteria).
- **The agency and the contractor must each designate a trained person**, as specified in section 630.1008(d) of the Rule, at the project-level who has the primary responsibility and sufficient authority for implementing the TMP and other safety and mobility aspects of the project.

More specific guidance on TMPs is provided in **Developing and Implementing Transportation Management Plans for Work Zones**. The Guide includes a listing and brief explanation of the different types of TTC, TO, and PI strategies and their characteristics and applicability. This Guide also has a matrix that summarizes the key aspects of the different strategies, which can be used as a quick reference guide. This Guide is available at [http://ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/18/05).

## □ Step 5 of 5: Advertise and Award Contract

This activity is already performed as part of existing design and construction programs, and is included in this discussion solely for process continuity and integrity.

The activities that generally occur in this step include finalization of ROW issues, finalization of utility and other coordination, submission and approval of fund requests, final review of bid package and project documents by the agency's contracts (bidding and letting) department, contract advertising, addressing contract amendments (if any), conducting pre-bid meetings (if any), and bid review and contract award. The following are some aspects to consider during the contracting process:

- Innovative and alternate contracting approaches (as alternatives to the traditional low-bid process) can help achieve the project objective, accelerate construction, and minimize impacts to road users. Examples include design-build, A+B bidding, lane-rentals, incentive/dis-incentive contracting, and performance-based specifications.
- Timing of the bidding and award process directly impacts the on-time completion of the project and the impacts to road users. For example, if contracts are let in early spring rather than in summer (to late summer), the contractor can take advantage of the spring, summer, and early fall season to complete the work in one construction season as opposed to extending it over two or more construction seasons.
- Timely budgeting and funding are key to ensuring on-time start and completion of work.
- Timely reviews of bids and other contract related issues (amendments, value engineering proposals) can avoid project delays.
- This is a good juncture to coordinate schedules of multiple projects (that may impact each other) by making final adjustments and coordination.
- ROW, utility, and other coordination issues need to be addressed on time.
- Increasingly, agencies are allowing contractors to participate in and provide input to the overall project and construction approach so that their field experience is incorporated into the project before designs, PS&Es, and bids are finalized. Agencies use pre-bid conferences, design competitions, and pre-qualification of contractors to seek contractor input. Such input may help produce designs that are practical to implement, facilitate rational bids, and avoid change orders.

Information on Innovative Contracting is available on the FHWA work zone web site at <http://www.ops.fhwa.dot.gov/wz/contracting/index.htm> (Accessed 01/18/06). Additional examples of innovative/alternative contracting approaches are available in the FHWA Work Zone Best Practices Guidebook at <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/18/06).



The Oregon Department of Transportation (ODOT) awarded the contract for the I-5 Interstate Bridge Lift Span Repair Project based on contractor performance and cost to ensure that repairs were made by the most qualified contractor with the most attractive price proposal. This was the first time that ODOT awarded a contract on any basis other than the lowest bid. Bidders submitted both a technical and a price proposal. The proposals were scored according to specific criteria that assigned points for technical merit and cost. The technical proposals were evaluated by a panel of experts from the ODOT Bridge Section, the design consultant, ODOT Program Services, and the Associated General Contractors (AGC) of America. This practice is most applicable on complex projects that require specialized equipment, materials, fabrication, or expertise. Because of State law ODOT needed to get an administrative exemption in the event the award was not made to the lowest bidder. Use of the performance and cost based award concept was also approved by FHWA under SEP-14 as an alternate bidding method.

Source FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/18/06).





## 7.0 Work Zone Impacts Assessment During Construction

### 7.1 What Happens During Construction?

Construction is the stage where the project is actually built in the field. The decisions made during the planning, preliminary engineering, and design stages are implemented during the construction stage.

The key activities that are performed during construction include:

- Conducting pre-construction coordination.
- Considering any alternate construction staging or traffic control approaches that may be proposed by the contractor through methods such as value engineering or partnering agreements<sup>1</sup>.
- Constructing the project and implementing the traffic control plan (TCP)<sup>2</sup>.
- Managing the construction and maintaining traffic through the work zone.
- Documenting any findings for assessments and evaluations.

During construction, agencies focus on implementing the TCP, managing the construction project, facilitating safety for motorists and workers, and maintaining traffic through the work zone. Recordkeeping of day-to-day project activities and tracking of project progress is performed using field diaries and project logs. Generally, such recordkeeping and tracking focuses on the actual construction (e.g., length of roadway section that is milled, volume of concrete placed). Construction and safety inspections are performed to ensure that the project execution and the TCP implementation comply with the plans, specifications, and estimates (PS&Es).

Many agencies recognize the need for increased monitoring and management of work zone safety and mobility impacts. For example, some agencies use queue thresholds, which if exceeded, could result in a temporary shutdown of the construction. Some agencies control work zone impacts through incentive/disincentive provisions for the contractor to limit delay (e.g., monitoring and management of travel time through the work zone). Many agencies are also trying to coordinate with stakeholders and communicate better with the public through web sites, project hotlines, and traveler information systems (e.g., 511<sup>3</sup> dial-in information, web sites, email updates). In spite of such efforts, there is recognition that a more concerted effort that employs transportation management concepts is needed to actively monitor and manage the work zone impacts of projects during construction.

<sup>1</sup> A brief overview of value engineering and partnering is provided in Section 7.4, under Step 2 of 7.

<sup>2</sup> In September 2004 the Federal Highway Administration (FHWA) updated the work zone regulation at 23 CFR 630 Subpart J and renamed it the Work Zone Safety and Mobility Rule (the Rule). The former Rule required the development of traffic control plans (TCPs) for all road projects. The updated Rule expands the former TCP requirement to now require the development and implementation of transportation management plans (TMPs) for all projects. More information on developing TMPs is available in *Developing and Implementing Transportation Management Plans for Work Zones*, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm).

<sup>3</sup> 511 is a 3-digit telephone number that is available for nationwide use. It provides current information about travel conditions, including information on work zones. This information is intended to help people make better travel decisions. Several States and metropolitan areas now offer 511 telephone traveler information services. More information on 511 is available online at <http://www.ops.fhwa.dot.gov/travelinfo/about/about511.htm> (Accessed 11/17/05).

## 7.2 Objectives of Work Zone Impacts Assessment During Construction

Work zone impacts can be better managed during construction by implementing transportation management plans (TMPs) for road projects, and by actively monitoring and managing work zone impacts during the course of the project implementation. Recognizing these aspects, the updated Work Zone Safety and Mobility Rule (the Rule) contains specific provisions that require TMP development and implementation, and the management of work zone impacts during project implementation. These provisions are briefly discussed below.

**Section 630.1012(b) of the Rule addresses TMPs.** A TMP consists of strategies to manage the work zone impacts of a project. Its scope, content, and degree of detail may vary based upon the State Department of Transportation or local transportation agency<sup>4</sup> work zone policy and understanding of the expected work zone impacts of the project. For a significant project (as defined in section 630.1010), the TMP must consist of a temporary traffic control (TTC) plan, and also address transportation operations (TO) and public information (PI) components. For individual projects or classes of projects that are determined to have less than significant work zone impacts, the TMP may consist only of a TTC plan. The consideration of TO and PI issues is encouraged for all projects.

**Section 630.1008(c) of the Rule pertains to management of work zone impacts during project implementation.** This provision requires the use of field observations, available work zone crash data, and operational information to manage work zone impacts for projects during implementation.

Table 1.1 in Section 1.6 of this document summarizes the provisions in the Rule that pertain to work zone impacts assessment and management.

In keeping with the above discussion, the objectives of work zone impacts assessment during construction are to:

- Address and resolve any pre-construction coordination issues.
- Assess the impact of any proposed changes prior to the start of work (e.g., contractor proposed alternate construction staging and/or TMP).
- Implement the TMP.
- Actively monitor and manage work zone impacts during construction.
- Revise the TMP and implement appropriate revisions, if necessary.
- Document any findings or lessons for use in performance assessments.

Work zone impacts management during construction may help answer questions such as:

- Were the assumptions, modeling/analysis, etc. that were made during project development accurate?
- Are there other TMP approaches and staging options not considered or incorporated during design that may further reduce work zone impacts?
- The work zone impacts assessment documentation indicates that the expected queue length is one-mile. Is that what is actually happening in the field?
- Are there any safety issues or locations where frequent incidents are occurring that the project construction team has been made aware of through project engineers, workers, or the general public?
- Are the work zone and the TMP meeting the overall expectations and performance goals for the project?
- Are individual TMP strategies as effective in managing work zone impacts as expected?
- Are there any bottleneck issues that need to be addressed?
- Do we need to make any modifications to the TMP or the construction staging so that work zone impacts can be managed better?
- Is there anything that we can learn from this project implementation, or is there any data/information that we can save for use in performance assessment?

## 7.3 Who are the Participants?

Table 7.1 shows the staff that may perform work zone impacts assessment during construction, along with the inputs and input providers, and the outputs and users of the output.

The Staff who may perform the assessment include:	
<ul style="list-style-type: none"> <li>■ The project construction team including construction managers, contractor managers, construction engineers, field personnel, project engineers, and construction/safety inspectors; and</li> <li>■ The project design team including designers, traffic engineers, highway engineers, safety engineers, and traffic operations and intelligent transportation system (ITS) engineers.</li> </ul>	
Inputs	Input Providers
<ul style="list-style-type: none"> <li>■ Applicable work zone policies, policy provisions, and performance goals/requirements.</li> <li>■ Outputs and products of the work zone impacts assessment conducted during design (PS&amp;Es, TMP, work zone impacts assessment documentation).</li> <li>■ Other inputs from regional stakeholders, the general public, and community/business representatives, as applicable.</li> <li>■ Contractor proposals for TMP revisions and construction staging.</li> </ul>	<ul style="list-style-type: none"> <li>■ Designers, pavement managers, bridge managers, traffic engineers/managers, safety engineers, planners, and maintenance managers.</li> <li>■ Technical specialists such as pavement experts, soil experts, hydraulics engineers, environmental experts, construction engineers, utility coordination personnel (water, sewage, power, gas, telecom infrastructure).</li> <li>■ Traffic management specialists (traffic operations/ITS).</li> <li>■ Marketing/public relations staff (as appropriate).</li> <li>■ Contractor managers and technical specialists.</li> <li>■ Other stakeholder groups such as local community representatives, business representatives, trucking associations, the American Automobile Association (AAA), and public safety agencies.</li> </ul>
Outputs	Users of the Outputs
<ul style="list-style-type: none"> <li>■ Observed and/or measured work zone impacts.</li> <li>■ Observed and/or measured effectiveness of TMP and/or individual TMP strategies.</li> <li>■ Revisions/refinements to the TMP, individual TMP strategies, and/or construction staging.</li> <li>■ Work zone safety and mobility performance information and data, lessons learned, and recommendations for policy/process improvements.</li> </ul>	<ul style="list-style-type: none"> <li>■ Executive level managers.</li> <li>■ The project design team including planners and designers, highway and safety engineers, traffic engineers, and ITS/operations engineers.</li> <li>■ The project construction team including construction management and contracting, construction and safety inspectors, traffic operations and ITS engineers, marketing/public relations personnel, law enforcement coordination, and the contractor and contractor staff.</li> <li>■ Other stakeholders, such as AAA, trucking associations, businesses, neighborhood associations, media, public safety agencies, and regional transportation management center (TMC) operators.</li> <li>■ Applicable personnel who are responsible for conducting performance assessment</li> </ul>

**Table 7.1 Construction Work Zone Impacts Assessment Participants**

## 7.4 Managing Work Zone Impacts During Construction

Figure 7.1 illustrates the steps involved in work zone impacts assessment during construction. Some notes pertaining to the figure are presented in Table 7.2.

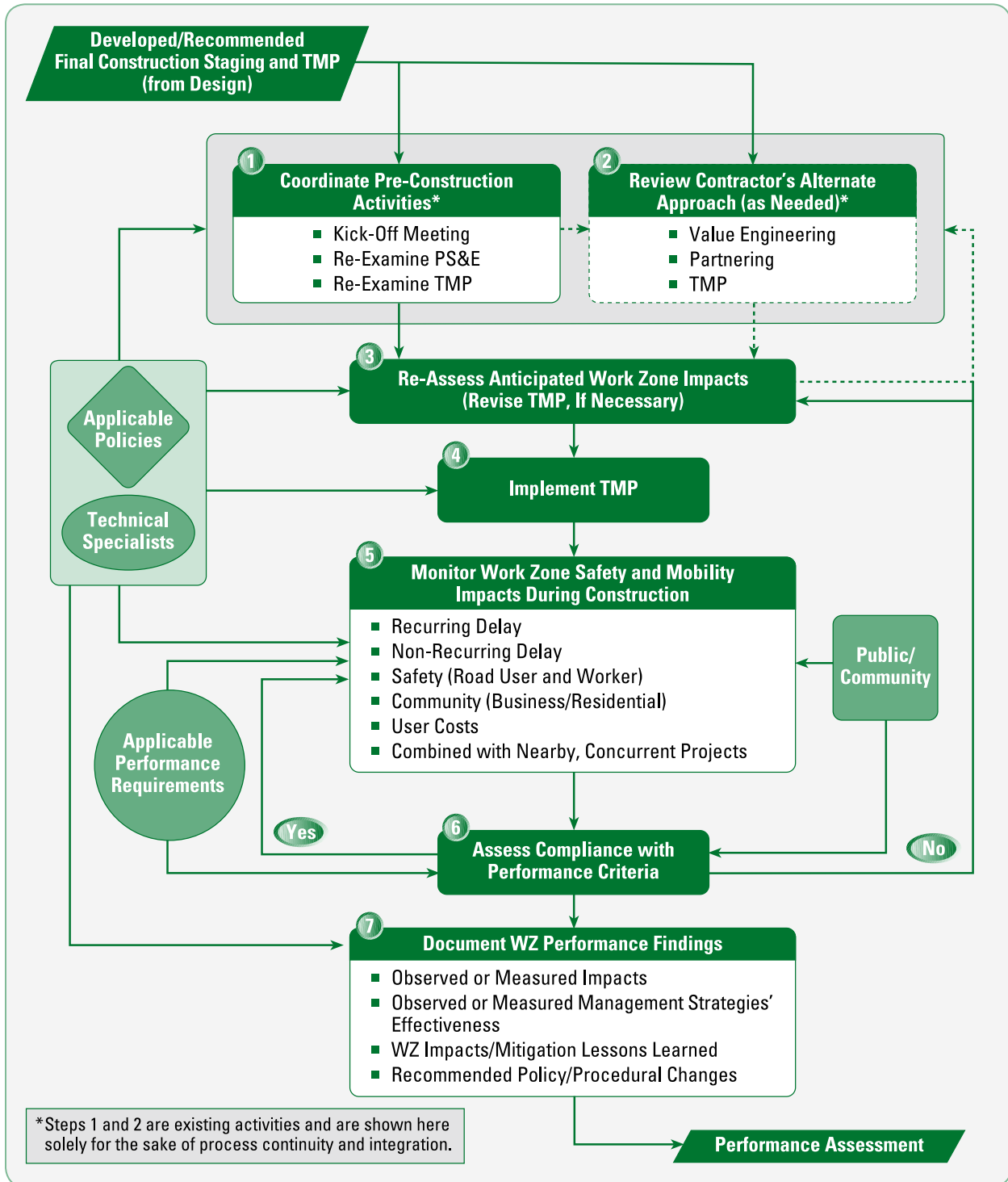


Figure 7.1 Construction — Work Zone Impacts Assessment Process

## Process Notes for Construction

**Input from and interaction with appropriate sources** (as shown in Figure 7.1), may be required during the process. These include:

- **Applicable Policies**, shown as a green diamond in the diagram, represents the agency's policies and related policy provisions (i.e., policy requirements, standards, and/or guidance) and appropriate processes, procedures, and practices that apply to the particular activity. They help with decision-making on specific issues during the process. For example, the agency's policy may recommend that any value engineering proposals submitted by the contractor need to be assessed for potential work zone impacts implications. Examples of other issues that may be addressed include work zone performance goals and/or requirements, type of work zone monitoring (e.g. qualitative vs. quantitative), issues to look out for (e.g., safety hot spots, congestion time and duration, work area access problems), performance aspects to monitor and/or measure (e.g., traffic volume, average speed, travel time, queue length, total crashes), and the actions to take based on the assessment results.
- **Technical Specialists**, shown as a green ellipse in the diagram, represents input from technical specialists in specific disciplines including highway engineers, construction engineers, traffic engineers, pavement specialists, structural engineers, environmental specialists, right-of-way (ROW) specialists, and hydraulics engineers.
- **Public/Community**, shown as a green square in the diagram, represents input from the general public including motorists, other highway users, businesses, residents, and neighborhood groups. This input may be provided through public involvement processes, customer feedback efforts, surveys, focus groups, etc.
- **Applicable Performance Requirements**, shown as a green circle in the diagram, represents the work zone performance requirements or goals. Such performance goals/requirements may be defined in the agency's policy for different types of projects and work zones (e.g., maximum allowable queue length for any freeway work zone is 3/4 of a mile for not more than a duration of half-hour at a time). Work zone performance goals/requirements may also be defined on a project-by-project basis.

**Table 7.2 Process Notes**

The following sections provide a brief discussion of the steps shown in Figure 7.1.

### □ **Step 1 of 7: Coordinate Pre-Construction Activities**

After the award of a contract, pre-construction coordination is performed to bring all concerned parties to the table, and to take steps towards project implementation. Typically, this involves holding a construction kick-off meeting that includes participation by agency construction management and inspection staff, project design staff, other technical specialists, contractor(s) and sub-contractor(s), utility companies, and local representatives (e.g., city, county). The purpose of this meeting is to review and re-examine the PS&Es and TMP, and develop action items related to next steps.

The TMP may be developed by the agency or by the contractor depending on the type of contract and agency policies and procedures<sup>5</sup>. For example, in the case of a performance-based contract, the contractor will have to develop the TMP based upon performance requirements specified by the agency. For a design-build contract, design and construction generally take place in tandem – i.e., when one phase of the project is being constructed, the subsequent phases are designed. Contractor developed TMPs should reflect the work zone impacts management objectives of the project, and must be submitted to the agency for review and approval prior to implementation.

<sup>5</sup> Section 630.1012(c) of the Rule addresses agency and contractor developed TMPs. It requires the plans, specifications, and estimates (PS&Es) to include either a TMP or provisions for contractors to develop a TMP at the most appropriate project phase as applicable to the chosen contracting methodology for the project. Contractor developed TMPs shall be subject to the approval of the State, and shall not be implemented before such approval.

If a TMP has already been developed (which is often the case), minor modifications may be proposed during pre-construction coordination. If the proposed changes are major, they are generally submitted through a formal value engineering process or through a partnering agreement between the agency and the contractor (discussed in Step 2). Any proposed modifications need to be assessed for work zone impacts implications (discussed in Step 3), and must be reviewed and approved by the agency prior to implementation.

Pre-construction coordination is already performed as part of existing construction programs and practices, and is included in this discussion for process continuity and integrity.

## □ Step 2 of 7: Review Contractor's Alternate Approach (As Needed)

This activity is performed on an as needed basis to respond to and review any alternate approach(es) that may be proposed by the contractor. The contractor may propose an alternate construction/staging approach or recommend changes to the TMP. Such a proposal may be submitted as part of the bid package, at the kick-off meeting, prior to the start of work, or further along in the construction process. The proposal may be submitted formally (i.e., through a value engineering proposal or through a partnering agreement) or informally. The purpose of such alternate proposals may be to reduce overall construction time, reduce project costs, improve construction quality, use better construction methods, and facilitate better work zone transportation management. Any changes that the contractor proposes are reviewed by the agency and must be approved prior to implementation. Issues that are addressed in such reviews include consistency with project objectives, worker safety, work zone safety and mobility needs, and adherence to standards and requirements such as agency design specifications and the Manual on Uniform Traffic Control Devices (MUTCD)<sup>6</sup>. The review of contractors' alternate proposals is already performed as part of current construction programs and practices.

The two most common approaches used to facilitate contractor participation are partnering and value engineering:

- **Partnering** is a concept whereby the agency and the contractor<sup>6</sup> work in a joint, non-adversarial relationship to complete a road project in a timely fashion with minimal disruption. The objective is to facilitate amicable and quick resolution of any possible issues and/or disputes that may arise during construction. All involved parties and the public benefit through such partnering. Partnering is initiated by conducting a workshop attended by decision makers and representatives from all stakeholder groups who are either affected by the outcome, or who can affect the outcome of the project. The workshop addresses issues such as construction phase responsibilities, work processes, conflict resolution, potential problems, and partnering follow-up activities. Costs of the partnering workshop are generally shared between the agency and the contractor. When utilizing the partnering process, the bid documents and PS&Es should include information on the partnering process so that the contractor understands that the agency's objective is to create a cooperative team environment.

<sup>6</sup> The MUTCD is available at <http://mutcd.fhwa.dot.gov>.

<sup>7</sup> If design is performed by a third party (e.g., a private consultant), the designer may also participate in the partnering process. In case of design-build contracts, the designer and contractor are part of the same team

- **Value engineering (VE)** is defined by the FHWA as “the systematic application of recognized techniques by a multi-disciplined team which identifies the function of a product or service; establishes a worth for that function; generates alternatives through the use of creative thinking; and provides the needed functions, reliably, at the lowest overall cost.”<sup>8</sup> Applying the VE process to suitable projects helps achieve the objective of the best overall project value for the taxpayer. Simply stated, VE is an organized application of common sense and technical knowledge directed at finding and eliminating unnecessary costs in a project. VE can either be performed during design or construction. Contractors may submit VE proposals for the agency’s review prior to or during construction. VE recommendations are not implemented before review and approval by the agency. More information on value engineering is available on the FHWA Value Engineering web site at <http://www.fhwa.dot.gov/ve/index.htm> (Accessed 11/15/05).

Any changes that are proposed to the project need to be assessed for their work zone impacts implications before they are approved, and the TMP may need to be adjusted to reflect those changes. For example, in the case of VE, the project team should not compromise on the TMP and the work zone safety and mobility needs of the project just to save costs. The reassessment of work zone impacts in response to any proposed changes is discussed in Step 3.



- TIP:**
- Partnering and VE studies can be used to identify potential ways to further reduce work zone impacts. This is not intended to supplant the proactive intent of early assessment (in prior planning and design stages), but would help capitalize on the more detailed information and practical knowledge that are available during construction. For example, a project involving lane closures may call for work to be performed on weekdays in the time window between the morning and evening peak periods of travel. The contractor, as part of a VE proposal may suggest a combination of night work and extended weekend closures. This may help reduce the ongoing work site setup and break down costs, increase the window of work available, and reduce the duration of the project, thereby reducing overall costs and accelerating project completion. As part of the VE proposal, the contractor may also conduct an assessment of the work zone impacts of the proposed approach, and indicate to the agency that due to a combination of night work, weekend work, and accelerated project delivery, the work zone impacts are expected to be reduced.
  - The agency’s policies, procedures, and processes should allow the flexibility necessary to explore and utilize various approaches to address work zone related issues and impacts. VE studies and partnering agreements are encouraged, consistent with regulatory requirements and thresholds, to help assess the potential for work zone impact reductions. Adequate agency procedures should be in place to ensure that contractor proposals are reviewed in a timely manner, and that a response is provided to the contractor in sufficient time to take advantage of any improvements the proposal may offer. Contractor innovation can be encouraged by allowing the contractor to share in any cost savings achieved through the implementation of such proposals.





The South Carolina Department of Transportation (SC DOT) and the South Carolina FHWA Division conducted a partnering workshop to develop initiatives to improve traffic flow and safety and reduce actual construction time on the State's highways. The 1-day workshop drew representatives from SC DOT, contractors, industry, and FHWA. The workshop was jointly hosted by FHWA, SC DOT, and the Carolina Associated General Contractors of America (CAGC). The purpose of the workshop was to identify contracting issues, specifications, and other barriers to reducing construction time, improving safety, and minimizing traveler inconvenience and disruption in work zones. The workshop participants then worked on finding ways to overcome those barriers.

Source: FHWA Construction and Maintenance Fact Sheets – Optimizing Highway Performance: Partnering for Work Zone Safety in South Carolina, December 1998. URL: <http://www.fhwa.dot.gov/construction/fs98001.pdf> (Accessed 11/23/05).



The State of Florida uses flexible start times (up to 100 days from notice to proceed) to reduce the time period the public is exposed to construction conditions and increase the frequency of completing contracts within the authorized contract time.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 9/13/05).

### **Step 3 of 7: Reassess Anticipated Work Zone Impacts (Revise TMP, if necessary)**

As a result of the pre-construction activities and/or any alternate approach(es) proposed by the contractor, the agency, the contractor, and/or the project design team may need to re-assess the potential work zone impacts and “tweak” the TMP to effectively manage safety and mobility on the project. Construction supervision staff and traffic control/management specialists may also be involved in the re-assessment and tweaking of the design level TMP.

Any changes proposed by the contractor (or others) to the construction staging or to the TMP should be re-assessed for effects on work zone impacts, and on the potential effectiveness of the TMP. Any proposed changes will need to be approved by the agency prior to implementation. For example, the contractor may propose an alternate approach that proposes to reduce the cost of the project and the total construction duration. The agency should review any cost reductions to see that they will not compromise work zone safety and mobility (e.g., reduction or elimination of work zone safety devices and/or TMP components that help preserve mobility). The agency should also ensure that any proposed reduction in construction duration does not adversely influence work zone impacts (e.g., extending construction into the peak periods of travel can result in intolerable travel delays to motorists).

The following activities may be considered as a framework for the reassessment of the work zone impacts:

- Determine if any issues identified during pre-construction coordination may affect the work zone impacts of the project (e.g., assess potential impacts of any planned maintenance and operations (M&O) activities to determine if they affect planned traffic operations for the work zone).
- Understand any proposed changes.
- Identify any effects that the proposed changes may have on the original thinking with regards to work zone impacts, and work zone design and transportation management.
- If necessary (e.g., if the proposed changes are major) apply the concepts and impacts assessment steps recommended in the design section of this document (Section 6.0).
- Revise the work zone impacts assessment to reflect the changes.
- If the potential work zone impacts are expected to be different (from what was originally anticipated), identify any new strategies for inclusion in the TMP or modify existing TMP strategies or construction staging appropriately<sup>9</sup>.
- Understand the cost implications of the additions or revisions to the TMP and develop an action plan to account for any potential cost increases (or allocate and share any potential cost decreases).

If no changes are proposed to the construction staging or the TMP in Steps 1 and 2, the reassessment of work zone impacts in this step may be accomplished with minimal effort, and may involve just a quick recap and re-confirmation of expected impacts.

#### **Step 4 of 7: Implement TMP**

This involves the implementation of the selected construction staging approach and TMP. Practitioners are encouraged<sup>10</sup> to consult with appropriate stakeholders on an ongoing basis for the duration of the construction. Examples of stakeholders include transit agencies, regional transportation management centers (TMCs), law enforcement and emergency response agencies, local and regional transportation agencies, railroad operators, freight movers, utility suppliers, schools, and business communities. The purpose of such consultation is to keep the stakeholders informed, seek their input on and knowledge of regional issues, and improve inter-agency and intra-agency coordination and response to work zone issues. Sometimes, such consultation may also include the general public, and community and business organizations, as appropriate.

Ongoing communication with the public, as part of the PI component of the project (if applicable) or through other methods and channels, is also an important aspect of TMP implementation and work zone management during construction. Such public outreach and communication may include information on the expected work zone impacts, changing conditions on the project (i.e., lane closures, ramp-closures, etc.), commuter alternatives and incentive programs, and real-time traveler information. More detailed information on work zone related public information and outreach is available in **Work Zone Public Information and Outreach Strategies**<sup>11</sup>.

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<sup>9</sup> This is represented in Figure 7.1 as the dotted arrow that connects Step 3 back to Steps 1 and 2.

<sup>10</sup> Section 630.1012(b)(4) of the Rule recommends that TMPs be developed and implemented in sustained consultation with stakeholders.

<sup>11</sup> Available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm)

## □ **Step 5 of 7: Monitor Work Zone Safety and Mobility Impacts During Construction**

Steps 5 and 6 represent the ongoing management of work zone impacts in the field during the construction phase. In this step, work zone safety and mobility are monitored and/or measured to determine how well the TMP and the work zone are performing. Until construction is underway, information pertaining to work zone impacts is expected or anticipated. Once construction begins, it is the responsibility of the agency, construction management team, and/or the contractor team to monitor and/or measure the actual work zone impacts of the project. They determine if the actual impacts comply with agency policies, fall within a reasonable range of what was anticipated (e.g., expected impacts predicted through prior analyses, any performance requirements specified in the contract), and whether the impacts meet the desired level of safety and mobility performance for that work zone. Applicable performance requirements and criteria may have been determined during design and incorporated in the contract documents and PS&E package.

Monitoring and measuring<sup>12</sup> may be done with available information and data sources, including field observations, crash data, operational information, and construction and safety inspections. Sometimes the contractor may have to take additional action to monitor and/or measure the work zone impacts. Examples of such actions include measuring travel time through the work zone using floating car studies or having tow-trucks available on stand-by to clear any incidents so as to maintain traffic flow through the work zone. Record keeping on project events and incidents (e.g., queue spillover, crashes) and other issues may also aid this process.

While specific issues vary from project to project, the major performance aspects to monitor/measure include safety, recurring congestion, non-recurring congestion (e.g., incident related delay), community and environmental impacts, and combined issues/impacts with nearby, concurrent projects. Congestion in the work zone can also affect project efficiency. Issues such as delays to vehicles delivering materials to the work zone may be indicators of work zone congestion. Examples of performance aspects that may be monitored are provided in Table 7.3, and more detail is available in Section 8.0 of this document. Depending on the project, feedback from businesses, residents, and neighborhood groups may also be appropriate. If it is determined that the actual work zone impacts are unacceptable, then the team needs to identify approaches to modify the TMP and/or the construction staging approach to minimize the impacts. This is discussed in Step 6.

<sup>12</sup> Section 630.1008(c) of the Rule requires the use of field observations, available work zone crash data, and operational information to manage work zone impacts for specific projects during implementation.

Performance Aspect	Sample Considerations
<b>Safety</b>	<ul style="list-style-type: none"> <li>■ Has the average number of total crashes for that corridor/locality increased since construction started?</li> <li>■ Are there any obvious safety issues related to the TMP, such as, inadequate lane widths, tight turning radii, inadequate advance warning?</li> </ul>
<b>Recurring congestion</b>	<ul style="list-style-type: none"> <li>■ Are queues within acceptable limits?</li> </ul>
<b>Non-recurring congestion</b>	<ul style="list-style-type: none"> <li>■ Is incident related congestion within acceptable limits?</li> <li>■ Is the work zone incident response/management plan meeting pre-established response and clearance times?</li> </ul>
<b>Community and environmental impacts</b>	<ul style="list-style-type: none"> <li>■ Are there any complaints from the residential and business communities regarding construction related disturbance, access issues, etc?</li> <li>■ Are user costs as a result of the work zone impacts within acceptable limits?</li> </ul>
<b>Combined impacts</b>	<ul style="list-style-type: none"> <li>■ Has the project construction zone adversely impacted adjacent construction zones or has it been impacted by other projects?</li> </ul>
<b>Project impacts</b>	<ul style="list-style-type: none"> <li>■ Have there been delays in the delivery of materials to the work zone?</li> <li>■ Have the management strategies reduced these delays?</li> </ul>

**Table 7.3 Sample Performance Aspects to Monitor and Measure**



In Missouri, active construction work zones are reviewed by the appropriate Missouri DOT (MoDOT) resident engineer and the district engineer to ensure that the following actions are taken:

- Notify the District Work Zone Coordinator 48 hours before any work requiring a lane closure begins
- Work with the contractor to ensure lane closures are minimized
- Make every effort to minimize traffic backups
- Ensure all contract specifications, special provisions, and work restrictions are enforced
- Ensure all work zones are neat, orderly, and effective for the safety of highway workers and motorists
- Ensure work zone speed limits are appropriate in active and non-active work.

Source: Missouri Department of Transportation, 2003 MoDOT Work Zone Guidelines, March 2003, URL: [http://modot.mo.gov/business/documents/MoDOT2003WorkZonesGuidelines\\_000.pdf](http://modot.mo.gov/business/documents/MoDOT2003WorkZonesGuidelines_000.pdf) (Accessed 09/13/05).



On major Interstate reconstruction projects, the Iowa Department of Transportation uses contract services to provide 24-hour-per-day continuous monitoring of traffic control devices and incident response. The contractor traverses the work zone providing assistance to stranded motorists and maintaining traffic control devices. This results in better traffic flow and prompt notification of incidents and problems.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 8/15/05).

## □ Step 6 of 7: Assess Compliance with Performance Criteria

This step represents the decision-making juncture where the information/data from the impacts monitoring and measurement performed in the previous step are used to determine whether the TMP and/or construction staging approach need to be modified in order to manage work zone impacts better. This may be performed by the agency and/or construction/contractor team, with any changes being reviewed and approved by the agency prior to implementation.

If the actual work zone impacts of the project are within acceptable limits of performance requirements and criteria established for the project or by agency policy, then no changes are needed, and the TMP implementation and monitoring should continue<sup>13</sup>.

If the actual work zone impacts are not within acceptable limits of the performance requirements and criteria, then the project construction/contractor team should take the necessary actions to minimize the impacts. One option is to implement any pre-established TMP contingency plans<sup>14</sup> or use “what-if loops” to resolve any unintended consequences (e.g., if queues are excessive, parking restrictions may be implemented on a detour route to provide more travel lanes during peak periods. If that does not suffice, the TMP and/or the construction staging approach may need to be modified appropriately<sup>15</sup>. This revision may either be a small change that is carried out with the approval of the project engineer on site, or may be a more involved process that requires work stoppage, identification of problem areas or issues, reassessment of the work zone impacts, and modification of the construction staging and/or TMP. TMP and construction staging modifications need to be approved by the agency prior to implementation. The input and participation of the project design team and other technical specialists should be sought as necessary and appropriate for the situation at hand.

<sup>13</sup> This is represented in Figure 7.1 as the arrow that connects Step 6 back to Step 5 with a “Yes” indication (i.e., the performance criteria and requirements are being met).

<sup>14</sup> More detailed information on TMPs and contingency plans is available in Developing and Implementing Transportation Management Plans for Work Zones, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm) (Accessed 11/15/05)

<sup>15</sup> This is represented in Figure 7.1 as the solid arrow that connects Step 6 back to Step 3, and its dotted extension to Steps 1 and 2. This arrow has a “No” indication (i.e., the performance criteria and requirements are not being met).



In 1997, the Virginia Department of Transportation (VDOT) implemented a Work Zone Safety Checklist for reviewing and documenting the status/condition of work zones for construction/maintenance/utility/permit operations. Construction inspectors are required to fill out the form at least once a week. Every other review is performed at night. The contractor is given a copy for correcting work zone deficiencies, and a copy is filed with the project records. This resulted in consistent work zone reviews, improved documentation of work zone conditions, and improved response time to work zone deficiencies by contractors.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 11/23/05).

### **Step 7 of 7: Document Work Zone Performance Findings**

This step involves the documentation of the findings of the work zone impacts monitoring process. This documentation should be done throughout the course of the project construction phase. If possible, after the project is complete, this information should be summarized to document:

- The observed and/or measured impacts.
- A comparison of the actual work zone impacts versus the anticipated work zone impacts of the project.
- The effectiveness of the implemented TMP and its constituent management strategies.
- Best practices.
- Innovative approaches/techniques/technologies used on the project.
- Lessons learned and mistakes to avoid.
- Any recommendations for policy or procedural change.

Such performance documentation, if performed at the individual project-level, supports the assessment of work zone performance on a large scale (regional/district level, agency-level, State-level, etc.). Information for project-level assessments provides the basis for conducting overall agency work zone performance assessment (discussed in Section 8.0 of this document).

## 8.0 Performance Assessment

### 8.1 What is Performance Assessment?

Periodic evaluation of work zone policies, processes, procedures, and work zone impacts aids in the process of addressing and managing the safety and mobility impacts of work zones. Performance assessments both at the *project-level* and *program-level* provide the required feedback to make policy, process, procedure, and program improvements and evaluate the effectiveness of work zone management strategies.

Understanding how work zones perform is a critical step in identifying how to improve work zone safety and mobility. The updated Rule (the Rule) contains provisions that address work zone performance assessment. Section 630.1008(c) of the Rule requires State Departments of Transportation and local transportation agencies<sup>1</sup> to “continually pursue improvement of work zone safety and mobility by analyzing work zone crash and operational data from multiple projects to improve State processes and procedures.” It also recommends that, “States should maintain elements of the data and information resources that are necessary to support these activities.” Section 630.1008(e) requires States to perform a process review at least every two years. This review may include the evaluation of work zone data Statewide and/or for randomly selected projects. Appropriate staff representing the various project development stages, different offices within the State, and the Federal Highway Administration (FHWA) should participate in this review. Other non-State stakeholders may also participate, as appropriate. The results of the review are intended to lead to improvements in work zone processes and procedures, data and information resources, and training programs to enhance efforts to address safety and mobility for current and future work zones. Ongoing performance assessment helps an agency gather information and identify issues and successful practices that will be useful in performing process reviews<sup>2</sup>.

Work zone performance assessment is not intended to require agencies to embark on a large data collection, storage, and analysis effort. The goal is to improve work zone safety and mobility by making effective use of the available data and information sources. Examples of available data and information sources include project logs, field observations, crash records, operational data from transportation management centers (TMCs) and intelligent transportation system (ITS) devices, other monitoring activities including work zone speed enforcement or citations, and complaints from the public and other stakeholders.

### 8.2 Objectives of Work Zone Performance Assessment

Work zone performance assessment may be performed at two levels: 1) at the program-level (i.e., assessing the performance of work zone policies, processes, and procedures); and 2) at the project-level (i.e., assessing the actual performance of the work zone and management strategies on individual projects in the field). Performance assessment includes:

- Collection of data, including project-related information and public/stakeholder perception data.

<sup>1</sup> Hereinafter referred to as agencies.

<sup>2</sup> More information about performing process reviews can be found in Section 4.0 of Implementing the Rule on Work Zone Safety and Mobility, available at [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm).

- Synthesis and analysis of data at multiple levels (i.e., project, program, local, regional, State, and national) and comparison of findings to performance metrics.
- Application of the analysis results toward continually improving work zone policy, practices, policies, processes, and procedures.

There are four key measures of work zone performance:

- Safety.
- Mobility.
- Construction efficiency and effectiveness.
- Public perception and satisfaction.

Where feasible and appropriate, these performance measures should be evaluated quantitatively. In the absence of funding and/or data availability, measures of performance may be evaluated qualitatively.

Development and application of the performance assessment process for work zones will help address the following concerns:

- How are work zones performing with respect to mobility and safety?
- Are the best possible decisions in planning, designing, and implementing our work zones being made?
- Are customer expectations being met with respect to maintaining safety and mobility and minimizing business and community impacts both through, and in and around the work zone?
- Can areas for improvement be identified?
- What has worked/not worked – which strategies have proven the most/least effective in improving the safety and mobility of work zones?
- What other strategies can be considered for implementation?
- Are there certain combinations of strategies that seem to work well?
- Are there any work zone safety and mobility trends that can be identified, either at the national level or local level? What can be done to advocate the characteristics associated with the good trends? What can be done to remedy the problems associated with the bad trends?
- Should policies or standard procedures be adjusted based on what has been observed and/or measured?
- Can consistency be brought about through the identification of trends, issues, and problems and in the standardization of tools and guidelines for application at the agency and/or national level?



### 8.3 Who are the Participants?

The end users of the performance assessment process are the management-level executive and technical staff who will use the findings to refine and/or develop new policies, processes, and procedures. However, the assessment of performance and development of recommendations will likely be performed by technical staff with input and review by different disciplines, including: planning, engineering and design, construction, maintenance, and operations. Table 8.1 shows the likely participants in performance assessment.

<ul style="list-style-type: none"> <li>■ The staff who may perform the performance assessment are typically technical and may be from one of many disciplines, depending on the organizational structure of the agency.</li> <li>■ Based on the performance assessment findings, the technical staff provide input to management-level staff for policy, process, and procedural modifications.</li> </ul>	
Inputs	Input Providers
<ul style="list-style-type: none"> <li>■ Applicable work zone policies and policy provisions – What are we assessing performance against? What are our performance objectives?</li> <li>■ Project/work zone details including project type, work zone characteristics, and influencing factors (e.g., weather, special events) and work zone management strategies used.</li> <li>■ Construction and/or transportation management plan (TMP) evaluation/effectiveness documentation for individual projects, including:                         <ul style="list-style-type: none"> <li>- Observed/measured impacts.</li> <li>- Observed/measured effectiveness of management strategies.</li> <li>- Comparison of what really happened versus what was planned/predicted.</li> <li>- Lessons learned.</li> <li>- Recommended policy/procedural changes.</li> </ul> </li> <li>■ Information, experiences, findings, and lessons learned from other aspects of program delivery.</li> <li>■ Public outreach and stakeholder feedback.</li> </ul>	<ul style="list-style-type: none"> <li>■ Agency technical staff, including planners, designers, engineers, and technical specialists, who are responsible for planning and designing road projects.</li> <li>■ Field staff, including construction engineers, project engineers, and field inspectors, who are responsible for building the project and for monitoring and managing the work zone impacts of the project in the field).</li> <li>■ Contractor staff and contracting associations (e.g., ATSSA, ARTBA, AGC)<sup>3</sup>.</li> <li>■ General public, through public outreach and feedback.</li> <li>■ Regional stakeholders such as regional transportation providers, police, fire, emergency medical services, regional TMCs, local jurisdictions (county, city, village, township, etc.), and railroad agencies and operators.</li> <li>■ Industry and public safety associations such as trucking associations, the American Automobile Association (AAA), etc.</li> <li>■ Media agencies including newspapers and television agencies.</li> </ul>
Outputs	Users of the Outputs
<ul style="list-style-type: none"> <li>■ Analysis results of performance/impacts (i.e., crashes, delay, speeds, travel times, throughput, queue length, etc.).</li> <li>■ Effectiveness of management strategies.</li> <li>■ Lessons learned, trends, successes, failures, and best practices.</li> <li>■ Recommended changes/improvements to policies, processes, practices, and procedures for continuing improvement to policy, planning, design, and construction processes, and performance assessment.</li> </ul>	<ul style="list-style-type: none"> <li>■ Management level staff who represent the highest level of decision-making in the agency.</li> <li>■ Technical staff (planners, designers, engineers, etc.) responsible for recommending and implementing policies, processes, and procedures.</li> <li>■ Field staff (construction, inspection, etc.) and consultant/contractor staff who are responsible for identifying, implementing, and recommending policy, program, procedure, and project development and implementation changes or improvements.</li> </ul>

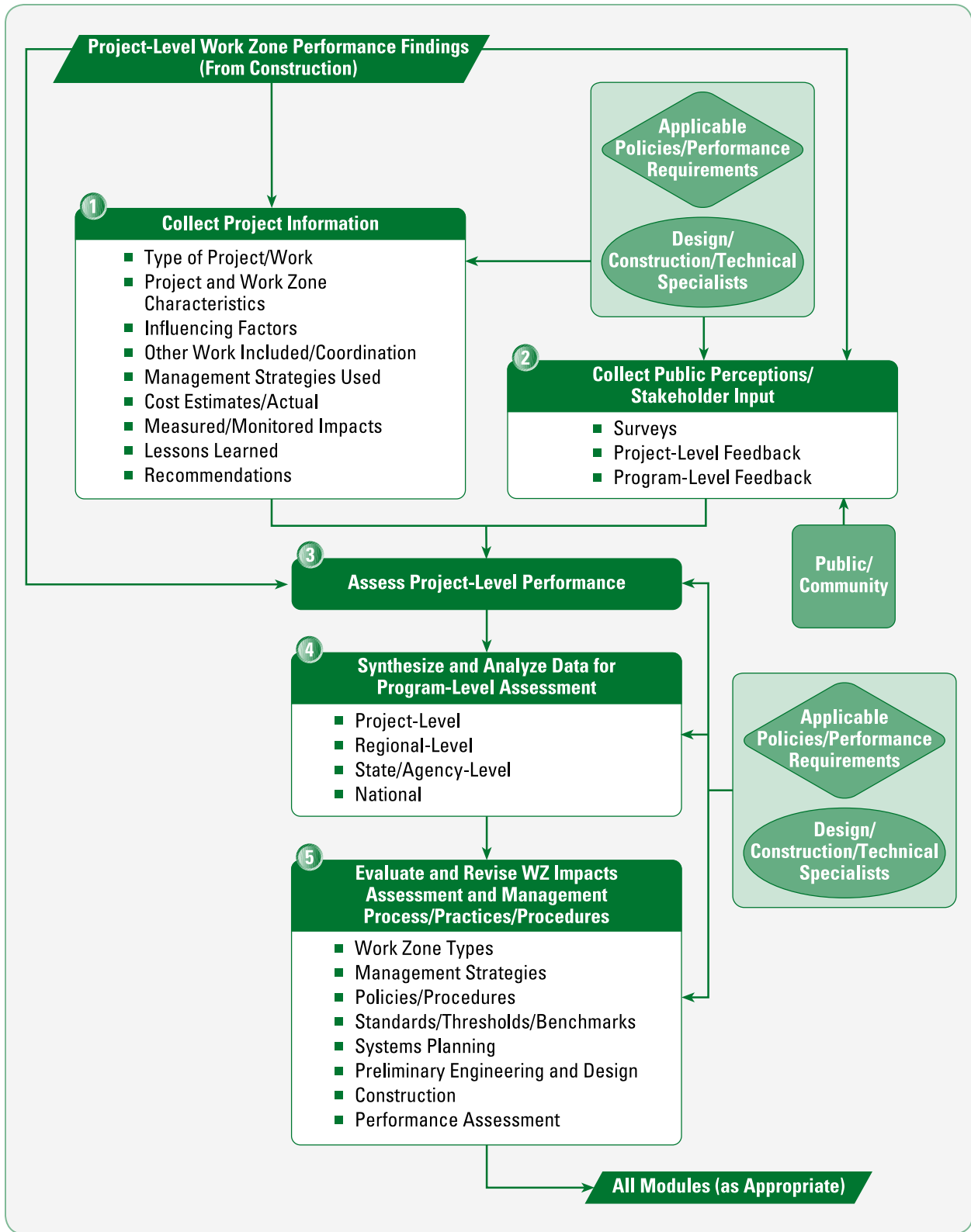
**Table 8.1 Performance Assessment Participants**

<sup>3</sup> ATSSA – American Traffic Safety Services Association; ARTBA – American Road and Transportation Builders Association; AGC – Associated General Contractors of America

## 8.4 Conducting Work Zone Performance Assessment

In general, the current state of work zone performance assessment is in its infancy. However, information that could be used for such an evaluation is often available or will be available in the future as agencies face increased pressure to measure and report performance to stakeholders; more technology is deployed through ITS and TMCs; and as agencies further implement the requirements and recommendations of the Rule.

The steps described in the following pages provide guidance and a method to develop and improve work zone impacts assessment and ultimately, improve work zone policies, processes, and procedures. Generally, this guidance consists of the steps identified in Figure 8.1. Some notes pertaining to the figure are presented in Table 8.2.



**Figure 8.1 Work Zone Performance Assessment Process**

### Process Notes for Performance Assessment

**Input from appropriate sources** (as shown in Figure 8.1), may be required during performance assessment. These include:

- **Applicable Policies/Performance Requirements**, shown as a green diamond in the diagram, represents the agency's policies and related policy provisions (i.e., policy requirements, standards, and/or guidance) and appropriate procedures, procedures, and practices that may relate to the particular activity. These policies drive decision-making on issues such as the type of performance assessment (e.g. qualitative vs. quantitative), performance measures to assess (e.g., traffic volume, average speed, travel time, queue length, total crashes), ways to measure (e.g., data on speed variance in the work zone, if available, can be used as a safety indicator), and the type of actions to take based on the assessment results.
- **Design/Construction/Technical Specialists**, shown as a green ellipse in the diagram, represents input from design engineers, traffic engineers, and construction engineers who have a good understanding of project design and construction issues. It also represents input from technical specialists in specific disciplines including highway engineers, pavement specialists, structural engineers, environmental specialists, right-of-way (ROW) specialists, and hydraulics engineers.
- **Public/Community**, shown as a green square in the diagram, represents input from the general public including motorists, other highway users, businesses, residents, neighborhood groups, etc. This input may be provided through public involvement processes, customer feedback efforts, surveys, focus groups, etc.

**Table 8.2 Process Notes**

#### □ **Step 1 of 5: Collect Project Information**

The first step in performance assessment is to collect and synthesize project-level information. As shown in the process diagram, this includes information and data items pertaining to the project characteristics, project environment, TMP and its strategies, anticipated and actual work zone impacts, costs, lessons learned, and recommendations for policy and/or procedural change. Project information may be grouped as shown in Table 8.3.

<p><b>Project/Work Zone Details</b></p>	<p>Detailed information on the type of work and configuration of the work zone, such as:</p> <p><b>Project Type</b></p> <ul style="list-style-type: none"> <li>■ Impact based classification (e.g., significant and non-significant).</li> <li>■ Functional classification (based on type of roadwork being performed).</li> </ul> <p><b>Project and Work Zone Characteristics</b></p> <ul style="list-style-type: none"> <li>■ Location (urban, suburban, rural).</li> <li>■ Road classification.</li> <li>■ Owner agency (State, region, county, city).</li> <li>■ Length.</li> <li>■ Duration.</li> <li>■ Geometrics.</li> <li>■ Working hours.</li> <li>■ Lane closure scenarios and strategies (positive separation, lane closure, total road closure, etc.).</li> <li>■ Choice of materials (i.e., concrete or asphalt, etc.).</li> <li>■ Project cost.</li> <li>■ Contracting method (single contract vs. multiple contracts, etc.).</li> </ul>
<p><b>Influencing Factors (Context)</b></p>	<p>Factors that may have had an influence on the observed and/or measured performance impacts, such as:</p> <ul style="list-style-type: none"> <li>■ Travel modes served.</li> <li>■ Availability of alternative routes.</li> <li>■ Presence of other concurrent work zones nearby.</li> <li>■ Weather.</li> <li>■ Incidents.</li> <li>■ Special events.</li> <li>■ Road and pavement condition (geometrics, pavement type, road condition).</li> <li>■ Regional information (such as the existence of a regional ITS system).</li> </ul>
<p><b>Work Zone Management Strategies</b></p>	<p>The types of work zone mitigation measures and strategies utilized are an important element. These include:</p> <ul style="list-style-type: none"> <li>■ Temporary traffic control (TTC) strategies.</li> <li>■ Public information (PI) strategies.</li> <li>■ Transportation operations (TO) strategies.</li> <li>■ Use of ITS or other surveillance equipment for work zone monitoring and operations.</li> <li>■ Management strategies and improvements made on alternate routes.</li> <li>■ Costs associated with the management strategies and monitoring.</li> </ul>
<p><b>Performance Information</b></p>	<p>Observed and/or measured performance impacts of the work zone and the management strategies collected during the construction or maintenance activity or monitoring. This may include indirect measure. For example, speeds through a work zone in excess of the posted speed limit could be an indirect measure of safety (i.e., unsafe conditions exist even though crashes may not have been observed in the specific instance). Also includes recommendations and lessons learned.</p>

**Table 8.3 Project Information Categories and Examples for Performance Assessment**

## □ Step 2 of 5: Collect Public Perceptions/Stakeholder Inputs

In addition to observed and/or measured performance, another important aspect of performance assessment involves public perceptions and input. Meeting the performance requirements alone does not guarantee that the public's expectation with regards to the safety and the quality of their travel is met. Public perception often turns out to be an eye-opener for many agencies. Therefore, it is important to get feedback from the public regarding the effectiveness of an agency's work zone transportation management efforts. (Similarly, as illustrated in the process flow diagrams for the other processes, it is important to appropriately involve the public and solicit their input during the various phases of project planning and development). If public perception surveys, focus groups, or other data collection efforts are conducted during project implementation, that information should be included in performance assessment. Stakeholder feedback and input through surveys and complaints may also be used to assess public perceptions at the program, regional, and/or agency-levels.



The New Mexico State Highway and Transportation Department assessed the use of ITS strategies for the Big I Construction Project (I-40/ I-25) in Albuquerque to manage traffic through the work zone. The assessment included system performance, system evaluation, mobility and safety impacts, cost savings, public reception/reaction, and obstacles encountered/lessons learned.

Source: Intelligent Transportation Systems in Work Zones: A Case Study. Work Zone Traffic and Incident Management System, 2004, URL: <http://www.ops.fhwa.dot.gov/wz/its/index.htm> (Accessed 8/16/05).

## □ Step 3 of 5: Assess Project-Level Performance

Agencies are encouraged to perform project-level performance assessments to improve work zone policies, processes, and procedures and improve their work zone data and information resources. Most of the data needed for this assessment should be available from each project's monitoring efforts including field observations, crash data, and operational data. It is important that traffic and safety monitoring data collected during construction be documented and maintained in a consistent manner for each project. Table 8.4 presents some examples of performance measures that may be considered.



The Michigan Department of Transportation conducted an evaluation of the temporary ITS for the reconstruction of I-496 in Lansing.

Source: Federal Highway Administration, ITS Deployment Analysis System Case Study 2: Michigan Department of Transportation Evaluation of the Temporary ITS for the Reconstruction of I-496 in Lansing, Michigan, April 2002. URL: <http://www.camsys.com/idas/CaseStudies/CaseStudy2/caseStudyFrame.htm> (Accessed 09/13/05).

Work Zone Performance Assessment Areas	Example Measures/Impacts
<p><b>Work Zone Safety Performance.</b> This aspect of work zone performance addresses both traffic and worker safety. Measures are typically obtained over/during a period of time.</p>	<ul style="list-style-type: none"> <li>■ Traffic crash statistics.</li> <li>■ Circumstances leading to the occurrence of crashes.</li> <li>■ Influencing factors.</li> <li>■ Average speeds and speed variance.</li> <li>■ Worker fatalities and injuries.</li> <li>■ Work area incidents/near misses.</li> </ul>
<p><b>Work Zone Mobility Performance.</b> This aspect of work zone performance provides a representation of the ease, convenience, and efficiency of the transportation system through, in, and around the work zone. Specifically, work zone mobility pertains to moving road users smoothly through or around a work zone area with a minimum delay compared to baseline travel when no work zone is present.</p>	<ul style="list-style-type: none"> <li>■ Delay.</li> <li>■ Speed.</li> <li>■ Travel time.</li> <li>■ Queue length.</li> <li>■ Vehicle and/or person throughput.</li> <li>■ Business/community accessibility.</li> </ul>
<p><b>Construction Efficiency and Effectiveness.</b> This aspect of work zone performance provides an assessment of the efficiency and the effectiveness of the actual construction project itself. Even though the efficiency and effectiveness of construction may seem like an unrelated aspect, it is key to the safety and mobility performance of work zones. For example, project delays cause the impacts of the work zones to last longer, and poor quality work require repetitive fixes and repairs at a later stage.</p>	<ul style="list-style-type: none"> <li>■ On-time completion.</li> <li>■ Cost-efficiency/effectiveness.</li> <li>■ Quality of work.</li> <li>■ Needs satisfaction (i.e., project addressed roadway issues/problems).</li> </ul>
<p><b>Public Perception.</b> This aspect of work zone performance provides an indication of what the traveling public feels about the performance and impacts of work zones. In spite of the best possible work zone designs and management strategies used, negative public perception about a project may damage the image of a transportation agency, perhaps even resulting in project stoppage. Public perception data can be collected before, during, and after the implementation of road projects. Documentation of public input may yield information that may be useful for implementing work zone designs and strategies that resonate with what the public wants. Public perception data may be collected through surveys (telephone, Internet, roadside), focus groups, and public meetings.</p>	<ul style="list-style-type: none"> <li>■ Calls/comments received – pro and con.</li> <li>■ Customer satisfaction indexes.</li> <li>■ User perceptions about the safety and mobility of the work zone.</li> <li>■ Use of certain management strategies (e.g., web site visits).</li> <li>■ User perceptions about the effectiveness of certain management strategies.</li> </ul>

**Table 8.4 Example Work Zone Performance Assessment Measures**

## □ **Step 4 of 5: Synthesize and Analyze Data for Program-Level Assessment**

This step represents the synthesis and analysis of performance assessment data and information gathered from the various sources. This data may be aggregated and collated to perform analysis and make inferences/recommendations at the project, program, regional, State and/or national levels. Appropriate data analysis tools may be used for the assessments (e.g., spreadsheets, statistical analysis tools, simulation software).

Project-level work zone performance data serve as the basis for program-level and other higher-level assessments. The flow of data to and from the project-level to other higher levels will likely require a few years of data collection at the project-level to establish critical masses and statistically significant trends and inferences. Such data flows from the project-level to other higher levels and vice-versa should ideally reflect a bottom-up as well as a top-down flow structure. The bottom-up flow represents the incremental flow of basic data and the associated analyses from the project-level through the higher levels. The top-down flow represents the reverse data flow of national-level trends, figures, and analyses that may be used for decision-making at the State, regional, program and project-levels.

The lack of sufficient before and after data, especially before data, is often cited as a hindrance to performance measurement assessments. The establishment of a comprehensive work zone performance measurement framework and sustained implementation of work zone performance measurement will eliminate such obstacles. The four areas of interest in work zone performance assessment are safety, mobility, construction efficiency and effectiveness, and public perception and satisfaction. These are presented in Table 8.3, along with examples of performance measures that fall under each of the areas.

Data collection and analysis will likely involve a combination of existing/available sources and methods, and ideally, a performance tracking process/program specifically intended for work zones. Some of the data collection methods/sources include:

- Transportation planning and forecasting models.
- Transportation and traffic simulation models.
- Field observations.
- Specific field measurements, either infrastructure based (e.g., dynamic queue detection and management) or probe vehicle based (e.g., floating car study).
- Crash records.
- Traffic records.
- Construction project logs.
- Construction project plans, designs, and estimates.
- Traffic incident management and response logs.
- Archived ITS data from existing deployed systems.
- Use of ITS data from work zone specific ITS systems.
- In-vehicle data from Intelligent Vehicle (IV) systems.



- Previously available data and reports.
- TMP and TMP evaluation findings.
- Interviews.
- Surveys.
- Focus Groups.



Indiana DOT's Design Manual Section 81-1.03(01) recommends that upon the completion of a project, the TMP team prepare a report identifying the successes and failures of the TMP.

Source: Indiana Department of Transportation, Chapter 81 of the Indiana Design Manual, Transportation Management Plans, URL: <http://www.in.gov/dot/div/contracts/standards/dm/Part%208/Ch%2081/Ch81.pdf> (Accessed 8/16/05).



The National Work Zone Safety Information Clearinghouse contains work zone crash and accident data including links to various work zone crash "press releases" and studies, including program-level assessments.

Source: The National Work Zone Safety Information Clearinghouse, Work Zone Crash/Accident Data. URL: [http://wzsafety.tamu.edu/crash\\_data/](http://wzsafety.tamu.edu/crash_data/) (Accessed 09/13/05).

## **Step 5 of 5: Evaluate and Revise Work Zone Impacts Assessment and Management Process/Practices/Procedures**

This is the final step in the performance assessment process, where the information from Steps 3 and 4 are used to develop lessons learned and to evaluate and revise policies, processes, practices, and/or procedures. Items that should be assessed/reassessed and revised as necessary include:

- Work zone types (i.e., significant/non-significant projects, type of roadwork being performed, etc.).
- Work zone management strategies.
- Programs (e.g., training).
- Policies (e.g., for maintenance of traffic).
- Procedures (e.g., for identifying significant projects or developing TMPs).
- Standards (e.g., design standards, contract specifications).
- Thresholds/benchmarks.
- Systems planning process.
- Preliminary engineering and design processes.
- Construction process.
- Performance assessment process.



The State of California conducted a performance review of the costs, enforcement alternatives, automated enforcement tools, and recommendations associated with the California Department of Transportation (Caltrans) Construction Zone Enhanced Enforcement Program (COZEEP). In place since 1992, COZEEP involves an agreement between Caltrans and the California Highway Patrol (CHP), where Caltrans pays the CHP for providing officers and their vehicles for use in construction zones, particularly for speed enforcement.

Source: The Report of the California Performance Review – Government for the People for a Change, Volume 4, Issues and Recommendations, INF12 Improve Efficiency of Extra Enforcement Program in Highway Work Zones with Fewer Resources. URL: <http://cpr.ca.gov/report/cprprt/issrec/inf/inf12.htm> (Accessed 09/13/05).



The New York State Department of Transportation (NYSDOT) conducts an annual quality assessment program to monitor the condition of its work zones. Initiated in the 1980s, this program compiles detailed information on a large sample of work zones on DOT projects each year. The information is used to track work zone quality, and to identify needed revisions and improvements to work zone procedures.

Source: A Quality Assurance Program For Work Zone Traffic Control, TRB Transportation Research Record 1745, 2001. Copies of recent annual reports may be obtained by contacting Mr. Charles Riedel at NYSDOT at [criedel@dot.state.ny.us](mailto:criedel@dot.state.ny.us) or at 518-457-2185.



In 2003, as the Ohio Department of Transportation (ODOT) was embarking on the largest construction program in its history, the ODOT Director was concerned about the impact the resulting work zones would have on crashes. The Director questioned if work zones were causing more accidents, and if so, what could be done to limit the increase in crashes. In response to these questions, ODOT began analyzing work zone crashes and performing before and after analyses of crash rates for a set of work zones. ODOT obtains work zone crash reports in near real time from local law enforcement and inputs the information from the reports into a spreadsheet that can sort and compare crashes to historical pre-construction crash frequency for the same road segments. Using this information, ODOT looks for abnormally high concentrations of crashes in work zones. When these high concentrations are found, ODOT makes field visits to identify the causes and determine solutions. Through these analyses ODOT has been able to identify some common factors contributing to a number of work zone crashes. To date, these factors include inadequate off-ramp capacity, inadequate ramp merges, and insufficient paved shoulders. As a result of this analysis, ODOT has made some changes to work zone design standards so that they can mitigate these problems early in the project development process and prevent replicating past problems.

Source: Transportation Research Board (TRB) 84th Annual Meeting, Session 476: Work Zone Impacts and Mitigation Efforts, How One State DOT is Addressing Work Zone Impacts, Dave Holstein, Ohio Department of Transportation (ODOT), January 11, 2005, URL: <http://webboard.trb.org/file.asp?file=David+Holstein%2Epdf> (Accessed May 30, 2006).



The following resources may be useful for incorporating performance measures and goals in decision-making:

1. Performance measurement section of the FHWA Office of Operations web site. URL: [http://www.ops.fhwa.dot.gov/perf\\_measurement/index.htm](http://www.ops.fhwa.dot.gov/perf_measurement/index.htm) (Accessed 09/08/05).
2. Performance measurement section of the FHWA Work Zone web site. URL: [http://www.ops.fhwa.dot.gov/wz/decision\\_support/perf\\_measurement.htm](http://www.ops.fhwa.dot.gov/wz/decision_support/perf_measurement.htm) (Accessed 09/08/05).
3. Transportation Research Board (TRB) Performance Measurement Committee (A5022/ABC30). URL: <http://www.trb-performancemeasurement.org/> (Accessed 09/08/05).
4. Online Performance Measurement Exchange sponsored by the TRB performance measurement committee and the FHWA. URL: <http://knowledge.fhwa.dot.gov/cops/pm.nsf/home> (Accessed 09/08/05).
5. American Association of State Highway and Transportation Officials (AASHTO) Quality Information Center. URL: <http://www.transportation1.org/quality> (Accessed 09/08/05).
6. TRB Transportation Research Circular E-C073, "Performance Measures to Improve Transportation Planning Practice: A Peer Exchange." URL: [http://trb.org/news/blurb\\_detail.asp?id=5022](http://trb.org/news/blurb_detail.asp?id=5022) (Accessed 09/08/05).
7. The Washington State Department of Transportation best practices inventory of performance measurement practices in other State departments of transportation. <http://www.wsdot.wa.gov/accountability/library/default.htm> (Accessed 09/08/05)
8. California Department of Transportation, Transportation System Performance Measures web site. URL: <http://www.dot.ca.gov/hq/tsip/tspm/index.htm> (Accessed 09/08/05).
9. Florida Department of Transportation Mobility Performance Measures web site. URL: <http://www.dot.state.fl.us/planning/statistics/mobilitymeasures/default.htm> (Accessed 09/08/05).
10. The FHWA is developing a framework that can be used to support efforts to develop and implement work zone performance measures. This includes the development of national and project-level performance measures, the tracking of measures over time, and the encouragement of widespread use and understanding of these measures. URL: [http://www.ops.fhwa.dot.gov/wz/decision\\_support/perf\\_measurement.htm](http://www.ops.fhwa.dot.gov/wz/decision_support/perf_measurement.htm) (Accessed 09/08/05).



## 9.0 Work Zone Impacts Assessment in Maintenance and Operations

### 9.1 Overview of Maintenance and Operations (M&O)

Maintenance and operations (M&O) encompass the activities that help maintain and upkeep highways to be safe, usable, and at an acceptable level of operation. M&O includes both planned and emergency work that addresses preservation and upkeep of right-of-way (ROW), pavement, structures, safety devices, signs, roadside aesthetics (e.g., trees, planting), illumination equipment, and other roadway and roadside features/facilities. M&O does not include reconstruction or other major improvements. Typical examples of M&O work include installation and maintenance of traffic signs and other roadside devices, debris removal, mowing operations, utility work, painting/striping, minor guard-rail work, pavement patching, small pavement repair and overlay work, limited bridge repairs (decks and substructure), culvert replacement, traffic signal maintenance, and lighting work. Special or emergency maintenance or repair may be necessitated by storms (or other weather conditions), slides, settlements, accidents, equipment failure/outage, or other unexpected damage to a roadway, structure, or facility.

M&O may either be performed by state and local agency<sup>1</sup> maintenance personnel or be contracted to private entities. Contract maintenance is a predominant practice in some agencies and is increasing in many others. A majority of M&O activities are implemented through short-term and/or mobile work zones. In urban areas, M&O is generally performed at night. Sometimes, M&O activities (e.g., minor pavement overlay or pothole patching) at different locations along a corridor are combined into a single project involving a longer duration work zone that lasts anywhere from a few days to a few weeks.

The Manual on Uniform Traffic Control Devices (MUTCD) defines 5 work types based on their work duration and time at a location. They are: (a) long-term stationary – work that occupies a location more than 3 days; (b) 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; (c) short-term stationary – daytime work that occupies a location for more than 1 hour within a single daylight period; (d) short duration – work that occupies a location up to 1 hour; and (e) mobile – work that moves intermittently or continuously. Most M&O work zones generally fall under categories b, c, d, and e.

Source: MUTCD 2003 Edition Revision 1. URL: <http://mutcd.fhwa.dot.gov/> (Accessed 01/25/06).

<sup>1</sup> Hereinafter referred to as agencies.

## 9.2 Objectives of Assessing Work Zone Impacts in M&O

M&O activities are typically smaller in scale than construction projects because of the short-term nature of the work and the level of effort needed. However they do cause work zone impacts – sometimes even large impacts, depending on the type and location of the activity (e.g., day-time shoulder work on a high-volume urban corridor can lead to major slow-downs and backups). Currently, most agencies provide for work zone traffic control during M&O by using typical temporary traffic control (TTC) approaches/standards that apply to different types of M&O activities. Field crews select appropriate TTC plans for their respective activities by using standardized procedures, field handbooks, and their experience. Agencies develop (and periodically update) their typical TTC plans/standards, procedures, and field handbooks using engineering judgment, analyses, and guidance provided in the MUTCD and other sources such as the American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide<sup>2</sup>.

In the past, agencies mainly focused on providing for traffic and worker safety in developing their typicals and standards for M&O traffic control. Increasingly, many agencies are considering the mobility aspects of M&O work zones as well (e.g., combining and consolidating multiple activities, performing M&O during night and off-peak hours, performing M&O as part of large construction projects.). Many agencies are also recognizing the need to plan and coordinate M&O activities to minimize conflicts with other ongoing construction activities, and to minimize the overall work zone impacts on the transportation system.

The work zone impacts of M&O activities need to be addressed from the overall system management perspective in addition to the individual activity/corridor perspective. For example, a maintenance lane-closure on a particular roadway may use a TTC plan that helps maintain and manage traffic through that maintenance work zone. However if that highway is the designated alternate route for a larger construction project, closing a lane on the alternate route can reduce its traffic carrying capacity, leading to backups and delays for traffic diverting from the mainline of the large construction project. Such a situation may be avoided by scheduling the maintenance work such that its impacts are minimized (e.g., before/after the mainline construction project).

Assessing and managing the work zone impacts of M&O activities involves the following four key activities:

- **Enhance agency procedures so that the direct safety and mobility impacts of M&O activities are minimized and better managed** (e.g., improving TTC procedures, improving the visibility of maintenance workers/vehicles, better public information and advance warning systems, permitted lane-closure times, off-peak/nighttime work).
- **Plan and coordinate M&O such that overall system-wide impacts are minimized** (e.g., performing M&O activities as part of planned construction projects to minimize doing the M&O work as a separate activity – “don’t dig up the same road twice”).
- **Implement and manage M&O activities such that they have minimal impacts on other construction projects and vice-versa** (e.g., consider detour routes, diversions, adjacent highway sections).

- **Incorporate features in construction projects that would facilitate future M&O with minimum disruption** (e.g., wider shoulders, maintenance turn-about, designated pullouts).

Work zone impacts assessment in M&O involves the same concepts and guidance presented in prior sections. The types of work zone safety and mobility issues and management strategies to consider are basically the same. Therefore, this section will focus mainly on the four aspects listed above. However specific work zone impacts issues that pertain especially to M&O are discussed at appropriate locations. The reader may refer to Table 2.7 – Work Zone Impacts Considerations in Chapter 2.0 for a detailed list of the different work zone impacts issues and considerations that may be addressed.

Work zone impacts assessment in M&O may help provide answers to the following types of questions:

- Given the district's construction program for the upcoming year, are there any scheduled/periodic maintenance activities that may have an impact on, or be impacted by, any of the construction projects?
- The winter snow season is over and I need to patch-up the potholes on the region's roadways. There are a few roadway sections that are due for pavement resurfacing in early spring. Can I hold off on the pothole patching for those roadway sections and just wait for the resurfacing?
- How do the work zone impacts of multiple maintenance lane-closures compare with those of combining lane-closures into a single project?
- A certain utility company needs to upgrade its infrastructure along a roadway and needs to perform the work through several utility cuts on the roadway. Is there any way of combining that work with planned rehabilitation on that roadway?
- A section of high-volume/high-speed roadway is going to be widened by one lane in each direction. Along with this roadway widening, I would like to widen the inner shoulders on that facility from a half-shoulder to full-shoulder to improve safety and provide for easy future maintenance, incident management, etc. How can I justify the added cost for this shoulder widening?
- Are there any innovative strategies that I can use to provide better protection for my maintenance personnel?
- What are the impacts of performing scheduled maintenance on a designated alternate route for an ongoing construction project? Can I perform the work such that the impact to the mainline construction project and any traffic diverting from it are minimal?
- Is there any planned utility or other maintenance work that can be accomplished along with my upcoming pavement rehabilitation project? If so, how will that affect my work schedule and how can I include the utility work into my project without adversely affecting my work?

## 9.3 Who Performs the Assessment?

The following is an overview of the staff that may be involved in assessing and managing the work zone impacts of M&O activities:

- **Maintenance managers, engineers, and supervisors belonging to the maintenance departments of transportation agencies** are the primary staff responsible for planning, coordinating, implementing and managing M&O activities. They are responsible for developing/updating standard processes, procedures, and guidelines related to M&O (e.g., developing typical TTC plans for different types of short-term work zones). They are also responsible for assessing and managing the work zone impacts of M&O activities on a day-to-day basis.
- **In the field, agency and/or contractor<sup>3</sup> maintenance crews, and agency maintenance supervisors** are responsible for implementing and monitoring their M&O activities such that their work zone impacts are minimized.
- **Input from and interaction with different entities may be required at appropriate junctures (e.g., when coordinating M&O projects with the construction program for a region/district), including:**
  - Agency technical staff and specialists including planners, highway engineers/designers, safety engineers, traffic engineers/managers, operations/intelligent transportation systems (ITS) engineers, pavement managers/experts, bridge managers, utility coordination personnel (water, sewage, power, gas, telecom infrastructure), and marketing/public relations staff.
  - Other stakeholders such as law enforcement agency personnel, emergency response personnel, other transportation agencies, and regional transportation management center (TMC) operators may also provide input.
  - Sometimes the input of other stakeholder groups, such as local community representatives, business representatives, other public safety agencies, trucking associations, and American Automobile Association (AAA), may also be needed.

## 9.4 Assessment Framework

Assessing and managing the work zone impacts of M&O activities may be performed by: (a) improving agency procedures so that the direct safety and mobility impacts of M&O activities are minimized and better managed; (b) planning and coordinating M&O such that overall system-wide impacts are minimized; (c) implementing and managing M&O activities such that they have minimal impacts on other construction projects and vice-versa; and (d) incorporating features in construction projects that would facilitate future M&O with minimum disruption. These are briefly discussed in the following subsections.



### 9.4.1 Improving Agency Procedures so that the Direct Safety and Mobility Impacts of M&O Activities are Minimized and Better Managed

M&O activities present some of the biggest work zone safety and mobility challenges. Most M&O activities are implemented through short-term and/or mobile work zones. Unlike stationary/long-term work zones, often there are no barricades, drums, or cones to outline the work area in M&O work zones. Worker and motorist safety is the number one priority; however, it may not be efficient to setup an elaborate work zone for an activity that may take a very short time to perform, both from a resource utilization perspective as well as a traffic mobility perspective.

Therefore M&O work zones present a significant challenge in terms of:

- Delineating and protecting the work zone adequately enough to provide visibility and safety for the workers and any advance warning crew.
- Providing sufficient space and time for the crew to efficiently and effectively perform their work.
- Providing sufficient advance warning to motorists so that they may take appropriate action to slow down or change lanes well in advance of the work area.
- Setting up the work zone, implementing the work, and clearing the work zone setup such that the mobility impacts are minimal.

Transportation agencies use many processes, procedures, and guidelines that help address the above challenges. The MUTCD provides general TTC guidelines for intermediate-term stationary, short-term, and mobile operations. Many agencies use typical TTC templates and other guidelines to help setup appropriate traffic control and management plans for different types of M&O activities. A majority of such guidelines are based on the MUTCD and are customized according to the individual needs of different agencies.

The following are some additional issues that agencies can consider in assessing and managing the impacts of their M&O activities:

- **Periodic review and update of agency M&O procedures and guidelines.** As time passes, M&O work zone safety and mobility needs may change and agencies should update their procedures to reflect current needs. For example, in the last few years many agencies are increasingly performing all M&O activities requiring lane-closures exclusively at night due to the steady increase in traffic volumes in urban areas. In updating their procedures and typical TTC plans, agencies should identify the potential safety hazards and mobility impacts of different types of M&O activities, and recommend countermeasures that help mitigate those impacts. Advanced technologies and methods should be considered as applicable, and when available.



The Washington State Department of Transportation (WSDOT) recommends the identification of “red zones” where short duration work zones are not a desirable choice due to poor traffic conditions (high volume, high speed, weaving areas, bridges, interchanges, etc.).

Source: WSDOT Work Zone Traffic Control Guidelines, January 2006. URL: <http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/Workzone.pdf> (Accessed 01/26/06).



The New York State Department of Transportation (NYSDOT) has identified seven intrusion countermeasures for stationary, mobile, and short duration work zones. They are: (1) reduced channelization spacing; (2) enhanced flagger stations; (3) rumble strips; (4) reduced speed limits; (5) police enforcement; (6) dynamic message signs (DMS); and (7) drone radar.

Source: Identification of Traffic Control Devices for Mobile and Short Duration Work Operations, Working Paper: Evaluation Criteria and Analysis, May 24, 2004, New Jersey Department of Transportation (NJDOT), City College of New York, NC State University Centennial Campus. URL: <http://www.utrc2.org/research/assets/97/wz-criteriawp1.pdf> (Accessed 01/25/06).



The Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center conducts technology research for improving highway maintenance and construction. One of the research products of the center is an automated machine for cone placement and retrieval. Traffic cones are one of the most common items used to delineate work zones. However, present methods of deploying traffic cones require considerable manual effort and expose workers to the hazards of traffic. The AHMCT Cone Machine automatically lays down cones at regular intervals, and then picks them up again later. A single operator can safely and quickly open and close busy lanes during construction or maintenance.

Source: AHMCT Research Center at UC-Davis, a joint program of University of California (UC), Davis and the California Department of Transportation Caltrans. URL: <http://www.ahmct.ucdavis.edu/index.htm?pg=Cones> (Accessed 01/25/06).

- **Reinforce and reemphasize the safety and mobility needs of M&O activities.** There may be a tendency in the field to underestimate the potential impacts of M&O activities due to the short-term nature and the size of the work. It is therefore important to reinforce and reemphasize the need to follow the MUTCD and other agency procedures and guidelines that govern the setup and management of M&O work zones. One way to accomplish this is to provide periodic training and training updates to M&O staff and field crews.



The Wisconsin Department of Transportation's (WisDOT) work zone guidelines contains a Maintenance Supervisor's Checklist, which is as follows:

1. Follow Part 6 and the Wisconsin Supplement of the MUTCD.
2. Have a traffic control plan before going to the work site.
3. Ask yourself, "What is the driver's view of the work site—at night, during peak hours, etc.?"
4. Investigate crashes/incidents to identify if changes are needed in the traffic control plan.

Source: Wisconsin Department of Transportation (WisDOT) Work Zone Safety Guidelines for Construction, Maintenance, and Utility Operations, January 2003. URL: <http://www.dot.wisconsin.gov/library/publications/format/books/wzsguide.pdf> (Accessed 01/25/06).

The National Highway Institute (NHI) course, “Work Zone Traffic Control for Maintenance Operations (Short-Term)” provides guidance and training for field personnel working in the planning, selection, application, and operation of short-term work zones. More information is available at [http://www.nhi.fhwa.dot.gov/training/brows\\_catalog.aspx](http://www.nhi.fhwa.dot.gov/training/brows_catalog.aspx). Enter 380060 in the Course Number box and click “Search.” (Accessed 01/26/06).

- **Explicitly address the mobility issues associated with M&O activities.** Sometimes there may be a tendency to underestimate the mobility impacts of M&O activities that are short-term and/or mobile. However, given the steady increase in traffic volumes over the years and the need to maintain and better operate our limited highway infrastructure, it is essential to address and mitigate the mobility impacts of performing any work on our highways. This is especially applicable to urban areas with pre-existing heavy congestion. Several agencies have adopted and many more are increasingly adopting practices that minimize the mobility impacts of M&O activities. Some of the strategies to consider include:
  - Night work.
  - Off-peak work.
  - M&O activity coordination and aggregation.
  - M&O schedule optimization.
  - Enhanced public information (e.g., advance notice using the different media outlets including web sites/email, improved methods to warn motorists in advance of M&O work zones using dynamic message signs (DMS) and other active warning devices).
  - Queuing and delay analysis for setting thresholds and providing guidance on allowable work hours and permitted lane closure times.
  - Addressing the impacts of M&O activities (and vice-versa) on nearby transportation infrastructure and on other construction projects (discussed in Section 9.4.3).



The Washington State Department of Transportation (WSDOT) uses look-up charts to determine whether or not a maintenance lane-closure can be implemented on a particular corridor (based on the road classification) at a particular time of day. This controls the traffic impacts of the maintenance activity.

Source: FHWA Workshop Conducted at WSDOT headquarters in connection with the updates to the work zone regulations in the Code of Federal Regulations (CFR).

- **Improved communication and coordination.** On a day-to-day basis, M&O staff and crew members perform a variety of activities that span across different levels of complexity (e.g., something as simple as changing a bulb in a roadway light fixture to something as complicated as performing repair work on a bridge shoulder). Field maintenance crew may be involved in multiple activities and job-sites during the course of their work shift, and sometimes they may be pulled from their scheduled maintenance to tend to an emergency maintenance request. In the midst of all this, communication and coordination may falter. However, the lack of proper

communication may lead to problems from both a maintenance efficiency and effectiveness perspective, as well as from a motorist impact perspective. For example, a local traffic signal crew may be performing emergency traffic signal repairs at an intersection just downstream of an Interstate highway off-ramp. The activity may lead to traffic backup onto the freeway off-ramp with possible spillover onto the mainline. If the appropriate State DOT authority or the local TMC were notified about the work, they can advise motorists about potential backups via DMSs and possibly re-route them to a different off-ramp.

It is important for maintenance supervisors, staff and crew to understand that M&O activities not only have impacts at the immediate work location and corridor level, but also have system-level impacts that extend into other corridors, intersections, interchanges, etc. Sustained communications with appropriate regional/local entities (e.g., TMC operators, local/county traffic signal system operators, transit and railroad agencies, State DOT operations managers) can keep concerned stakeholders informed about any work activity that is taking place on the transportation system. Many regions have regional TMCs that provide information to motorists via DMSs, media outlets, and other information channels. If maintenance staff keep them updated on a daily basis of their planned activities (and emergency activities as and when they come up), the TMC operators can then provide periodic and timely updates to the traveling public and other agencies.



The Wisconsin Department of Transportation (WisDOT) recommends that, if there is a rail crossing near the work area, coordination with the railroad company should occur before work starts. Lane restrictions, flagging, or other operations shall not create conditions where vehicles can be stopped on the railroad tracks with no means of escape. If traffic backups are anticipated to extend through the crossing, special procedures for warning motorists should be used, which are provided in WisDOT work zone guidelines.

Source: Wisconsin Department of Transportation (WisDOT) Work Zone Safety Guidelines for Construction, Maintenance, and Utility Operations, January 2003. URL: <http://www.dot.wisconsin.gov/library/publications/format/books/wzsguide.pdf> (Accessed 01/25/06).

- **Improved public information, awareness, and communication.** Public inattention, lack of awareness, and lack of sufficient advance warning are often cited as a major cause of crashes and safety issues when performing M&O work. Agencies should try to use all available information dissemination channels to inform the public of upcoming/planned M&O work, and provide sufficient warning in advance of M&O work zones. Traveler information web sites/email updates (either agency or non-agency) are a good resource for keeping track of and providing information on planned and ongoing M&O activities. Several new technologies are increasingly used to warn motorists and urge them to reduce speeds in advance of M&O work zones such as DMSs (portable or pre-existing), and speed display trailers.



The Texas Transportation Institute (TTI) conducted a survey of all State transportation agencies to obtain data on safety operations for mobile and short duration maintenance. The survey results indicated that the most significant hazards for all responding agencies were high speed traffic and inattentive motorists, which resulted in rear end crashes of safety vehicles and errant vehicles entering the shadow vehicle convoy or the work area. Some State agencies approach the solution to these issues by incorporating advance warning devices in addition to the standard MUTCD safety devices. Examples include brighter or fluorescent signs on shadow vehicles; trail vehicles with speed display boards below the arrow panel; use of better or additional lighting on shadow vehicles such as solid light bars, blue lights, or light emitting diode (LED) lights; dynamic message signs (DMSs) in advance of the work area; and police to enforce traffic laws.

Source: Ullman, Brook R., Melissa D. Finley, and Nada D. Trout, Identification of Hazards Associated with Mobile and Short Duration Work Zones. Report Number: 4174-1. Texas Transportation Institute, College Station, Texas, September 2003. URL: <http://tti.tamu.edu/documents/0-4174-1.pdf> (Accessed 01/25/06).

#### 9.4.2 Planning and Coordinating M&O to Minimize Overall System-Wide Impacts

M&O activities have both localized and system-wide impacts. Often, the lack of adequate planning and coordination between multiple M&O and construction activities performed by multiple agencies is a cause for increased traffic delays and frustration for motorists. M&O work adjacent to a construction work zone (at nearby intersections/interchanges, adjacent corridors, etc.), if performed in an uncoordinated manner, can create unwanted delays and frustration to motorists and may also interfere with the effective performance of the work. Lack of coordination between agency maintenance and construction departments during planning can result in conflicts and combined impacts that can delay project schedules and exacerbate motorist frustration.

The following are some issues to consider in planning and coordinating M&O activities so that their overall system-wide impacts are minimized and better managed:

- **Account for M&O needs and potential impacts during systems planning (i.e., when developing transportation plans and programs) by coordinating construction project schedules and plans with those of M&O activities.** The participation of maintenance engineers and staff in the planning and programming processes can help provide input towards such planning and coordination. For example, in developing a two-year Transportation Improvement Program (TIP) for a region, M&O activities can be planned and scheduled such that their conflicts and potential combined impacts can be minimized. Even something as simple as performing mowing operations on a highway section may not be able to take place if that highway section will be under construction. So agencies should make an effort to plan and coordinate within multiple M&O activities as well as with other construction projects.
- **Coordinate and combine multiple M&O activities into a single larger project.**



The California Department of Transportation (Caltrans) uses a Corridor Management Approach for Maintenance and Construction Operations to coordinate multiple construction/maintenance projects within a corridor. For maintenance projects, a complete corridor will be closed off during the night with a “maintenance gang” performing the work. Construction projects are much longer in duration and entail coordination among different projects to be tied into one corridor project. This practice has led to a reduction in overall congestion and delay as well as improved perception by the public through coordination and planning efforts by Caltrans.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/26/06).

- **Perform M&O activities as part of planned construction projects (whenever possible) to minimize doing the M&O work as a separate activity.** Another way of saying this is, “don’t dig up the same road twice.” For example, many agencies combine ITS infrastructure projects (e.g., laying a fiber-optic/communications conduit) along with ongoing construction projects.



In the City of Phoenix, design and construction of city water and sewer lines within the street right-of-way (ROW) is done by the Street Transportation Department. Prior to the implementation of this policy, each entity designed and constructed their facilities in a separate project. This resulted in neighborhoods being torn up on three separate occasions to construct the project. By bringing all work under the Street Transportation Department, the work could all be accomplished in one contract thereby saving time and money, increasing safety, and having less impact and disruption to the community. The City also implemented a penalty provision for utilities that trench through new pavements.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/26/06).

- **Coordinate, implement, and manage M&O and construction activities at the regional/district/corridor level to minimize overall impacts.**



The Chicago Department of Transportation (CDOT) has a policy to sequence, coordinate, and schedule projects to minimize motorist delay and interference to affected business/residential communities. Internal coordination meetings are routinely held to discuss various projects from the Bureaus of Traffic, Highways, and Bridges that have the greatest impact on traffic. Specifically, CDOT internally discusses the upcoming construction season's major projects and proceeds to map out coordinated project letting schedules in order to minimize motorist delay and interference to affected business/residential communities. Information that comes from these regular CDOT internal meetings is used to update their public web site. This leads to construction cost savings and travel time improvements and motorists/pedestrian safety improvements within construction and maintenance work zones.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/26/06).

- **Improve ongoing and day-to-day communications on M&O and construction activities at both the intra-agency and inter-agency levels.** This is the same as the "Improved Communication and Coordination" discussion in Section 9.4.1.



The Virginia Department of Transportation (VDOT) employs a Lane Closure Coordinator for Interstate Highways in a State Highway District. The coordinator serves as a single contact for compilation and distribution of planned lane closures in the coming week. This practice helps avoid concurrent lane closures, whether they are on maintenance, construction, operation, or utility work areas, on nearby sections of roadway and helps to avoid conflicts in operations. Ultimately, traffic delay and congestion due to multiple operations in nearby areas are reduced.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/26/06).

### 9.4.3 Implementing and Managing M&O Activities with Minimal Impacts on Other Construction Projects and Vice-Versa

M&O activities in the impactable vicinity of other construction projects can adversely affect traffic safety and mobility (and construction efficiency) of the construction project and vice-versa. Interfering M&O work is often cited as a major cause of construction project schedule delays and exacerbated work zone impacts. Conversely, a nearby construction project can also have a negative impact on an ongoing M&O activity.

Therefore, during the planning, design, and construction phases of a construction project, it is important to assess the potential impacts of any nearby M&O work that is scheduled to take place concurrently. During the construction process, if adverse impacts are experienced due to any nearby M&O work, appropriate actions should be taken to manage those impacts. Also before scheduling and implementing an M&O job, coordination should be performed to identify any nearby construction projects that could interfere with the M&O job or be interfered with by the M&O job. Such coordination should be forthcoming from both the construction side and the M&O side, and should take place at the planning/design level and the day-to-day operational level. Coordination and communication at the operational level can also help keep all parties informed, even in the case of emergency maintenance situations. The planning and coordination may be done as discussed in Sections 9.4.1 and 9.4.2.

Some of the issues that may be considered in assessing the impacts of M&O work on construction projects include:

- M&O that affects detours or diversion routes.
- Impacts of M&O within or adjacent to an active construction project – e.g., an M&O lane closure that interferes with a project lane closure.
- Overlapping or contradictory signs between construction project and M&O activities.
- M&O work that can result in stoppage of construction or schedule delays (e.g., utility delays).
- Multiple work zones within close vicinity of each other (e.g., along the same corridor) resulting in added motorist frustration.



The California Department of Transportation (Caltrans) uses a District Work Zone Traffic Management Coordinator in each of the 12 Caltrans Districts. The cumulative effect of projects in close proximity can sometimes lead to poor, inefficient operations. Also, travel volumes tend to be dynamic in nature and fluctuate due to incidents or recreational/holiday demand. The Coordinator is able to see the “bigger picture” and make decisions that provide relief to an area affected by construction (e.g., halt lane closures, use temporary signals). The Coordinator stays abreast of the regional traffic situation, whereas the Resident Engineer tends to focus on the happenings within the project limits of his/her contract.

Source: FHWA Work Zone Best Practices Guidebook, April 2000, <http://ops.fhwa.dot.gov/wz/practices/best/Default.htm> (Accessed 01/26/06).





The Missouri Department of Transportation (MoDOT) requires all maintenance and internal work zone activities requiring lane closures to be reviewed by the District Work Zone Coordinator to reduce the work zone effects on motorists. The District Engineer ensures the appropriate district staff considers the following actions when scheduling lane closures:

- Notifying the District Work Zone Coordinator 48 hours before beginning any non-emergency work requiring a lane closure.
- Scheduling lane closures during off-peak and/or nighttime hours, when possible.
- Ensuring work zones are maintained in a neat, orderly, and effective manner for the safety of highway workers and motorists.
- Scheduling multiple tasks in a single work zone, rather than scheduling multiple lane closures in the same area.
- Making every effort to minimize traffic backups.
- Ensuring the appropriate traffic-control equipment is used.
- Ensuring work zone speed limits are appropriate in active and non-active work zones.

The above guidelines apply to commercial utility/permit work as well.

Source: Missouri Department of Transportation (MoDOT) Work Zone Guidelines, 2004.

URL: <http://www.modot.org/business/documents/MoDOTWorkZonesGuidelines.pdf> (Accessed 01/26/06).

#### 9.4.4 Incorporating Features in Construction Projects to Facilitate Future M&O with Minimum Disruption

In designing construction projects (roadway rehabilitation/reconstruction, etc.) features should be incorporated, whenever possible, to facilitate future M&O with minimum disruption. Examples of such features include:

- Wider shoulders.
- Wider bridge decks.
- Maintenance turn-about.
- Designated pullouts.
- Use of non-contact roadway sensors (instead of embedded pavement loops).
- Making roadway and roadside structures (e.g., sign support structures, DMS message boards) easily accessible without requiring lane closures or excessive traffic interference.
- Using roadside and roadway devices that facilitate fast and easy maintenance (e.g., in the case of tower mounted equipment, using lowering devices instead of having to use a bucket truck to get on top of the tower).
- Reducing the need for and cost of maintenance/upgrade work by using longer-life materials (e.g., long-life pavement markings and lane markers).



The Washington State Department of Transportation (WSDOT) is trying to address the issue of maintenance and re-installation of raised pavement markers (also referred to as “buttons”). The button crew gets hit by traffic often as they move down the road at 1 mph installing the raised pavement markers. WSDOT considered several strategies but have exhausted all options. The types of raised pavement markers that are currently in use need to be replaced every two years. Therefore, WSDOT is considering alternatives to the currently available raised pavement marker technology.

Source: FHWA Workshop Conducted at WSDOT headquarters in connection with the updates to the work zone regulations in the Code of Federal Regulations (CFR).



The New York State Department of Transportation (NYSDOT) incorporates design features to accommodate future work zone mobility needs, such as wider bridges to facilitate use of the shoulder as a travel lane during construction and avoiding piers in medians.

Source: NYSDOT comments in response to the FHWA Advance Notice of Proposed Rulemaking (ANPRM) on Work Zone Safety, June 6, 2002, United States Department of Transportation (USDOT) online Docket Management System. URL: [http://dmses.dot.gov/docimages/pdf81/175976\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/175976_web.pdf) (Accessed 01/18/06).

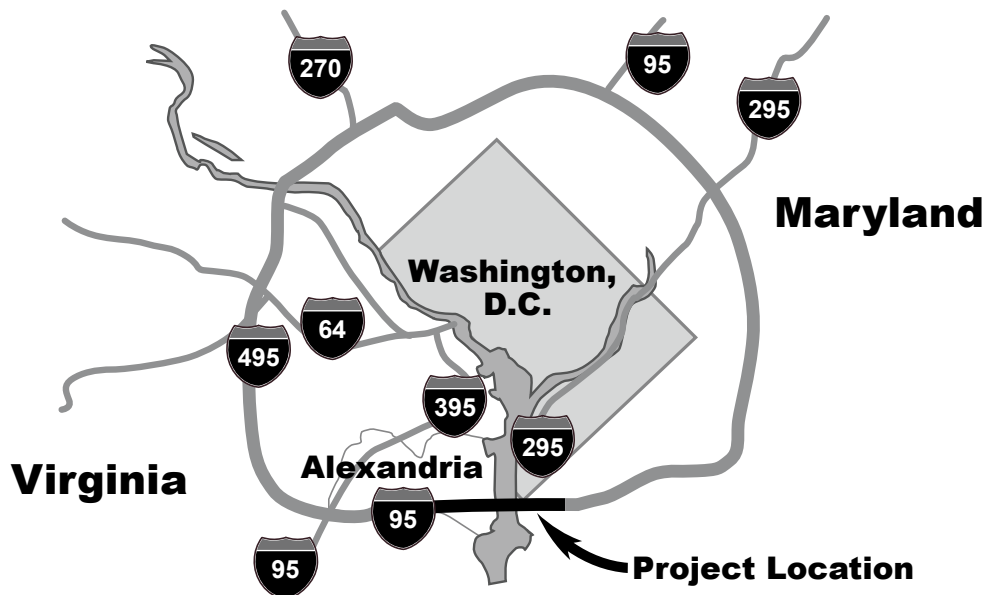
The FHWA Highways for LIFE program focuses on how to build a highway *safer, longer lasting, at a lower cost, and faster*. More information on this program is available at <http://www.fhwa.dot.gov/hfl> (Accessed 01/18/06).

# Appendix A – Example Work Zone Impacts Assessment: Virginia Department of Transportation I-495/U.S. Route 1 Interchange Reconstruction Project

## Project Overview

The Woodrow Wilson Bridge (WWB) project, in the Commonwealth of Virginia and State of Maryland, is a 7.5 mile-long corridor located on I-95/495 (also referred to as the Capital Beltway) extending from MD 210 interchange in Maryland, over the Potomac River, to Telegraph Road in Virginia. The existing Woodrow Wilson Bridge carries more than three times the traffic that it was designed to handle. Daily miles-long backups occur on both sides of the bridge where eight-lanes merge down to six for the bridge crossing, and several adjacent interchanges feed into the bridge causing merge/weave issues. The WWB project consists of widening I-95/495 to 12 lanes at the bridge and reconstructing four interchanges, including the I-495/U.S. Route 1 interchange in Virginia. The example work zone impacts assessment discussed in this appendix focuses on the I-495/U.S. Route 1 Interchange Reconstruction project. More information and data related to the project can be found at <http://wilsonbridge.com>.

Figure A.1 presents a high-level map of the WWB project location and Figure A.2 presents a more detailed location map (including the I-495/U.S. Route 1 Interchange).



**Figure A.1 High-Level WWB Project Location Map**  
 (Source: <http://www.wilsonbridge.com/po-projectArea.htm>)



## I-495/U.S. Route 1 Interchange

**Figure A.2 Detailed Project Location Map**

The I-495/U.S. Route 1 Interchange project involves complete reconstruction of the existing interchange to provide for increased capacity, better geometry, and improved safety. This involves:

- Bridge replacement and widening of the I-95/I-495 mainline roadway section from 0.91 miles west of U.S. Route 1 to the west abutment of the Potomac River Bridge at Royal Street.
- Replacement of all the ramp movements.
- Ramp connections to future HOV lanes.
- Ramp connection to Eisenhower Valley at Mill Road.
- Intersection improvements.
- Retaining and sound barrier walls.
- An extensive ground improvement program.
- Utility relocations, including electrical transmission tower relocation.

## Work Zone Impacts Assessment Process Example

This section contains an overview of the components of the work zone impacts assessment process that were applied to the I-495/U.S. Route 1 Interchange project to date.

### Policy

The Virginia Department of Transportation (VDOT) has a general policy related to construction work zone lane closures. Briefly:

- Lane closures are not permitted during AM and PM peak hour periods, Monday through Friday.
- One lane can be closed during non-peak hour periods Monday through Friday.
- Multiple lanes can be closed during overnight and weekend periods.

This policy was revised and tailored to address specific local issues related to the I-495/U.S. Route 1 interchange due to the following considerations:

- Extensive commuter traffic.
- Heavy traffic during Friday afternoons related to travelers departing the area early for the weekend.
- Recreational traffic related to events in Alexandria.
- Heavy overnight commercial traffic.
- Regional recreational traffic related to major/special events (e.g., Washington Redskins football games, stadium concerts).

VDOT's general policy related to construction work zone lane closures was revised to address the local environment of the I-495/U.S. Route 1 interchange. Some of the highlights include:

- Lane closures are not permitted between 5:00 – 9:00 AM and 3:00 – 7:00 PM, Monday through Thursday.
- Lane closures are not permitted between 5:00 – 9:00 AM and Noon – 10:30 PM on Fridays.
- One lane can be closed between 9:00 AM – 3:00 PM and 7:00 – 10:30 PM, Monday through Thursday.
- Multiple lanes can be closed between 10:30 PM – 5:00 AM, Sunday through Thursday.
- Directional and total roadway closures are permitted between Midnight – 5:00 AM, Sunday through Thursday for up to 20-minutes.
- Lane closures or traffic restrictions will not be permitted on Saturdays, Sundays, and holidays from noon the day before the holiday until noon the day after the holiday unless otherwise approved by the Engineer. When a holiday falls on a Friday, lane closures are not permitted from noon Thursday to noon Monday. When a holiday falls on a Monday, lane closures are not permitted from noon Friday to noon Tuesday.
- Lane closures are not permitted on Washington Redskins game days or other special events as specified by the Engineer.
- In case of emergency or accidents, the construction access lanes on the shoulder within the project or lane closure limits (Outer Loop Express) must be available for emergency vehicles.
- A shoulder cutout area should be deployed for every continuous ¼-mile of shoulder closure to provide a place for disable vehicles, nominally 10 feet by 200 feet in size.

Construction at the I-495/U.S. Route 1 interchange is to be conducted concurrent with other WWB construction projects. As such, a WWB project-wide Lane Closure Policy was developed to address differences in Virginia and Maryland lane closure policies and practices for providing for the safe, orderly and efficient movement of traffic through adjacent work zones. The WWB Lane Closure Policy addresses:

- Procedures for approval to implement a lane closure including a detailed request form to provide consistency among all contractors.

- Advance notification requirements (by lane closure type).
- Advance notification limits to avoid “blanket” lane closure approvals.
- How to secure State Police support.
- Requirements and points of contact for lane closures.
- Lane closure restrictions.
- Holiday schedule.

The overall policy and policy provisions were applied to the respective program delivery stages as follows:

- **Systems Planning** – No work zone policy provisions were applied during the systems planning stage of the I-495 /U.S. Route 1 project.
- **Project Development** – Revisions to VDOT’s lane closure policy as described above were adhered to during the design of final plans, specifications, and estimates development. Lane closure exceptions have been granted to allow for:
  - Emergency repairs.
  - Extensions to existing work zones due to unforeseen complications that prevented the completion of planned work.
  - Opportunities for contractors to perform operations that have minimal traffic impact during off peak hours.
- **Construction** – The contractor has complied with and has not recommended changes to the work zone policy provisions above.
- **Performance Assessment** – Work zone policy provisions have not been assessed to date.

Since the project is underway and will not be complete until 2008, feedback from the various stages is not available to develop recommendations.

### **Systems Planning**

A Transportation Technical Report was developed for the WWB Project that also addresses the I-495/U.S. Route 1 interchange project. The report is the definitive technical transportation planning and analysis document for the WWB project and is one of several technical reports that are part of the documentation for the WWB Environmental Impact Statement (EIS). The Transportation Technical Report provides substantive, extensive, and detailed transportation data including:

- An Introduction section with details on the project location, description, history, purpose and the need for action.
- Summary of findings.
- An overview of the existing transportation system including details on policy context, land use and travel patterns, roadway network, operational conditions, truck travel, and existing transit services.
- A detailed overview of alternatives including the development process, future travel demand and patterns, end-to-end alternatives and a description of the no-build and build alternatives.

- An assessment of future conditions including land use and travel patterns, operational performance and project related arterials, safety and operational performance, toll collection and public transportation.

A screening-level work zone impact assessment was not specifically conducted to identify whether the I-495/U.S. Route 1 interchange constituted a “significant project”. However, it would clearly be a significant project under any criteria developed or based on engineering judgment. In addition, specific work zone management strategies were not developed during the planning phase of the project.

The EIS sets forth 51-pages of construction impacts for the WWB project, many of which are related to the I-495 /U.S. Route 1 interchange including:

- General phasing plans for six types of construction activities were set forth for the I-495 / U.S. Route 1 project. These include distinct phasing plans for:
  - Demolition, utility work and permits, earthwork and drainage, pile driving, and foundation construction.
  - Mobilization, demolition, utility work, earthwork and drainage, pile driving, and foundation construction.
  - Utility work and permits (if required), earthwork and drainage, pile driving, foundation construction, substructure construction and superstructure construction.
  - Shift traffic to new lanes, earthwork and drainage, pile driving, substructure construction, demolition of old lanes, and superstructure construction.
  - Utility work and permits (if required), earthwork and drainage, pile driving, substructure construction, and superstructure construction.
  - Superstructure construction, paving, signing and lighting and landscaping.
- Construction staging areas.
- Environmental impacts and potential mitigation measures, including traffic, socio-economic, air quality, noise, natural environment, and cultural resources. Mitigation measures set forth in the EIS were clearly labeled as “potential” mitigation measures. Some of the measures identified for construction traffic impact mitigation included:
  - Maintenance of traffic and construction sequencing will be planned and scheduled to minimize delay throughout the project area.
  - Six lanes of traffic will be maintained over the Potomac River throughout the construction period.
  - Access to businesses and residences affected by construction will be provided.
  - Rerouting of traffic may be necessary during the construction. Lane or ramp closures could create circuitous routes for emergency services, but access will be maintained to all areas.
  - Signs will be used as appropriate to provide notice of road closures, detours, and other pertinent information.
  - Local media will be notified appropriately in advance of construction related activities that could excessively inconvenience the community.

- Signs will be posted in the project vicinity with a hotline phone number for questions.
- During final design, a maintenance of traffic plan for both pedestrians and bicyclists will also be developed, based on consultation with local jurisdictions and organizations.

The WWB Project Record of Decision (ROD) specifically states the design development process for the WWB project (which includes the I-495/U.S. Route 1 interchange) shall meet 12 design goals to the maximum extent possible. Three of the 12 goals are construction related:

- All practicable measures shall be taken to minimize the construction period of the project.
- Construction impacts to historic and archeological resources shall be avoided or minimized to the extent possible. If possible, construction related traffic in the City of Alexandria would be routed away from residential areas via South Street to minimize construction related traffic through residential areas north of the project.
- The project shall be designed to avoid all temporary and permanent impacts to a local cemetery.

In addition, the ROD sets forth the following commitments and considerations:

- Federal, State, county and local jurisdictions and organizations will be involved in the review process for maintenance of traffic (MOT) plans.
- Detailed maintenance or traffic plans will be developed for each individual contract that address vehicular, pedestrian and bicycle traffic.
- Coordination with local jurisdictions, community groups and residents to further identify and evaluate potential construction activities and their effects (i.e., haul routes, dust control, etc.).
- Use signs, as appropriate, to provide notice of road closures, detours, etc.
- Post signs in the project area with the phone number of a hot line people can call about project-related activities.

### **Preliminary Engineering**

The following materials were available at the outset of preliminary engineering development:

- WWB Transportation Technical Report.
- WWB Record of Decision.
- A separate WWB Project Traffic Projections and Operational Analyses document published four years after the WWB Project Technical Transportation Report. This report reflects the use of updated traffic data and land use assumptions for the agreed upon design alternative.
- Conceptual horizontal plan view roadway alignment drawings.



- **WWB Construction Contract Summary.** A graphical depiction of the anticipated construction projects was developed to illustrate the physical limits of each project. Start dates, end dates, and critical path dates were also set forth. This tool enabled engineers to better understand design and construction issues related to individual projects (e.g., I-495/U.S. Route 1 interchange) and coordination issues related to other adjacent contracts.
- **WWB Project Master Schedule.** The schedule sets forth start and finish dates for all construction contracts envisioned at the outset of the preliminary engineering phase of the project. The schedule was updated monthly.

The I-495/U.S. Route 1 project was not re-assessed, nor the overall WWB project. The sheer complexity and size of the I-495/U.S. Route 1 interchange were understood by all parties involved in the project.

Candidate construction approaches were not developed as part of the preliminary engineering phase of the project because the final roadway alignment was not set forth until the end of the preliminary engineering design phase.

One of initial efforts of the preliminary engineering phase of the project was to identify cost savings through value engineering (e.g., elimination of a ramp, revisions to roadway alignment that conceptually could result in construction costs savings and time reductions). Once this was completed, engineers then began the extensive and detailed efforts necessary to decide on the horizontal and vertical roadway alignment and identify other issues (e.g., right-of-way requirements, utility relocation requirements) that needed to be addressed. A preliminary engineering cost estimate was developed for comparing an engineering cost estimate to the available, budgeted funding for the project.

An actual assessment of whether the project was significant was not conducted for the I-495/U.S. Route 1 project, or for the WWB project. However, it was understood that the expansion and reconstruction of the I-495/U.S. Route 1 interchange was a significant project – whether by itself or as part of the larger WWB project.

The following work zone strategies were identified and examined in detail for their applicability to minimize construction impacts upon traffic flow:

- **Intelligent Transportation Systems (ITS)** – ITS that was anticipated to be designed for the final roadway alignment was also sought to be designed and deployed to help in the management of traffic during construction.
- **Incident Management** – Strategies that would enhance incident management during and after the construction of the Woodrow Wilson Bridge (WWB) project were examined.
- **Travel Demand Management (TDM)/Transit** – Strategies that could divert traffic away from the WWB construction zone were examined. Public information was also addressed as part of TDM/transit strategy identification.
- **Local Street Operations** – Strategies and improvements along major alternate routes to be used by traffic diverting from the WWB construction zone to facilitate local travel during construction and times of incidents were examined.

ITS, incident management, TDM/transit, public information, and local street operations strategies that were identified as being cost effective and practical were recommended for approval and inclusion in the 30% preliminary project cost estimate. Only selected ITS, incident management and public information strategies were included in the 30% preliminary cost estimate as the TDM/transit and local street operations strategies were found not to be cost effective or practical.

It was also agreed that the deployment of the incident management and public information programs would be managed by the General Engineering Consultant (GEC). Program elements were not specific to the I-495/U.S. Route 1 interchange; rather, they were WWB project-wide. Having the GEC manage these programs would also enable a deployment of specific actions and activities that could be matched against anticipated spikes in corridor-wide work zone lane and/or ramp closure impacts.

## Design

In addition to the aforementioned Transportation Technical Report, Record of Decision and other materials (e.g., WWB Traffic Projections and Operational Analysis), the following materials were available and gathered at the outset of final engineering design development:

- 30% preliminary engineering plans and cost estimate.
- Additional traffic characteristics (e.g., volume, turning movements) used to aid in the preliminary engineering plan development.
- Updated WWB Construction Contract Summary.
- Updated WWB Project Master Schedule.

Multiple candidate construction staging approaches were developed for the I-495/U.S. Route 1 interchange contract, concurrent with taking the 30% preliminary design plans to the semi-final design stage. The management strategies themselves were not reassessed.

Similar to the Preliminary Engineering Module, the expansion and reconstruction of the I-495/U.S. Route 1 interchange was understood to be a significant project. As such, work zone impacts were analyzed for each candidate construction staging approach to build the I-495/U.S. Route 1 interchange including:

- Detailed traffic engineering analyses were conducted to assess the traffic operations impacts related to closing shoulders, lanes, ramps, traffic switches, and queues.
- The ability to respond, clear and manage incidents was reviewed with an emphasis on providing an incident management friendly work zone.
- Opportunities to advance the deployment of permanent ITS field devices (e.g., closed-circuit television (CCTV) cameras, highway advisory radio (HAR), and dynamic message signs (DMS)) for use in supporting maintaining traffic flow through the construction zone were examined.

Coupled with this quantitative and qualitative analysis, working session meetings were held to review the various approaches with an emphasis on reviewing:

- Constructability.
- Feasibility.
- Budget impacts.
- Community impacts.
- Environmental impacts.

A series of iterative working session meetings and refinements to proposed construction staging ultimately led to the selection of an agreed upon construction staging sequence and supporting traffic control plan for the I-495/U.S. Route 1 interchange.

A final construction staging and supporting traffic control plan was developed for the I-495/U.S. Route 1 interchange project. Drawings specifying construction staging and detailed signing, striping and placement of traffic control devices were developed and set forth in the final contract plans.

A separate ITS construction contract was developed to advance the deployment of selected CCTV camera and DMS. The purpose for the break-out was twofold – to complete installation in advance of major interchange construction and traffic impacts, and to obtain the services of an ITS contractor in lieu of a general contractor. A special provision was developed and included in the final contract that required the contractor to submit site-specific traffic control plans for approval prior to the implementation of any work zones.

During the completion of the final design plans for the I-495/U.S. Route 1 Interchange, designers examined different methods to accelerate the duration of construction. Alternative maintenance of traffic plans were developed and CORSIM modeling software was used to further assess the traffic impacts of the alternate MOT plans. At this time, the contractor has not implemented these alternate MOT plans.

### **Construction**

An I-495/U.S. Route 1 Construction Project Kick-off Meeting was held with key personnel including the contractor, Virginia DOT staff, the construction management and inspection team, and local utility agencies. Elected officials and representatives of local and county agencies were also invited to attend. Contract plans, construction staging, the traffic control plan and the WWB Project Lane Closure Policy were reviewed in detail. No alternative approach was proposed by the I-495/U.S. Route 1 interchange contractor. Thus, the anticipated work zone impacts reassessment was not conducted.

Through the first year of construction, construction staging and traffic control have been implemented by the general contractor as set forth in the final contract plans. Partnering meetings, held bi-weekly, have resulted in recommended substantive changes to construction staging and traffic control. The Contractor proposed the closure of a one-block stretch of a local street that would facilitate the installation of numerous utilities, traffic signal and a TMS conduit system that would require numerous lane closures for several months. The contractor's reasoning behind this proposal was they would go in and do the work, close the road one time, and have a viable detour route that would not send motorists to far from the existing route.

As a result of this proposal, a Synchro model analysis was conducted to analyze the implications of the disruption to motorist traveling through the work zone area. The result of the modeling indicated numerous improvements in traffic flow with no delays to motorists. Field observation demonstrated that the results of the analysis were consistent with how traffic was flowing through the work zone. As such, the recommended change was implemented.

With respect to work zone safety and mobility impacts monitoring during construction, the General Engineering Consultant team:


- Conducts windshield surveys to review construction signing and striping installations for proper use and placement.
- Conducts windshield surveys to monitor average queue lengths within and approaching the construction zone.
- Conducts quarterly meetings, or meetings as needed with the State, county and local agency incident management community to review operations and advise them in advance of major construction changes.
- Conducts an evaluation of traffic signal timing to insure signals are operating efficiently and effectively.
- Has a dedicated staff person responsible for monitoring work zones with the use of CCTV at the project office.
- Has a dedicated staff person responsible for updating real-time work zone information by utilizing highway advisory radio system.
- Has dedicated staff responsible for addressing questions and issues raised by the local business and residential communities.
- Coordinates lane closures and other operational issues with other nearby major roadway reconstruction projects.
- Has work zone safety and mobility as a standing item for construction Partnering meetings.

A project web site was established for the overall WWB project (<http://wilsonbridge.com>). This site contains information on:

- The overall WWB project.
- “Bridge Bucks” which provides a \$50 incentive for using alternative modes of transportation.
- “Mission Possible, Keep You Moving” program providing traveler information on:
  - Commuter solutions.
  - Employer solutions.
  - Current traffic conditions (real-time traffic, lane closures, traveler information).
  - Regional travel solutions.
  - Clearing traffic incidents.
  - Bridge openings.
  - Mariner’s alerts.

- Construction program (including the I-495/U.S. Route 1 Interchange project).
- Project news.
- Neighborhood news.
- Environmental aspects.
- Civil rights/DBE programs.
- Project scrapbook.
- Project videos.

Media releases similar to that shown in Figure A.3 are used to provide information to motorists on lane closure updates, major traffic changes, detours, etc.



**Woodrow  
Wilson  
Bridge  
Project**

## *Media Advisory*

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For Immediate Release  
May 17, 2005

Contacts: **Michelle Holland, WWB Project**  
703/329-0300 or 703/930-7286 (cell)  
**John Undeland, WWB Project**  
703/329-0300 or 571/237-2690 (cell)  
**Joan Morris, VDOT**  
703/383-2465 or 703/826-9789 (cell)

**\* IMPORTANT TRAFFIC CHANGE IN ALEXANDRIA, VA THIS WEEKEND \***

**RAMPS FROM ROUTE 1 TO CAPITAL BELTWAY (OUTER LOOP)  
TEMPORARILY CLOSED THIS SATURDAY  
Drivers Must Use Signed Detours**

WHAT/WHERE:      The ramps taking southbound and northbound Route 1 motorists to the Capital Beltway Outer Loop (toward Maryland) are scheduled to be temporarily closed this Saturday (5/21/05). As an alternative, drivers will be detoured southbound on the Beltway Inner Loop to the next exit (Telegraph Road). The Telegraph Road Exit allows drivers to loop back to the Beltway Outer Loop.

**Figure A.3 Sample News/Media Release from WWB Project Web Site**

In March 2005, information about the project construction periods (phases) and the anticipated traffic impacts for 2005-06 was made available in a presentation that can be viewed on the project web site (<http://wilsonbridge.com/powerpoint/050322-NicholsonCityCouncilPres.pdf>). The presentation includes Figure A.4, which shows the work that was scheduled to occur during various construction periods for the I-495/U.S. 1 project.

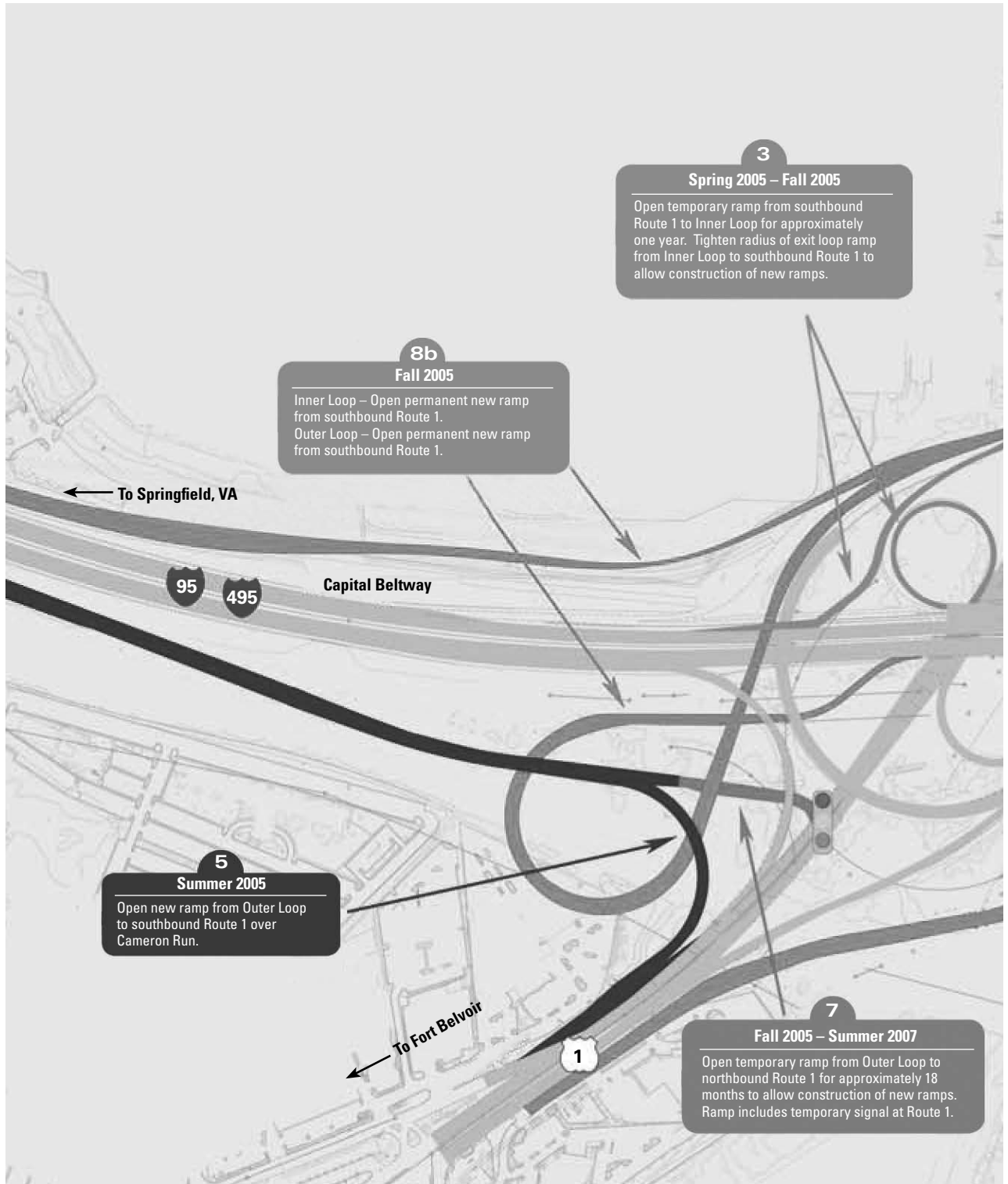
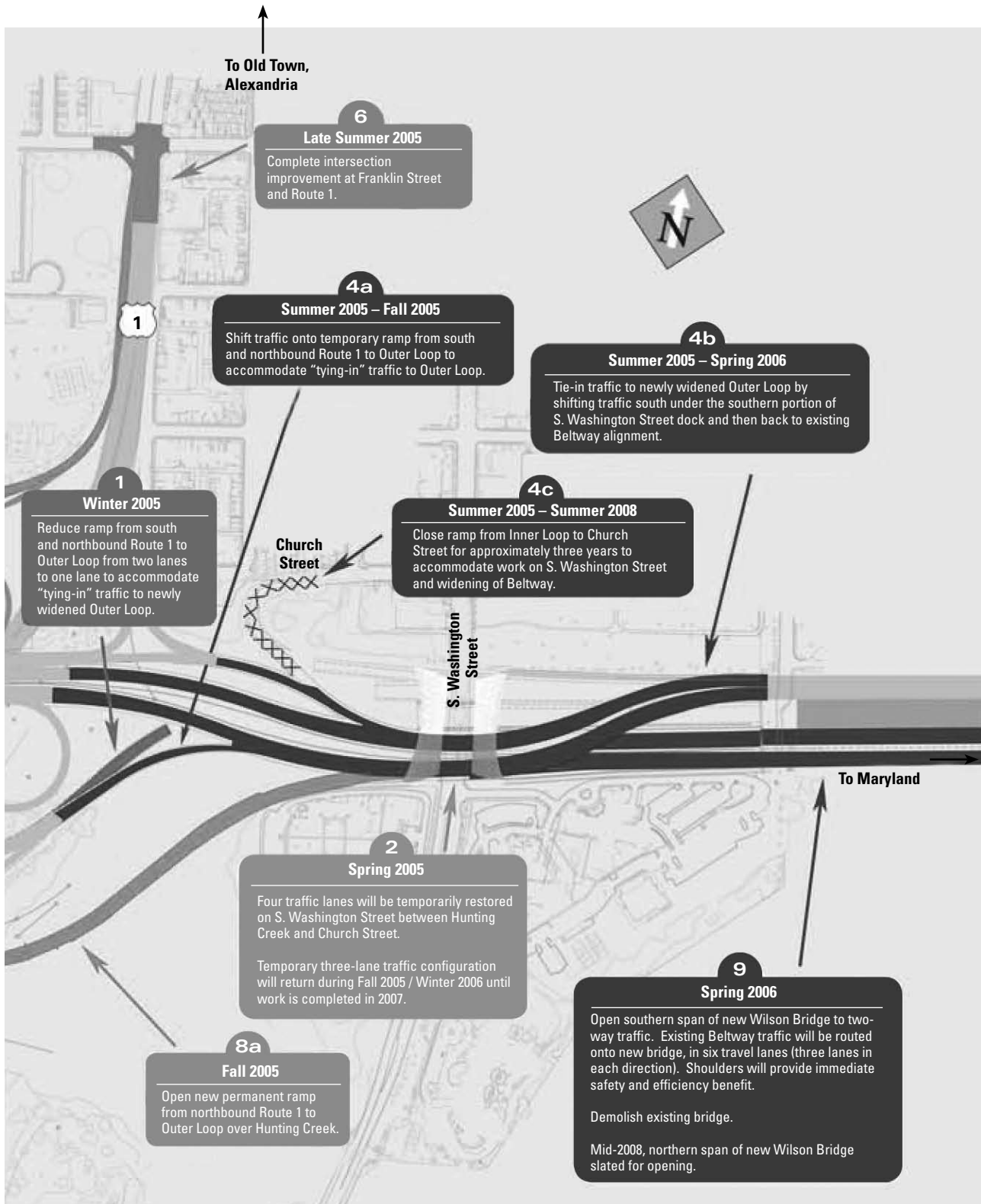


Figure A.4 Anticipated I-495/U.S. 1 Traffic Impacts 2005-06



The presentation also contains several color-coded maps showing the anticipated U.S. 1 traffic impacts for the different construction periods, with a focus on impacts to the City of Alexandria. In the maps, the traffic impacts are classified into several levels:

- **Improvement** – decrease in delays/travel times expected; opening new ramp/roadway; improved shoulders.
- **Low** – slight increase in delays/travel times expected; lower speed, narrow or temporary ramp; slight lane shift, new temporary traffic signal.
- **Moderate** – modest increase in delays/travel times expected; considerable lane shift; new merge point with minimal acceleration lane.
- **Severe** – substantial increase in delays/travel times expected; significant lane shift.

Mitigation measures suggested for addressing these work zone safety and mobility impacts include:

- Sequencing construction activities.
- Reducing speeds to 50 mph in the project corridor.
- Enhancing signs and pavement markings for clear and positive guidance.
- Increasing police presence.
- Coordinating activities with City of Alexandria traffic (signal timing, etc.).
- Using CCTV cameras.
- Disseminating real-time traffic information via HAR, overhead and portable VMS, project web site, and e-mail list.
- Disseminating information about scheduled traffic changes (e.g., lane closure schedules) via telephone hotline, project web site, and media/stakeholder outlets.

During construction, work zone performance has been monitored through field observations and work zone evaluations.

### **Performance Assessment**

The I-495/U.S. Route 1 Interchange project was under construction during development of this document. This step has not yet been conducted.



## Appendix B – Impacts Analysis Tools

Several methodologies and tools are available for conducting transportation analyses and estimating the effects of various transportation planning alternatives and projects. These tools vary in level of complexity, and each tool offers different capabilities. Some tools were designed specifically for work zone applications. Other traffic analysis tools, although not designed specifically for work zones, can be used for to analyze work zone situations. This section includes information on both of these types of tools.

### Types of Traffic Analysis Tools

Traffic analysis tools can be grouped into the following categories:

- **Sketch-planning tools** – Sketch-planning methodologies and tools produce general order-of-magnitude estimates of travel demand and traffic operations in response to transportation improvements. They allow for evaluation of specific projects or alternatives without conducting an in-depth engineering analysis. Sketch-planning tools perform some or all of the functions of other analysis tool types using simplified analyses techniques and highly aggregate data. Such techniques are primarily used to prepare preliminary materials and budgets, and are not considered a substitute for the detailed engineering analysis often needed later in the project design and implementation process. Sketch-planning approaches are typically the simplest and least costly of traffic analysis techniques, and are usually limited in scope, analytical robustness, and presentation capabilities. Examples of sketch-planning tools include QuickZone, Surface Transportation Efficiency Analysis Model (STEAM), and ITS Deployment Analysis System (IDAS). QuickZone was developed for work zone applications and is described in the Work Zone Specific Analysis Tools section later in this appendix.
- **Travel demand models** – Travel demand models have specific analytical capabilities, such as the prediction of travel demand and the consideration of destination choice, mode choice, time-of-day travel choice, and route choice, as well as the representation of traffic flow in the highway network. These are mathematical models that forecast future travel demand based on current conditions, and future projections of household and employment characteristics. Travel demand models were originally developed to determine the benefits and impacts of major highway improvements in metropolitan areas. Travel demand models are suited for static analyses and are not capable of dynamic traffic analysis (i.e., time-varying analyses). Therefore, they have only limited capabilities to evaluate ITS/operational strategies and operational characteristics such as speed, delay, and queuing. Examples of travel demand models include TransCAD, Cube, Quick Response System (QRS) model, Équilibre Multimodal, Multimodal Equilibrium 2 (EMME2), IDAS<sup>1</sup>, and VISUM.
- **Analytical/deterministic tools (HCM Based)** – Most analytical/deterministic tools implement the procedures of the Highway Capacity Manual (HCM). HCM procedures are closed-form, macroscopic, deterministic, and static analytical procedures that estimate capacity and performance measures to determine the level of service (e.g., density, speed, and delay). They are closed-form because they are not iterative. The practitioner inputs the data and parameters and, after a sequence of analytical steps, the HCM procedures produce a single answer. Moreover, HCM procedures are macroscopic (inputs and outputs deal with average performance during a 15-minute or a one-hour

<sup>1</sup> The ITS Deployment Analysis System (IDAS) may be classified as both a sketch-planning tool and a travel demand model, because it uses sketch-planning methods to estimate the benefits and costs of ITS/operational strategies using a travel demand model as the base.

analysis period), deterministic (any given set of inputs will always yield the same answer), and static (they predict average operating conditions over a fixed time period and do not deal with transitions in operations from one state to another). As such, these tools quickly predict capacity, density, speed, delay, and queuing on a variety of transportation facilities and are validated with field data, laboratory test beds, or small-scale experiments. Analytical/deterministic tools are good for analyzing the performance of isolated or small-scale transportation facilities, but are limited in their ability to analyze network or system effects. Examples of analytical/deterministic tools include Highway Capacity Software (HCS), Synchro, and the TEAPAC suite of programs.

- **Traffic signal optimization tools** – Traffic signal optimization tools are similar to analytical/deterministic tools, and are largely based on HCM procedures. However, traffic signal optimization tools are primarily designed to develop optimal signal phasings and timing plans for isolated signal intersections, arterial streets, or signal networks. Some optimization tools can also be used for optimizing ramp metering rates for freeway ramp control. The more advanced traffic signal optimization tools are capable of modeling actuated and semi-actuated traffic signals, with or without signal coordination. Examples of traffic signal optimization tools include Progression Analysis and Signal System Evaluation Routine (PASSER), Signal Operations Analysis Package (SOAP), Synchro, Traffic Network Study Tool (TRANSYT-7F), Time-Space Diagram for Windows (TSDWin), and the TEAPAC suite of programs.
- **Macroscopic simulation models** – Macroscopic simulation models are based on deterministic relationships of flow, speed, and density of the traffic stream. The simulation in a macroscopic model takes place on a section-by-section basis rather than tracking individual vehicles. Macroscopic simulation models were originally developed to model traffic in distinct transportation subnetworks, such as freeways, corridors (including freeways and parallel arterials), surface street grid networks, and rural highways. They consider platoons of vehicles and simulate traffic flow in small time increments. Macroscopic simulation models operate on the basis of aggregate speed/volume and demand/capacity relationships. Macroscopic models have considerably less demanding computer requirements than microscopic models. They do not, however, have the ability to analyze transportation improvements in as much detail as microscopic models, and do not consider trip generation, trip distribution, and mode choice in their evaluation of changes in transportation systems. Examples of macroscopic simulation models include Bottleneck Traffic Simulator (BTS), Freeway Corridor Simulation Model (FREQ), Corridor Flow Simulation Software (CORFLO), PASSER, and TRANSYT-7F.
- **Mesoscopic simulation models** – Mesoscopic models combine properties of both microscopic (discussed below) and macroscopic simulation models. As in microscopic models, the mesoscopic models' unit of traffic flow is the individual vehicle. Similar to microscopic simulation models, mesoscopic tools assign vehicle types and driver behavior, as well as their relationships with the roadway characteristics. Their movement, however, follows the approach of macroscopic models and is governed by the average speed on the travel link. Mesoscopic model travel prediction takes place at an aggregate level, and does not consider dynamic speed/volume relationships. As such, mesoscopic models provide less accuracy than microsimulation tools, but are superior to typical planning analysis techniques. Examples of mesoscopic models include Continuous Traffic Assignment Model (CONTRAM), and Dynamic Network Assignment Simulation Model for Advanced Road Telematics for Planning (DYNASMART-P).

- **Microscopic simulation models** – Microscopic simulation models simulate the movement of individual vehicles, based on theories of car-following and lane-changing. Typically, vehicles enter a transportation network using a statistical distribution of arrivals (a stochastic process), and are tracked through the network over small time intervals (e.g., one second or fraction of a second). Typically, upon entry, each vehicle is assigned a destination, a vehicle type, and a driver type. In many microscopic simulation models, the traffic operational characteristics of each vehicle are influenced by vertical grade, horizontal curvature, and super-elevation, based on relationships developed in prior research. Computer time and storage requirements for microscopic models are large, usually limiting the network size and the number of simulation runs that can be completed. Examples of microscopic simulation models include Traffic Software Integrated System/Corridor Simulation (TSIS/CORSIM), INTEGRATION, SimTraffic, Wide Area Traffic Simulation (WATSim), VISSIM, and Parallel Microscopic Traffic Simulator (PARAMICS).

More information on traffic analysis tools can be found on the FHWA Office of Operations Traffic Analysis Tools web site, available at <http://www.ops.fhwa.dot.gov/trafficanalysistools/index.htm> (Accessed 9/16/05).

## Work Zone Specific Analysis Tools

- **QuickZone** is a work zone delay estimation model developed by the Federal Highway Administration (FHWA) Research, Development, and Technology (RD&T) program. QuickZone was developed to help State and local transportation agencies better understand and consider the impacts of work zones as they plan, design, and implement their highway projects. QuickZone can help enable the consideration of the work zone impacts of alternate work zone design and mitigation strategies. QuickZone provides this capability to project planners and engineers, whereby they can obtain an estimate of delay, queuing, and user costs associated with alternate work zone design and mitigation strategies. The ability to estimate these work zone impacts at the early planning and design stages will facilitate better decision-making that will ultimately improve the operational performance of highways during construction and maintenance activities, and minimize the impacts on road users and businesses.

QuickZone provides analysis options to estimate work zone delays and user costs for different demand patterns and for temporal (seasonal, weekly, daily) and spatial variations of work zone configurations. It can quantify corridor delay resulting from capacity decreases in work zones; identify the impact on delay of alternative construction phasing plans; and support tradeoff analyses between construction costs and delay costs. Work zone impacts and costs are estimated for an average day of work, which can then be amortized to get an estimate of average annual costs based on a user-specified life-cycle for the improvement. It can assess the impact of delay-mitigation strategies, such as alternate routing, signal re-timing, lane widening, and ramp metering. In addition to estimating work zone delays and user costs, QuickZone also provides a sketch-planning analysis of travel behavioral changes in response to work zones. QuickZone also supports the calculation of work-completion incentives.

The software will therefore help highway agencies better phase and stage their construction and maintenance activities. For example, QuickZone enables road owners and contractors to compare the effects of doing highway work at night instead of during the day, or that of diverting traffic to one road versus another road at various stages of construction<sup>2</sup>. Information on QuickZone can be found at <http://www.tfhrcc.gov/its/quickzon.htm> (Accessed 09/16/05).

- **QUEWZ-98** is a microcomputer analysis tool for planning and scheduling freeway work zone lane closures. It analyzes traffic conditions on a freeway segment with and without a lane closure in place and provides estimates of the additional road user costs and of the queuing resulting from a work zone lane closure. The road user costs calculated include travel time, vehicle operating costs, and excess emissions. A user's manual for QUEWZ-98 is available. After describing the capabilities and input data requirements of QUEWZ-98, it provides instructions on using Q98MENU, a menu-driven user interface, to run QUEWZ-98. It also includes three examples to illustrate the various input and output options that are available. QUEWZ-98 can be obtained from McTrans at <http://mctrans.ce.ufl.edu/> (Accessed 09/16/05).
- **Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS)** is a computer model intended to estimate the maximum amount (distance) of highway that can be rehabilitated or reconstructed within various closure timeframes. This model integrates pavement, construction, and traffic related decision-making by balancing numerous constraints such as scheduling interfaces, pavement materials and design, contractor logistics and resources, and traffic operations. When combined with a traffic model, the CA4PRS software can help determine which pavement structures and rehabilitation strategies maximize on-schedule construction production without creating unacceptable traffic delays. More information on CA4PRS is available at <http://www.dot.ca.gov/newtech/roadway/ca4prs/ca4prs.htm> (Accessed 01/06/06), and <http://www.ce.berkeley.edu/~eblee/CA4PRS.htm> (Accessed 01/06/06).

Additional information on work zone analysis tools can be found at the Work Zone & Traffic Analysis/Management section of the FHWA work zone web site, available at [http://ops.fhwa.dot.gov/wz/traffic\\_analysis.htm](http://ops.fhwa.dot.gov/wz/traffic_analysis.htm) (Accessed 06/05/06).

## Choice of Analysis Tools

There is no one analytical tool that can do everything or solve every problem. The method or tool selected for any analysis should be consistent with the analysis needs and fit within budget and resource requirements. Using too complex of a tool for the analysis needs, such as using a microsimulation tool for preliminary screening of scenarios, may result in a poor use of resources. At the same time, using too simplistic of a tool for the situation, for example using a travel demand model for detailed design of an operational strategy, may result in inaccurate or unreliable results.

Some tools, such as IDAS and DYNASMART-P, were not designed specifically for work zones but they can be used to analyze work zone situations. For example, IDAS may be used to analyze work zone situations in a planning context for a sketch-planning level analysis, while DYNASMART-P may be used to perform a more detailed operational analysis on a dynamic (time-varying) basis.

The FHWA Traffic Analysis Toolbox provides reference information on current tools and also presents a needs-based framework for selecting the appropriate tools. The Toolbox provides a spreadsheet-based tool selection framework that is based on user-specific analysis needs and criteria. The Toolbox is available at <http://www.ops.fhwa.dot.gov/trafficanalysistools/toolbox.htm> (accessed 06/05/06).



## Appendix C – Resources Referenced in This Document

The following resources were referenced in examples throughout this Guide.

### A. Work Zone Best Practices Guidebook, Federal Highway Administration, April 2000

Many of the examples referenced in this Guide come from the Federal Highway Administration (FHWA) Work Zone Best Practices Guidebook (<http://www.ops.fhwa.dot.gov/wz/practices/best/Default.htm>). This guidebook is a resource designed to give state and local transportation agencies, construction contractors, transportation planners, trainers, and others access to information and points of contact about current helpful practices for achieving work zone safety and mobility. The best practice entries describe approaches used by transportation agencies, along with contact information. Each organization must determine which of these practices are best suited for its particular situation, considering all the factors that affect work zone operations. Each best practice entry describes some of these factors for consideration.

The best practices are organized by the following 11 categories:

- Policy and Procedures
- Public Relations, Education, and Outreach
- Prediction Modeling and Impact Analysis: Congestion and Crashes
- Planning and Programming
- Project Development and Design
- Contracting and Bidding Procedures
- Construction/Maintenance Materials, Methods, and Specification
- Traveler and Traffic Information
- Enforcement
- ITS and Innovative Technology
- Evaluation and Feedback

From <http://www.ops.fhwa.dot.gov/wz/practices/best/bestpractices.htm>, users can access an online (html) version of the Guidebook that enables searching for practices. Searches can be done using the 11 categories, through several cross-references (e.g., State/agency using the practice), by a subject index, or through a keyword search of all best practices. A PDF version of the Work Zone Best Practices Guidebook is also available at this site and can be downloaded.

## **B. Comments in Response to the FHWA Advance Notice of Proposed Rulemaking (ANPRM) on Work Zone Safety and Mobility**

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3. Wisconsin Department of Transportation, May 31, 2002, URL: [http://dmses.dot.gov/docimages/pdf81/176160\\_web.pdf](http://dmses.dot.gov/docimages/pdf81/176160_web.pdf)

## **C. Comments in Response to the FHWA Notice of Proposed Rulemaking (NPRM) on Work Zone Safety and Mobility**

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8. "AASHTO Roadside Design Guide, Chapter 9, Traffic Barriers, Traffic Control Devices, and Other Safety Features for Work Zones," American Association of State Highway and Transportation Officials (AASHTO), 2002, URL: <http://bookstore.transportation.org>
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## E. Training

36. Work Zone Traffic Control for Maintenance Operations (Short-Term), National Highway Institute (NHI) Course, U.S. Department of Transportation, Federal Highway Administration, URL: "[http://www.nhi.fhwa.dot.gov/training/brows\\_catalog.aspx](http://www.nhi.fhwa.dot.gov/training/brows_catalog.aspx). Enter 380060 in the Course Number box and click "Search."

## F. Web Sites

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39. American Association of State Highway and Transportation Officials (AASHTO) Quality Information Center, URL: <http://www.transportation1.org/quality/>
40. Best Practices Inventory of Performance Measurement Practices in Other State Departments of Transportation, Washington State Department of Transportation, URL: <http://www.wsdot.wa.gov/accountability/library/default.htm>
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45. Intelligent Transportation Systems Deployment Analysis System (IDAS) Web Site, URL: <http://idas.camsys.com/>
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54. QuickZone Web Site, U.S. Department of Transportation, Federal Highway Administration, URL: <http://www.tfsrc.gov/its/quickzon.htm>
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57. Transportation Research Board (TRB) Performance Measurement Committee (A5022/ABC30), URL: <http://www.trb-performancemeasurement.org/>
58. Transportation System Performance Measures Web Site, California Department of Transportation, URL: <http://www.dot.ca.gov/hq/tsip/tspm/index.htm>
59. Value Engineering Web Site, U.S. Department of Transportation, Federal Highway Administration, URL: <http://www.fhwa.dot.gov/ve/index.htm>
60. Work Zone Rule Web Site, U.S. Department of Transportation, Federal Highway Administration, URL: [http://www.ops.fhwa.dot.gov/wz/resources/final\\_rule.htm](http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm)
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		15. Supplementary Notes <b>FHWA Project Leader – Tracy Scriba, FHWA</b>	
16. Abstract <p><b>This Guide is designed to help transportation agencies develop and/or update their own procedures for assessing and managing the work zone impacts of their road projects throughout the different program delivery stages. Understanding work zone impacts is critical to developing effective work zone transportation management plans (TMPs) that provide for safety, mobility, and quality in maintaining, rehabilitating, and rebuilding the nation's highways. The primary intended audience for this Guide is transportation agency staff, including technical staff (planners, designers, construction/traffic engineers, highway/safety engineers, etc.); management and executive-level staff responsible for setting policy and program direction; field staff responsible for building projects and managing work zones; and staff responsible for assessing performance in these areas.</b></p> <p><b>This document also provides support to agencies in their efforts to implement the recently updated work zone regulations. In September 2004, the FHWA published updates to the work zone regulations at 23 CFR 630 Subpart J. The updated rule is referred to as the Work Zone Safety and Mobility Rule (Rule) and applies to all State and local governments that receive Federal-aid highway funding. Transportation agencies are required to comply with the provisions of the Rule by October 12, 2007. The changes made to the regulations broaden the former Rule to better address the work zone issues of today and the future.</b></p> <p><b>The Rule provides a decision-making framework that facilitates comprehensive consideration of the broader safety and mobility impacts of work zones across project development stages, and the adoption of additional strategies that help manage these impacts during project implementation. The Rule requires agencies to develop an agency-level work zone safety and mobility policy to support systematic consideration and management of work zone impacts across all stages of project development. Based on the policy, agencies will develop processes and procedures to support implementation of the policy. These include procedures that address work zone impacts assessment, work zone data, work zone training, and process reviews. The Rule also calls for the development of project-level procedures to help agencies assess and manage the work zone impacts of individual projects. While the Rule does not require a specific work zone impacts assessment process/procedure, it recommends that agencies develop and implement systematic procedures to assess work zone impacts in project development, and to manage safety and mobility during project implementation.</b></p> <p><b>This document is the last of four guidance documents developed on the Rule, and provides a general approach for conducting work zone impacts assessment and management, as well as many examples of the approaches currently being used by transportation agencies.</b></p>			
17. Key Words <b>Work zone, safety, mobility, road construction, road projects, work zone impacts, impacts assessment, work zone management strategies, work zone policy, regulation, rule, guidance</b>		18. Distribution Statement <b>No restrictions. This document is available to the public.</b>	
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