



U.S. Department of Transportation
Federal Highway Administration

Targeted Work Zone Engagement Framework Guidance Document



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16. Abstract The Targeted Work Zone Engagement Framework (“Framework”) was developed in 2016 to serve as a resource for FHWA personnel to easily and efficiently provide targeted assistance to State transportation agencies. It is designed to support work zone program personnel in enhancing the effectiveness of their work zone safety and mobility policies and procedures. It is intended for use by State agency staff in conjunction with FHWA subject matter experts to identify and assess work zone safety and mobility impact mitigation needs, determine useful resources, and implement improvements. The Framework, which has been updated to include tools and resources published since the original issue in 2016, includes a range of information resources (guidelines, field guides, podcasts, training, and analytical tools) along with guidance to assist agencies in determining how to improve their own work zone safety and mobility policies and procedures based on available data.			
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SI* (MODERN METRIC) CONVERSION				
FACTORS APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000 L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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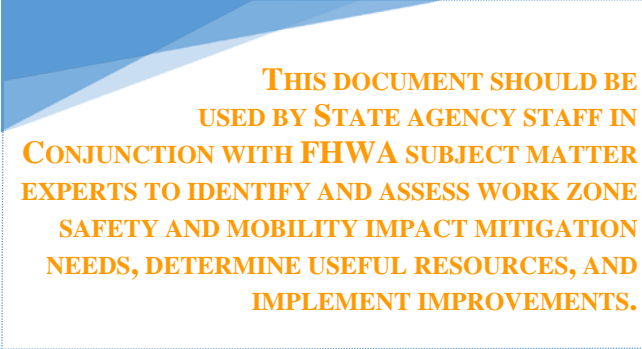
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CHAPTER 1. INTRODUCTION

The Federal Highway Administration (FHWA) developed the Targeted Work Zone Engagement Framework (“Framework”) to support work zone personnel at State transportation agencies in enhancing the effectiveness of their work zone safety and mobility policies and procedures. In support of [23 CFR Part 630 Subpart J of the Work Zone Safety and Mobility Rule](#), FHWA can apply this Framework to determine the stage at which a State transportation agency is operating with respect to identifying and eliminating work zone impacts. FHWA can then use these results to better assist agencies with identifying and assessing both their work zone safety and mobility impact mitigation needs as well as the best resources that States can leverage to implement improvements related to policies, procedures, and strategy deployments.



THIS DOCUMENT SHOULD BE USED BY STATE AGENCY STAFF IN CONJUNCTION WITH FHWA SUBJECT MATTER EXPERTS TO IDENTIFY AND ASSESS WORK ZONE SAFETY AND MOBILITY IMPACT MITIGATION NEEDS, DETERMINE USEFUL RESOURCES, AND IMPLEMENT IMPROVEMENTS.

WHY IS IT NEEDED?

A range of information resources (notable practice summaries, examples of various agency work zone policies, recent process reviews, etc.) are available for review by an agency attempting to improve its policies and procedures. However, prior to the development of this Framework, limited guidance was available to assist agencies in determining how to improve their own work zone safety and mobility policies and procedures based on available data. In addition, there was not a comprehensive, cohesive decision and application framework that could be used by FHWA to:

- 1) Best determine which agencies need and could benefit from additional assistance.
- 2) Help those priority agencies in determining their strategic needs with respect to work zone safety and mobility improvements.
- 3) Provide strategic assistance on how to best implement improvements in those policies and procedures once they have been determined.

HOW DOES IT WORK?

- Uses emphasis areas to allow FHWA to assist State transportation agencies in easily identifying goals and mitigation strategies to improve work zone operations with a specific focus.
- Helps agencies trying to assess how policies and procedures align with their desired emphasis areas.
- Recommends specific resources to best assist agencies in identifying, adopting, and evaluating strategies to improve work zone impact mitigation effectiveness.

WHAT ARE THE BENEFITS?

- Offers a comprehensive decision and application Framework for FHWA to best support agencies.
- Assists transportation agencies with determining their strategic needs with respect to work zone safety and mobility improvements.
- Provides strategic assistance on how to best implement improvements in those policies and procedures once they have been determined.

GUIDANCE DOCUMENT ORGANIZATION

This document was developed to serve as a resource for FHWA personnel to easily and efficiently provide targeted assistance to State transportation agencies. As such, the document is organized as follows:

Chapter 2. The Targeted Work Zone Engagement Framework – Describes the intent of the Framework and provides examples of how each Framework Step might be used in a targeted engagement effort with an agency.

Chapter 3. Emphasis Areas, Goals, and Mitigation Strategies – Provides the reader with a full listing of the emphasis areas, goals, and mitigation strategies associated with the Framework.

Chapter 4. Resources – Provides the reader with a complete listing of available work zone resources based on the Framework Step(s) under which an agency's work zone program falls.

CHAPTER 2. THE TARGETED WORK ZONE ENGAGEMENT FRAMEWORK

Figure 1 (see p. 4) illustrates the Framework developed to assist agencies in better targeting their efforts towards mitigating work zone safety and mobility impacts. The Framework is structured around, and encourages the utilization of, a traditional problem-solving approach whereby an agency:

- Develops a thorough understanding (what, where, when, why, etc.) of the work zone safety and mobility impacts it is experiencing.
- Establishes and prioritizes its goals for mitigating those impacts.
- Identifies strategies that are appropriate for helping to meet those goals.
- Assesses which strategy or strategies would be the most appropriate to implement.
- Determines what the agency needs to do to implement the strategy or strategies, and develops a plan to accomplish the implementation.
- Establishes how the agency will evaluate whether its efforts have been beneficial.
- Determines how lessons learned will be fed back into agency business processes to further improve future mitigation efforts.

Each of these bullet items corresponds to a “step” within this problem-solving approach. Some agencies will already have an understanding of their work zone impacts, have identified improvement goals, have established priorities of the goals for reducing those impacts, and may even know what strategies would best help them accomplish their goals. Engaging these agencies with resources that provide guidance on how to implement strategies and evaluate the effectiveness of those implementation efforts would likely have the greatest potential benefit. For agencies that do not yet have a strong grasp as to the types, amounts, and causes of work zone impacts, engaging them earlier in the Framework with resources on how to obtain a thorough understanding of work zone impacts is a more fitting approach. Once the appropriate step in the process is determined, the Framework provides a roadmap of resources to help guide agency efforts through the problem-solving approach to improve work zone impact mitigation.

The Framework is structured around four main emphasis areas, with improvement goals and corresponding mitigation strategies that could be employed to help realize those goals (for additional information on emphasis areas, goals, and strategies see chapter 3). Resources are then cataloged according to the mitigation strategies they touch upon, and the step(s) in this Framework for which they have potentially useful information to agencies. Presently, the Framework is structured heavily around the transportation management planning process established by FHWA several years ago. However, the Framework does have the flexibility to add new emphasis areas, goals, and mitigation strategies as needed to accommodate advances in technology, business processes, etc.

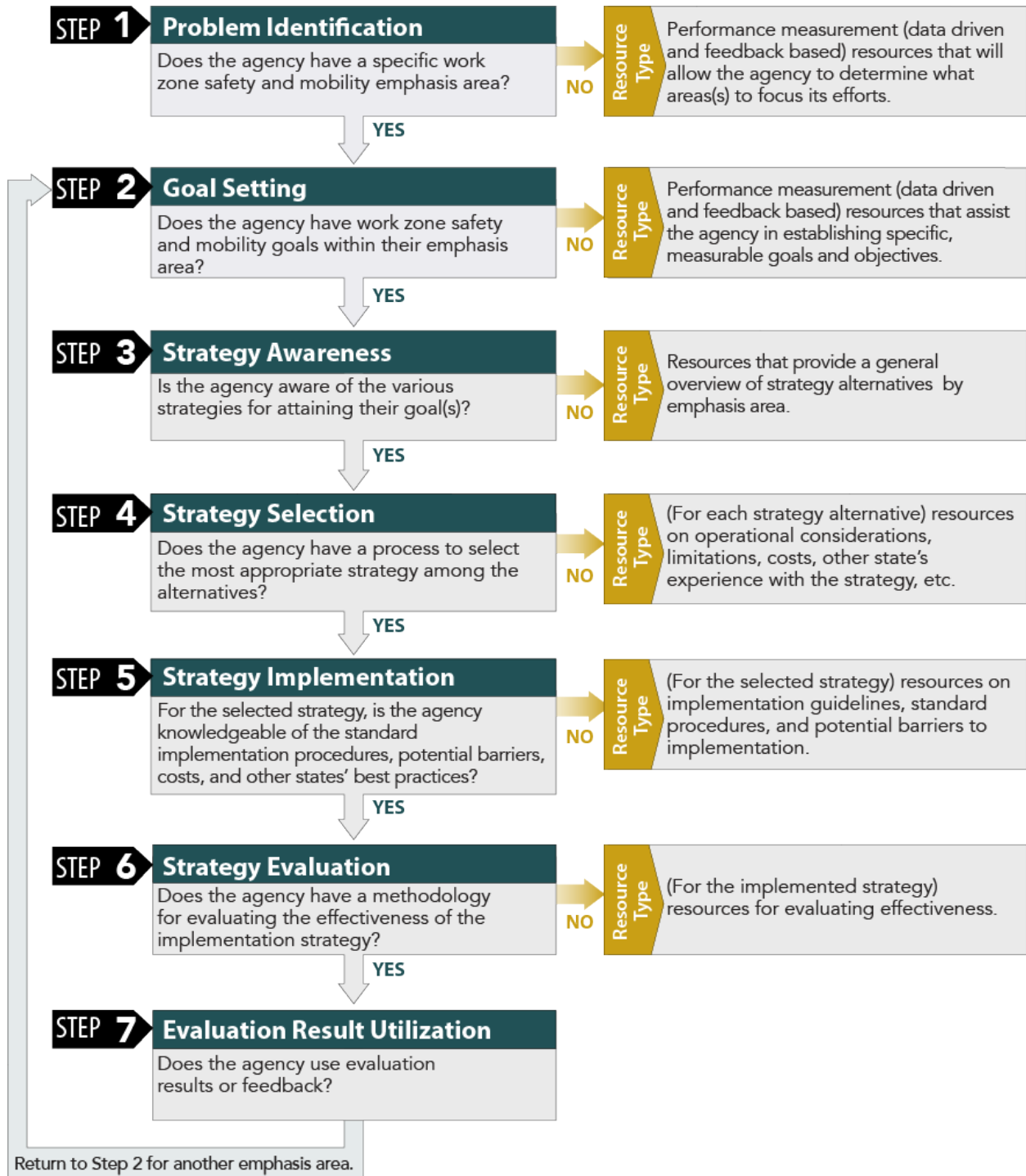


Figure 1. Diagram. The Work Zone Targeted Engagement Framework.

The following sections describe the intent of each Framework step and provide examples of how each Framework step might be utilized in a targeted engagement effort with an agency.

PROBLEM IDENTIFICATION

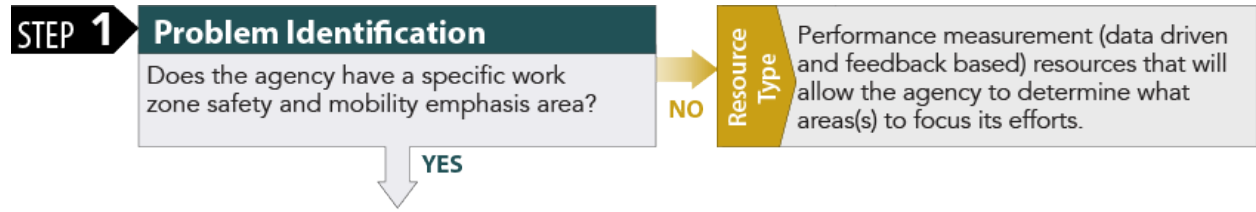


Figure 2. Diagram. Step 1 - Problem identification.

To effectively assist and engage a State agency in better managing work zone safety and mobility impacts, it is important for that agency to be fully aware of its specific work zone challenges and problem areas. Some State agencies have identified their work zone challenges or emphasis areas through their Strategic Highway Safety Plans (SHSPs) or similar directives. In some cases, the identified problems and challenges are specific enough to establish goals and potential mitigation strategies to help the agency achieve those goals. For these agencies, they are ready to move to the next step of the Framework (see step 2). For others, their goals and emphasis areas may still be so generic that a clear direction on emphasis areas and possible mitigation strategies to consider does not yet exist. Engaging with these agencies therefore begins with the first emphasis area: “lack of quantitative and/or qualitative evaluation of current work zone policies or practices.”

The Framework encourages a focused, data-driven approach to help define what work zone impact challenges currently exist and how pervasive they are throughout the organization (or parts thereof). For example, a data-driven approach encourages the analysis of a State’s crash database and any available mobility performance measure statistics to identify overrepresented attributes. Similarly, gathering and assessing the results of FHWA Division Office reviews, State process reviews or other State-FHWA interactions might also be used to better identify impacts, improvement goals, and subsequent priority emphasis areas from a process or procedural perspective.

As shown in table 1, Emphasis Area 1 is divided into five mitigation strategies under one common goal: “Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities.”

Table 1. Emphasis Area #1 – Mitigation strategies for consideration.

Goal Setting	Mitigation Strategy (i.e., “Improved utilization of...”)
Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post-work activities	• Work zone planning and traffic analysis tools and models
	• Crash data collection and performance measure reporting
	• Congestion data collection and performance measure reporting
	• Process reviews
	• Work zone safety audits

The first three strategies are quantitative approaches to understanding work zone safety and mobility issues, whereas the latter two are more qualitative in nature. However, all five strategies focus on ways that an agency can develop a more complete understanding of the work zone safety and mobility impacts it is generating. Therefore, the intent of the resources identified under Step 1 is to broaden and deepen current agency approaches to assessing work zone impacts and to emphasize outcome-based measurements. Presently, many agencies have a very limited understanding as to the level of safety or mobility impacts occurring within their jurisdictional boundaries. Some agencies tend to overemphasize field inspections to determine compliance with work zone traffic control standards, and assessments of safety impacts often end with current work zone fatality counts that are insufficient for developing a more complete understanding of what types of issues and conditions in work zones are contributing to safety problems. As a result, many agency highway safety plans (HSPs) do not address work zone crashes at all, or if they do, the mitigation strategies selected often tend to be high level and generic. Likewise, most agencies do not know the magnitude of mobility impacts being created in most work zones, or even how many work zones occur where mobility impacts are significant.

Example. One of the common ways in which agencies strive to identify problems or challenges in minimizing and mitigating work zone safety and mobility impacts is by conducting biennial process reviews. Some agencies focus primarily on the results of field inspections to do this, which can identify the types of standards and device requirements that are not being fully implemented in the field. However, limiting process reviews just to the results of these inspections often does not provide the agency with enough information to understand the extent and characteristics of work zone safety and mobility impacts occurring across the organization. The recently published [Guidance for Conducting Effective Work Zone Process Reviews](#) offers additional techniques that an agency could use to assess its work zone program such as interviews or surveys of its staff or development and monitoring of mobility-based performance measures (e.g., summaries of additional delays, hours of queuing, percent of its work zones not meeting its stated safety and mobility performance thresholds, etc.).

Another example related to conducting process reviews might be a more robust analysis of State work zone crash data by an agency. Often, only fatal crashes in work zones are examined as part of an agency's assessment of safety impacts, which offers limited insights into when, where, and how work zones are impacting safety. Better insights into work zone safety challenges can often be gleaned through analysis of all types of work zone crashes, incorporating exposure data from a sample of projects, calculating odd ratios of various zone crash types between work zone and non-work zone conditions, or other techniques that are discussed in the [Work Zone Safety Data Collection and Analysis Guide](#). For instance, an agency may choose to plot its work zone crashes onto a statewide map. Work zone crash "hot spots" are then examined in more detail to see if patterns or trends emerge. The agency may find that certain work zones experience more rear-end collisions than others and opt to dig further into these crashes to understand why they occur. They may find that certain work zones experience rear-end collisions during times when temporary lane closures are implemented, suggesting that queues may be contributing to safety issues. They may also find that other work zones are experiencing rear-end collisions during times when construction materials are being brought in or out of the work space, suggesting that work space access design and operations may be creating a safety issue.

GOAL SETTING

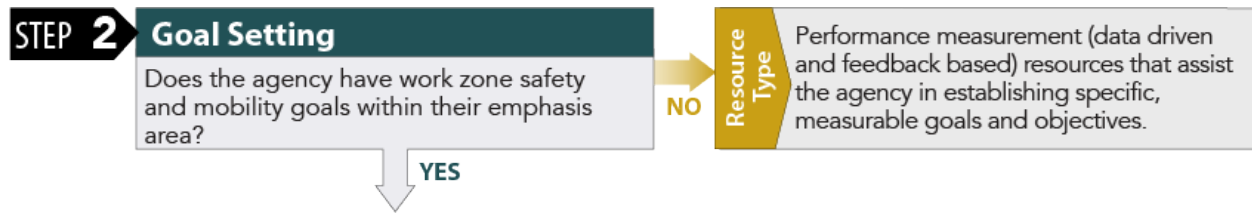


Figure 3. Diagram. Step 2 – Goal setting.

Step 2 of the Framework involves selecting appropriate goals for improving work zone safety and mobility mitigation and management efforts by an agency. At this point in the Framework, the emphasis is on assisting agencies who have developed a good understanding of their work zone safety and mobility problems and challenges (step 1) to focus their attention on a specific improvement goal or set of goals that are expected to mitigate or better manage those problems and challenges. Just as was the case in step 1, some agencies will already have identified goals they plan to pursue to better mitigate and manage work zone safety and mobility impacts. Providing assistance to those agencies would thus begin with one of the latter steps in this Framework. Table 2 summarizes common goals organized under Emphasis Areas 2, 3, and 4 of the Framework (note – Emphasis Area 1 was covered under step 1).

Table 2. Common goals associated with each emphasis area in the framework.

Emphasis Area		Possible Goals
2	Work zone design, driver safety, and worker safety	1. Improve work zone design/travel path delineation
		2. Better alert driver of travel path deviations
		3. Improve driver compliance to work zone devices, regulations
		4. Decrease work zone encroachment incidents
		5. Improve work zone access and egress safety and mobility
		6. Reduce conflict points within the work space
		7. Enhance temporary traffic control effectiveness at rural, low-volume work zones
		8. Improve worker situational awareness
3	Transportation management planning and congestion mitigation	1. Restrict traffic flow through the work zone
		2. Reduce trips through the work zone
		3. Reduce delay through the work zone
		4. Mitigate/manage congestion and rear-end crashes
		5. Accommodate pedestrians, including Americans with Disabilities Act requirements
		6. Mitigate urban conflict points
4	Road user public outreach	1. Improve public relationships

The main theme of Step 2 is the establishment of goals that are SMART:

- Specific.
- Measurable.

- Attainable.
- Relevant.
- Time-bound.

Depending on the agency, short-term goals, long-term goals, or both may be established. Agencies may select from among the 14 common goals which comprise Emphasis Areas 2 through 4 of the Framework. The goal(s) selected help point to a set of mitigation strategies that could help an agency meet its goal(s). Agencies may also choose to combine these common goals or develop goals that are similar to but worded differently from those shown in table 2. In such instances, a review of the list of mitigation strategies among these generic goals can assist agencies in targeting their efforts. However, it is important to keep in mind that goals that are not based on an understanding of when, where, or how work zone safety and mobility issues are occurring are more difficult to target with mitigation strategies. In turn, it is then more difficult to target engagement and assistance efforts that will yield measurable improvements in the stated goals.

Some agencies have established goals as part of their outputs of biennial work zone process reviews and/or efforts to develop and implement strategic and State-level highway safety plans (SHSPs and HSPs). In some cases, those goals may be sufficient for moving onto the next level of the Framework. In other cases, the goals may still be too generic to provide useful direction to the agency. For example, some agencies may have a goal to reduce work zone fatalities by a certain amount by a target date. In many instances, the amount of work zone fatality data is too limited by itself to be useful in identifying and implementing possible mitigation strategies that would be expected to affect this metric.

Example. Continuing on the examples discussed in step 1, an agency may decide to focus efforts on reducing work zone rear-end collisions. Staff analyses suggest that traffic queuing and congestion as well as the design of work zones and work zone access areas are significant issues. Using Table 2, an agency may be encouraged to establish a goal to “improve work zone access and egress safety and mobility” under Emphasis Area 2 in addition to one or more of the goals under Emphasis Area 3. Certainly, the goal to “mitigate/manage congestion and rear-end crashes” under area 3 would be a key goal, but the agency might also choose to include “reduce trips through the work zone” and “reduce delay through the work zone” as additional goals that would contribute to congestion mitigation.

It is also possible that an agency may establish goals related to improving work zone problem identification. This implies that at least some of the engagement effort would remain in step 1. For example, an agency’s process review may bring to light the fact that it does not know how many work zones are not meeting the stated policy regarding maximum acceptable work zone delay. The goal may be to determine how to properly gauge the agency’s level of compliance with its own threshold, and so a useful engagement effort would focus on resources associated with the “congestion data collection and performance measure reporting” strategy in step 1.

STRATEGY AWARENESS

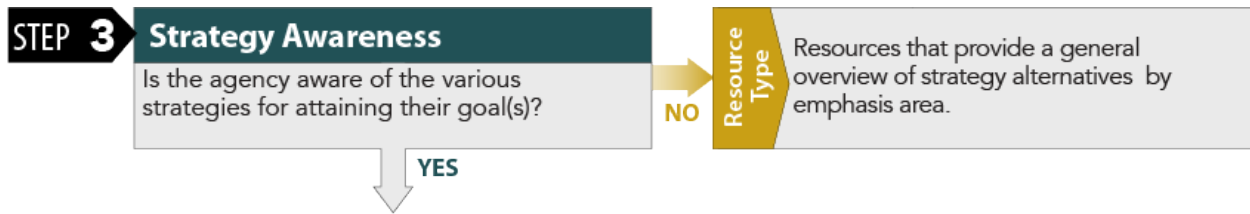


Figure 4. Diagram. Step 3 – Strategy awareness.

This step in the Framework exists to aid agencies in understanding the range of possible mitigation strategies available to help achieve their stated safety and mobility improvement goals. For agencies that desire to improve work zone safety and mobility in their jurisdictions, a tendency often exists to rush directly to selecting and implementing whatever strategy happens to be the popular “flavor of the month” nationally or regionally, even if a more objective assessment of agency needs and goals would suggest other options. The inclusion of this step in the Framework reminds agencies to consider the broad range of possible mitigation strategies that may be relevant to their identified needs and selected goals for work zone safety and mobility improvement.

Possible mitigation strategies have been identified for each of the goals described in step 2 of the Framework. These are summarized in table 3 through table 5, corresponding to Emphasis Areas 2 through 4 (the strategies related to step 1, problem identification, were described in the section entitled “Problem Identification” on p. 5). The resources listed for this step of the Framework provide a basic overview of the strategy or strategies of interest. Many of the resources describe such things as site or project conditions under which the strategies are most appropriate to use; relative costs; expertise required to design, implement, and operate; and examples of other agency experiences with their application.

Table 3. Emphasis Area #2 – Mitigation Strategies for consideration by goal.

Goal Setting	Mitigation Strategy (i.e., “Improved utilization of...”)
Improve Work Zone Design/Travel Path Delineation	<ul style="list-style-type: none"> • Work zone design guidelines (e.g., Manual on Uniform Traffic Control Devices, American Association of State Highway and Transportation Officials, etc.)
	<ul style="list-style-type: none"> • Channelizing devices
	<ul style="list-style-type: none"> • Temporary pavement markings
	<ul style="list-style-type: none"> • Flaggers and uniformed traffic control officers
	<ul style="list-style-type: none"> • Large Static signs/ marked detours
	<ul style="list-style-type: none"> • Portable changeable message signs
	<ul style="list-style-type: none"> • Arrow panels
	<ul style="list-style-type: none"> • Shadow vehicle
	<ul style="list-style-type: none"> • Enhanced flagger or automated flagger assistance devices
	<ul style="list-style-type: none"> • Temporary traffic signals
	<ul style="list-style-type: none"> • Work area lighting
	<ul style="list-style-type: none"> • High-visibility apparel for workers

Table 3. Emphasis Area #2 - Mitigation strategies for consideration by goal. (continued)

Goal Setting	Mitigation Strategy (i.e., “Improved utilization of...”)
Better alert driver of travel path deviations	• Temporary rumble strips
	• Warning lights
	• Intrusion alarms
	• Intelligent transportation system (ITS) technology
Improve driver compliance to work zone devices, regulations	• Law enforcement presence
	• Automated enforcement
	• Increased penalties for violations
Decrease work zone encroachment incidents	• Temporary traffic barriers
	• Moveable barrier systems
	• Reduced speed limit
Improve work zone access and egress safety and mobility	• ITS technology
	• Large static signs
Reduce conflict points within the work space	• Internal traffic control plan
Enhance temporary traffic control effectiveness at rural, low-volume work zones	• Flagging on low-volume roadways
	• Temporary traffic control on low volume roadways
Improve worker situational awareness	• Backing alarms
	• Worker training

Table 4. Emphasis Area #3 – Mitigation strategies for consideration by goal.

Goal Setting	Mitigation Strategy (i.e., “Improved utilization of...”)
Restrict Travel Through the Work Zone (WZ)	• Road closures
	• Ramp metering/closures
	• Lane shifts/closures
	• Median crossover
	• Rolling roadblock
	• Overweight and overheight truck restrictions
Reduce Trips through WZ	• Diversions/detours
	• Transit/ride-sharing service improvements/incentives
Reduce Delay of Trips through WZ	• Night/weekend work
	• Construction phasing
	• Project coordination (stakeholders/other projects)
	• Accelerated construction techniques
	• Accelerated contracting methods
Mitigate and Manage Congestion/ Reduce Rear-End Crash Potential	• Real-time traveler information system
	• Queue detection and warning system
	• Portable changeable message signs
	• Variable speed limit system
	• Dynamic lane merge system
	• Incident management

Table 4. Emphasis Area #3 – Mitigation strategies for consideration by goal. (continued)

Goal Setting	Mitigation Strategy (i.e., “Improved utilization of...”)
Accommodate Pedestrians and Americans with Disabilities Act Requirements	• Temporary traffic barriers
	• Channelizing devices
	• Americans with Disabilities Act-compliant wheelchair ramps and sidewalks
	• Audible information devices
	• Covered sidewalks/walkways to protect pedestrians
Urban Conflict Point Mitigation	• Static signs/marked detours
	• Parking restrictions
	• Turn restrictions
	• Modified signal timing/ coordination

Table 5. Emphasis Area #4 – Mitigation strategies for consideration by goal.

Goal Setting	Mitigation Strategy (i.e., “Improved utilization of...”)
Establish Public Relations	Public relations, education, and outreach
	Traveler information

Example. Referring back to the previous steps in the Framework, suppose an agency identified rear-end collisions as a key problem area and selected goals to “improve work zone access and egress safety and mobility” under Emphasis Area 2 as well as to “mitigate/manage congestion and rear-end crashes,” “reduce trips through the work zone,” and “reduce delay through the work zone” under Emphasis Area 3. In step 3 of the Framework, the targeted engagement effort would focus on raising agency awareness of the possible mitigation strategies that could be implemented as a way to reduce work zone rear-end crashes. Using the above tables, the list of possible mitigation strategies associated with each of the selected goals includes the following:

- ITS technology deployment at work space access points.
- Large static signs to improve driver awareness of those access points.
- Real-time traveler information system to warn of delays, encourage diversion.
- Queue detection and warning system to warn of slow or stopped traffic.
- Portable changeable message signs providing static messages to warn of possible slowdowns ahead.
- Variable speed limit system to encourage slower speeds through the work zone.
- Dynamic lane merge system to reduce aggressive driving and queue lengths.
- Incident management to reduce duration of queues caused by crashes and stalls.
- Diversions/detours to reduce duration and lengths of queues.
- Transit/ride-sharing service improvements/incentives to encourage diversion to other modes.
- Night/weekend work to minimize queues and delays due to lane closures.
- Construction phasing to reduce duration and lengths of queues and delays.
- Project coordination to maximize availability of other routes for diversion.
- Accelerated construction techniques to reduce frequency of queues and delays.
- Accelerated contracting methods to reduce frequency of queues and delays.

A range of resources are available to help raise agency awareness of these strategies. Some resources describe a single strategy, whereas others may cover several. Resources that cover multiple strategies of potential interest are often good items to examine initially. For instance, an agency could review the list of available resources that provide general information on the above strategies and find that [NCHRP Report 500: Volume 17, A Guide for Reducing Work Zone Collisions](#) provides information about seven of them. Similarly, the FHWA report [Developing and Implementing Transportation Management Plans for Work Zones](#) also includes general information about five of the strategies listed. Selecting a few additional resources for the strategies not covered in these two documents would provide an agency with focused information that would help it prepare for the next step in the Framework, strategy selection.

STRATEGY SELECTION

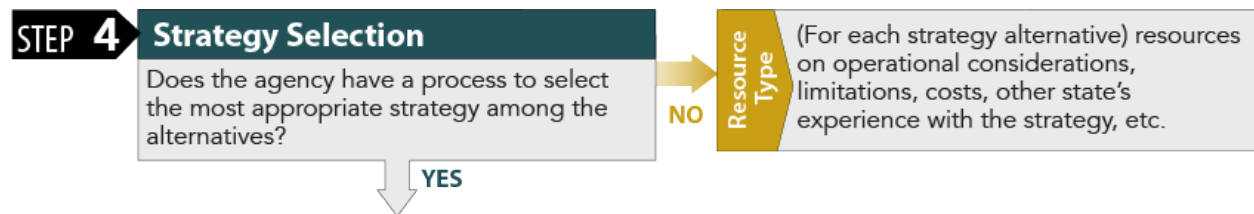


Figure 5. Diagram. Step 4 – Strategy selection.

The fourth step in the Framework is where agencies determine which of the available strategies they want to focus their implementation efforts on. Resources available for this step highlight information that could be used by agencies to help differentiate between strategies when making selection decisions. This could include various operational considerations, limitations, costs, and experiences of other agencies that have used the strategies. Some resources may cover both awareness-type information of the previous Framework step as well as information useful for making strategy selections. Note that not all of the resources have all of the listed types of information, so agencies may need to review multiple resources during this step of the Framework to obtain enough information upon which to base their decisions. It is also likely that agency-specific considerations will play a role in this step, such as what strategies (if any) that relate to those being considered are already implemented by an agency, which strategies require staff or consultant training to implement, etc.

Example. As with the previous strategy awareness step in the Framework, a few key resources provide information that agencies could find helpful when deciding whether to pursue implementation the various mitigation strategies listed. These include [NCHRP Report 500: Volume 17, A Guide for Reducing Work Zone Collisions](#), the FHWA reports [Developing and Implementing Transportation Management Plans for Work Zones](#) and [Work Zone Intelligent Transportation Systems Implementation Guide](#), and a guidance document developed under the FHWA work zone safety grant program entitled [Guidelines on Payment for Temporary Traffic Control](#). Other possible resources that an agency contemplating the above mitigation strategy list might find useful include other work zone safety grant guidance documents entitled [Nighttime Lighting Guidelines for Work Zones](#) and [Guidelines on the Use of Positive Protection in Temporary Traffic Control Zones](#), and an NCHRP report providing [Guidance for Cost](#)

[Estimation and Management for Highway Projects during Planning, Program, and Preconstruction.](#)

STRATEGY IMPLEMENTATION

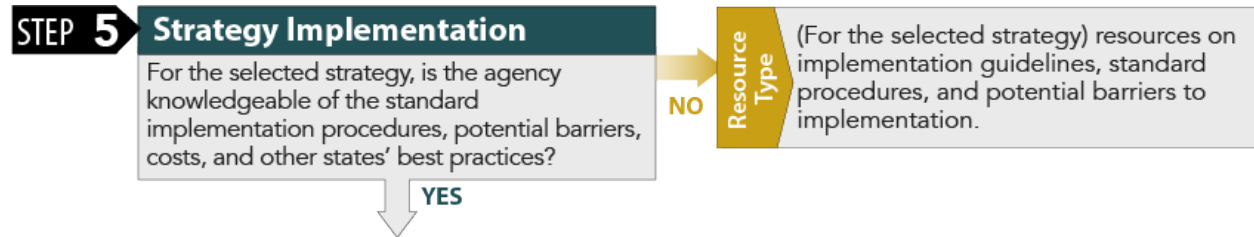


Figure 6. Diagram. Step 5 – Strategy implementation.

Strategy implementation is the fifth step in the Framework. As the name implies, agencies that have decided which strategy or strategies to adopt or incorporate into a project or way of doing projects would come to this step looking for information on how best to accomplish that implementation. Resources that will be of possible use to agencies at this step cover such items as strategy implementation standards, example deployment plans and procedures, staff training requirements, and lessons learned by other agencies that have implemented the strategy.

Example. Several of the resources listed above also contain information that can aid agencies in adopting and implementing their selected mitigation strategies. In addition, resources such as the [Construction Peer Network](#) or the [Work Zone ITS Peer Exchange](#) programs in place within FHWA provide a means of getting staff from agencies who have implemented certain strategies together with staff of an agency that may want to implement the strategies so that they can ask questions, share lessons learned, etc.

STRATEGY EVALUATION

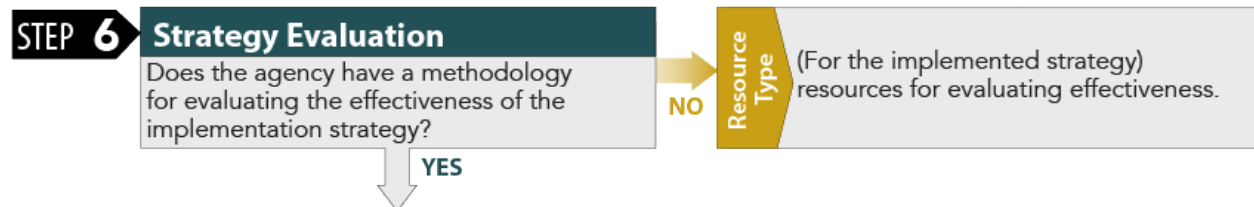


Figure 7. Diagram. Step 6 – Strategy evaluation.

Evaluation of the success of the implemented strategies in meeting the agency’s goals is the focus of step 6 in the Framework. Although evaluation is almost always highlighted as a key activity in any problem-solving framework, it is something that is usually not planned for or performed. Depending on the strategy, an agency may desire to assess the level of adoption of the strategy across all or part of the organization or to assess the level of impact that the strategy has had upon the intended goal. In the latter case, it may be difficult to isolate the effect of a single strategy if several strategies have been implemented together that are all related to the same or similar agency improvement goals.

Example. As part of an agency’s goals to reduce delays through its work zones, the decision might be made to incorporate a policy to require consideration of accelerated contracting methods for all projects exceeding a certain threshold. The agency may then choose to evaluate the extent to which this policy is being met by performing an audit on all or a sample of the projects meeting that threshold since the policy was enacted. This audit might be performed explicitly for that particular strategy, or might be incorporated into the agency’s upcoming biennial process review. If adoption of the policy is less than expected, the agency might then choose to send out a short survey to its project development staff in the field to assess whether there are issues with the way the policy is written or other agency requirements that are hampering adoption of the policy in some way.

EVALUATION RESULT UTILIZATION

The last step of the Framework, evaluation result utilization, does not have specific resources associated with it in the Framework. However, it is included to emphasize the importance of taking the knowledge gained in step 6 and incorporating it back into the business processes for the agency as well as updating the agency’s continuous improvement goals regarding work zone safety and mobility impact mitigation. The methods by which this is accomplished will be highly specific to the organizational structure and culture of the agency.

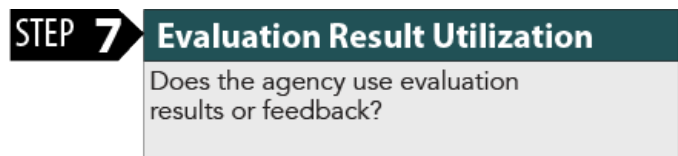


Figure 8. Diagram. Step 7 – Evaluation result utilization.

Example. In the example described in step 6, the agency may find that the thresholds used in the accelerated contracting methods policy are too high or too low to be effectively applied. The agency may decide to adjust the threshold for consideration and modify the language to further guide decisions about accelerated contracting method use for projects meeting the revised threshold.

CHAPTER 3. EMPHASIS AREAS, GOALS, AND MITIGATION STRATEGIES

Chapter 3 provides the reader with a full listing of the emphasis areas, goals, and mitigation strategies described step-by-step in chapter 2. As previously mentioned, the Framework has the flexibility to add new emphasis areas, goals, and mitigation strategies as needed to accommodate advances in the work zone operational arena.

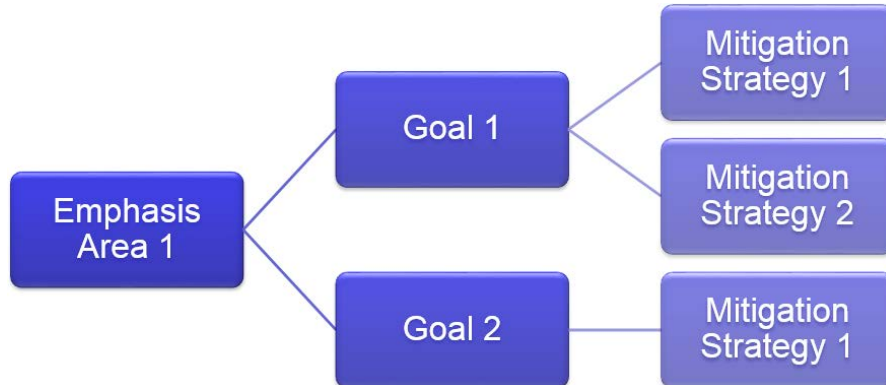


Figure 9. Diagram. Sample Framework structure.

Table 6. Common goals and mitigation strategies associated with Emphasis Area #1.

Emphasis Area #1: Lack of Quantitative and/ or Qualitative Evaluation of Current Work Zone Policies or Practices

Goal 1	Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-work, during-work, and post-work activities
Mitigation Strategies	
1	Work zone (WZ) planning tools/ modeling
2	Crash data collection and performance measure reporting
3	Congestion data collection and performance measure reporting
4	Process reviews
5	WZ safety audit

Table 7. Common goals and mitigation strategies associated with Emphasis Area #2.

Emphasis Area #2: Work Zone Encroachment Events, Intrusion Crashes, and Worker Injuries

Goal 1	Reduce driver confusion about the travel path up and potential for evasive action
Mitigation Strategies	
1	Channelizing devices
2	Temporary pavement markings
3	Flaggers and uniformed traffic control officers
4	Large static signs/ marked detours
5	Portable changeable message signs
6	Arrow panels
7	Shadow vehicle

**Table 7. Common goals and mitigation strategies associated with Emphasis Area #2.
(continued)**

*Emphasis Area #2: Work Zone Encroachment Events, Intrusion Crashes, and Worker Injuries
(continued)*

Goal 1	Reduce driver confusion about the travel path up and potential for evasive action
Mitigation Strategies	
8	Enhanced flagger set up or automatic flagger assistance devices
9	Temporary traffic signals
10	Proper lighting of work area
11	Worker high visibility apparel
Goal 2	Alert driver of any departures to the travel path
Mitigation Strategies	
1	Temporary rumble strips
2	Warning lights
3	Intrusion alarms
4	ITS technologies
Goal 3	Improve compliance to work zone rules or messages
Mitigation Strategies	
1	Law enforcement presence
2	Automated enforcement
3	Increased penalties for violations
Goal 4	Decrease severity of crashes due to WZ encroachment
Mitigation Strategies	
1	Temporary traffic barriers
2	Moveable barrier systems
3	Reduced speed limits
Goal 5	Improve WZ access/egress for large trucks and work vehicles
Mitigation Strategies	
1	ITS technologies
2	Large static signs
3	Temporary traffic control typical applications for work space access points
Goal 6	Reduce conflict points within WZ
Mitigation Strategies	
1	Internal traffic control plan
Goal 7	Enhance temporary traffic control effectiveness at rural, low-volume work zones
Mitigation Strategies	
1	Flagging on low-volume roadways
2	Temporary traffic control on low volume roadways
Goal 8	Improve Worker Situational Awareness
Mitigation Strategies	
1	Backing alarms
2	Worker training

Table 8. Common goals and mitigation strategies associated with Emphasis Area #3.
Emphasis Area #3: Congestion and Traffic Management Plan Challenges

Goal 1	Restrict travel through WZ
Mitigation Strategies	
1	Road closures
2	Ramp metering/closures
3	Lane shifts/closures
4	Median crossover
5	Rolling roadblock
6	Truck restrictions
Goal 2	Reduce trips through WZ
Mitigation Strategies	
1	Diversions/detours
2	Transit/ride sharing service improvements/incentive
Goal 3	Perform work in a way that minimizes effect on traffic
Mitigation Strategies	
1	Night/weekend work
2	Construction phasing to minimize traffic impacts
3	Project coordination with all stakeholders (utility work, developers, emergency services, schools, local businesses, etc.) and other projects in the jurisdiction
4	Accelerated construction techniques
5	Accelerated contracting methods
Goal 4	Congestion mitigation/rear-end crash reduction
Mitigation Strategies	
1	Intelligent transportation system technologies
2	Queue detection and warning system
3	Portable changeable message signs
4	Variable speed limit
5	Dynamic lane merge system
6	Incident management
Goal 5	Accommodate pedestrians and ADA requirements
Mitigation Strategies	
1	Temporary traffic barriers
2	Channelizing devices
3	Americans with Disabilities Act-compliant wheelchair ramps and sidewalks
4	Audible information devices
5	Covered sidewalks/walkways to protect pedestrians
Goal 6	Urban conflict point mitigation
Mitigation Strategies	
1	Static signs/marked detours
2	Parking restrictions
3	Turn restrictions
4	Modified signal timing/ coordination

Table 9. Common goals and mitigation strategies associated with Emphasis Area #4.
Emphasis Area #4: Road User Complaints and Negative Feedback to Work Zone

Goal 1	Establish Public Relations
Mitigation Strategies	
1	Public relation, education, and outreach
2	Traveler Information

CHAPTER 4. RESOURCES

Chapter 4 provides the reader with a complete listing of currently available work zone management resources. This list should be referenced only after determining the appropriate Framework step(s) under which an agency's work zone program falls.

This chapter is organized as follows:

Resources by Emphasis Area and Goal. Resources are organized, and hyperlinked, by table in an order which provides the reader with access to documents based on the emphasis area(s), goal(s), and associated mitigation strategy(ies) selected. Note that in the following tables:

“Type of Resource” includes:

- G (Guidelines)
- P (Podcasts)
- F (Field Guides)
- T (Training – instructional and web-based)
- A (Analytical Tools – research-based simulation, modeling, analysis and other tools developed to help agencies or practitioners mitigate work zone impacts and select appropriate safety strategies).

Framework steps include:

- SA (Step 1 – Strategy Awareness)
- SS (Step 2 – Strategy Selection)
- SI (Step 3 – Strategy Implementation)
- SE (Step 4 – Strategy Evaluation)

Resource Synopsis. Summaries and a hyperlink to the resource's location are provided for each resource identified.

RESOURCES BY EMPHASIS AREA AND GOAL

Table 10. Emphasis Area 1 – Quantitative or qualitative strategies and available resources by strategy.

Goal 1: Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities	Type of Resource	Mitigation Strategies				
		Work Zone Planning and Analysis Tools/Modeling	Crash Data Collection and Performance Measure Reporting	Congestion Data Collection and Performance Measure Reporting	Process Reviews	Work Zone Safety Audit
A Deep Learning Approach to Predict Severity Levels of Work Zone Crashes	A		X			
A Guide for Work Zone Crash Data Collection, Reporting, and Analysis	G	X	X			
A New Analytic Neuro-Fuzzy Model For Work Zone Capacity Estimation	A	X		X		
A Primer on Work Zone Safety and Mobility Performance Measurement	G	X	X	X		
A Tutorial on Establishing Effective Work Zone Performance Measures Webinar	T		X	X		
Analysis of Work-Zone Crash Reports to Determine Factors Associated with Crash Severity	A		X			
Best Practices for Managing Work Zone Data	G	X				
Best Practices in Work Zone Assessment, Data Collection, and Performance Evaluation	G		X	X	X	
Big-Data-Driven Traffic Surveillance System for Work Zone Monitoring and Decision Supporting	G	X	X	X		
Capacity Modeling and Control Optimization for Two-lane Highway Lane Closure Work Zones	A	X				
Considering Work Zone Impacts: Planning for Safety, Mobility and Constructability	G			X		
Dashboards for Closing the Loop on Monitoring Interstate Work Zone Maintenance of Traffic	A			X		

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Table 10. Emphasis Area 1 – Quantitative or qualitative strategies and available resources by strategy. (continued)

Goal 1: Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities	Type of Resource	Mitigation Strategies				
		Work Zone Planning and Analysis Tools/Modeling	Crash Data Collection and Performance Measure Reporting	Congestion Data Collection and Performance Measure Reporting	Process Reviews	Work Zone Safety Audit
Data-Driven Traffic Impact Assessment Tool for Work Zones	A	X				
Data Quality Review for Geographic Information System-based Crash and Work Zone Data Integration	A		X			
Developing and Implementing Successful Transportation Management Plans	T	X				
Development and Application of Work Zone Crash Modification Factors	G		X			
Development of Rate-Based Statewide Safety Performance Measures of Work Zones Using Imperfect Exposure Data: A Virginia Case Study	A		X			
Enhancing Work Zone Travel Time Estimation Using Smart Work Zone Data	A	X				
Estimation of Saturation Headway in Work Zones on Urban Streets	A	X				
Estimation of Traffic Impacts at Work Zones: State of the Practice	A	X				
Estimating the Safety Effects of Work Zone Characteristics and Countermeasures: A Guidebook	G		X			
Evaluation and Implementation of Traffic Simulation Models for Work Zones	A	X				
Evaluation of Traffic Control Options in Work Zones	A	X				
Federal Highway Administration Webinar on Road User Cost Analysis for Work Zone Applications	T	X	X	X		
Freeway Work Zone Free-Flow Speed Model Development	A	X				
Guidance for Conducting Effective Work Zone Process Reviews	G				X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Table 10. Emphasis Area 1 – Quantitative or qualitative strategies and available resources by strategy. (continued)

Goal 1: Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities	Type of Resource	Mitigation Strategies				
		Work Zone Planning and Analysis Tools/Modeling	Crash Data Collection and Performance Measure Reporting	Congestion Data Collection and Performance Measure Reporting	Process Reviews	Work Zone Safety Audit
Guidance on Data Needs, Availability, and Opportunities for Work Zone Performance Measures	G		X	X		
Highway Capacity Manual 2016, Chapter 11, Freeway Reliability Analysis	G	X	X			
Highway Capacity Manual 2016, Chapter 17, Urban Street Reliability and Advanced Transportation Demand Management	G	X	X			
Investigation of Work Zone Crash Casualty Patterns Using Association Rules	A		X			
Impact of Bottleneck Merge Control Strategies on Freeway Level of Service	A	X				
Work Zone Road Safety Audits: Teaming Up to Improve Safety	P					X
Strategies for Developing Work Zone Traffic Analyses	T	X				
Novel Method of Obtaining Critical Parameter in Safety Assessment for Maintenance Work Zone	A		X			
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G		X			X
National Cooperative Highway Research Program Synthesis 509: Highway Worker Safety	G		X			
National Highway Institute Course: Construction Zone Safety Inspection	T					X
National Highway Institute Innovations: Work Zone Assessment, Data Collection, and Performance Measurement Webinar	T		X	X		

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Table 10. Emphasis Area 1 – Quantitative or qualitative strategies and available resources by strategy. (continued)

Goal 1: Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities	Type of Resource	Mitigation Strategies				
		Work Zone Planning and Analysis Tools/Modeling	Crash Data Collection and Performance Measure Reporting	Congestion Data Collection and Performance Measure Reporting	Process Reviews	Work Zone Safety Audit
Optimal Trade-Offs between Construction Cost and Traffic Delay for Highway Work Zones	A	X				
Optimal Variable Speed Limit Control System for Freeway Work Zone Operations	A	X				
Optimizing the Planning of Highway Work Zones to Maximize Safety and Mobility	A	X				
Optimizing Scheduling of Long-term Highway Work Zone Projects	A	X				
Predicting Freeway Work Zone Delays and Costs with a Hybrid Machine-Learning Model	A	X				
Safe and Effective Work Zone Inspections	G		X			
Safety Assessment Tool for Construction Zone Work Phasing Plans	A		X			
Safety at Road Worksites: Stage 1 Working Papers	A	X				
Simplified Web-Based Decision Support Method for Traffic Management and Work Zone Analysis	A	X				
Simulation Guidance for Freeway Lane Closure Capacity Calibration	A	X				
Strategies for Developing Work Zone Traffic Analysis	T	X				
The Traffic Management Capability Maturity Framework: An FHWA [Federal Highway Administration] Tool to Help Agencies Advance Traffic Management Capability	A	X				
Traffic Analysis Toolbox Volume VIII: Work Zone Modeling & Simulation: A Guide for Decision Makers	G	X				

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Table 10. Emphasis Area 1 – Quantitative or qualitative strategies and available resources by strategy. (continued)

Goal 1: Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities	Type of Resource	Mitigation Strategies				
		Work Zone Planning and Analysis Tools/Modeling	Crash Data Collection and Performance Measure Reporting	Congestion Data Collection and Performance Measure Reporting	Process Reviews	Work Zone Safety Audit
Traffic Analysis Toolbox Volume IX: Work Zone Modeling and Simulation – A Guide for Analysts	G	X				
Traffic Analysis Toolbox Volume XII: Work Zone Traffic Analysis – Applications and Decision Framework	G	X				
Traffic Control Design Specialist	T	X				
Traffic Control Supervisor	T	X				
Traffic Impact Assessment Tool for Moving Work Zone Operations	A	X	X			
Transportation Construction Work-Zone Safety Impact on Time-Related Incentive Contracting Projects	A					
Using Modeling and Simulation Tools for Work Zone Analysis (leaflet)	G	X				
Using Simulation Models to Assess the Impacts of Highway Work Zone Strategies: Case Studies Along Interstate Highways in Massachusetts and Rhode Island	A	X				
Validating the Performance of the Federal Highway Administration Work Zone Model Version 1.0: A Case Study along I-91 in Springfield, Massachusetts	A	X		X		
Work Zone Analysis Tools – State Specific Tools Demonstration	T	X	X	X	X	
Work Zone Coordination Tool	A	X				
Work Zone Data Collection & Analysis: What, Why, and How	P		X	X		
Work Zone Fatality Reduction Strategies Webinar	T				X	
Work Zone Free Flow Speed Calculation Issues in Highway Capacity Manual 2016	G		X			

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Table 10. Emphasis Area 1 – Quantitative or qualitative strategies and available resources by strategy. (continued)

Goal 1: Identify agency-specific safety, mobility, customer satisfaction, and productivity impacts of pre-, during-, and post- work activities	Type of Resource	Mitigation Strategies				
		Work Zone Planning and Analysis Tools/Modeling	Crash Data Collection and Performance Measure Reporting	Congestion Data Collection and Performance Measure Reporting	Process Reviews	Work Zone Safety Audit
Work Zone Impacts Assessment: An Approach to Assess and Manage Work Zone Safety and Mobility Impacts of Road Projects	G	X				
Work Zone Impact Assessment Methods and Applications	A	X				
Work Zone Management Capability Maturity Framework On-Line Assessment Tool	A	X	X	X	X	X
Work Zone Operations Best Practices Guidebook (Third Edition)	G	X	X	X	X	X
Work Zone Performance Monitoring Application Development	A		X			
Work Zone Process Review Toolbox	G				X	
Work Zone Process Reviews – Overview Webinar	T				X	
Work Zone Road Safety Audit Guidelines and Prompt Lists	G					X
Work Zone Road Safety Audits: Common Items of Note	F					X
Work Zone Road Safety Audits: Teaming up To Improve Safety	P					X
Work Zone Road User Costs – Concepts and Applications	G	X	X	X		
Work Zone Safety Data Collection and Analysis Guide	G		X			
Work Zone Safety Performance Measures Guidance Booklet	G		X	X		
Work Zone Safety Performance Measures Training Module	T		X	X		
Work Zone Traffic Impact Analysis	T			X		
Work Zone Traffic Management Analysis Using Analytical Methods	T	X		X		

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Table 11. Emphasis Area 2 – Work Zone Design, Driver Safety, and Worker Safety (Not Goal Specific).

Goal: None	Type of Resource	General Guidance			
		SA	SS	SI	SE
A Guide to Short-Term Stationary, Short-Duration, and Mobile Work Zone Traffic Control	G	X	X	X	
Design and Operation of Work Zone Strategies to Improve Large Truck Safety	G	X	X	X	
Developing and Implementing Successful Transportation Management Plans	T	X	X	X	X
Guidelines on Motorcycle and Bicycle Work Zone Safety	G	X	X	X	
Installing and Maintaining Crashworthy Work Zone Traffic Control Devices	G	X	X	X	
Improving Large Truck Safety through the Design and Operation of Work Zones	T	X	X		
National Cooperative Highway Research Program Report 869: Estimating the Safety Effects of Work Zone Characteristics and Countermeasures: A Guidebook	G				X
Occupational Safety and Health Administration 10-Hour Training for Roadway Construction	T	X			
Smarter Work Zone Intelligent Transportation Systems	T	X	X	X	
Strategies to Enhance Large Truck Safety in Work Zones (Webinar)	T	X	X		
Temporary Traffic Control Tool Kit	G	X			
Utility Work Zone Traffic Control Guidelines	G	X			
Temporary Traffic Control Considerations for Urban Work Zones	T	X	X	X	
Webinar: The New ANSI A10.47 Standard (Work Zone Safety for Highway Construction)	T	X			
Work Zone Hazard Assessment: Identifying and Maintaining the Clear Zone	P	X			
Work Zone Safety Performance: Comparison of Alternative Traffic Control Strategies	A		X	X	
Work Zone Safety and Mobility Peer-to-Peer Program	T	X	X	X	X
Work Zone Worker Protection Field Guide	F	X		X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 12. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 1 to 4).

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies																	
		Channelizing Devices				Temporary Pavement Markings				Flaggers and Uniformed Traffic Control Officers				Large Static Signs/Marked Detours					
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE		
Advanced Work Zone Management and Design	T															X			
Americans with Disabilities Act Requirements for Accessibility in Temporary Traffic Control Zones	P		X	X															
Design and Operation of Work Zone Strategies to Improve Large Truck Safety	G	X														X			
Developing and Implementing Transportation Management Plans for Work Zones	G					X										X			
Development of a Precast Slim Temporary Concrete Safety Barrier STCSB 50 for Work Zone Applications	G		X																
Flagger Instructor Training	T									X		X							
Flagger Safety Toolbox Pamphlet	F									X		X							
Guidance for the Use of Temporary Pavement Markings in Work Zones	G					X		X											
Guidance: Use of Work Zone Clear Zones, Buffer Spaces, and Positive Protection Deflection Distances	F			X															
Guidelines on Ensuring Positive Guidance in Work Zones	G			X		X		X							X		X		
Guidelines on Payment for Temporary Traffic Control	G		X					X								X			

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 12. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 1 to 4). (continued)

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies															
		Channelizing Devices				Temporary Pavement Markings				Flaggers and Uniformed Traffic Control Officers				Large Static Signs/Marked Detours			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Introduction to Highway Work Zones in Urban Areas	T	X															
Installing and Maintaining Crashworthy Work Zone Traffic Control Devices	G	X	X	X										X	X	X	
Manual on Uniform Traffic Control Devices	G	X		X		X		X		X		X		X		X	
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G									X	X	X	X				
Night Work Flagging Toolbox Pamphlet	F									X							
Online Flagger Certification Training	T									X							
Proper Inspection of Temporary Traffic Control: Program, Process, and Projects	P			X	X			X	X							X	X
ROADWAY SAFETY+	T									X	X	X					
Safe Installation and Removal of Traffic Control Devices	T			X													
Strategies on Improving Worker Safety in Work Zones	G									X							
Temporary Traffic Control for Building and Maintaining Single and Multi-Lane Roundabouts	G	X															
Temporary Traffic Control for Building and Maintaining Single and Multi-Lane Roundabouts	T	X															

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 12. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 1 to 4). (continued)

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies															
		Channelizing Devices				Temporary Pavement Markings				Flaggers and Uniformed Traffic Control Officers				Large Static Signs/Marked Detours			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Urban Work Zone Design	T	X															
Work Zone Operations Best Practices Guidebook (Third Edition)	G											X					

Table 13. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 5 to 8).

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies															
		Portable Changeable Message Signs				Arrow Panels				Shadow Vehicle				Enhanced Flagger or AFADs			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Advanced Work Zone Management and Design	T	X															
Development of a Moving Automatic Flagger Assistance Device for Moving Work Zone Operations	G													X	X		
Field Guide for the Use and Placement of Shadow Vehicles in Work Zones	F									X	X	X					
Flagger Safety Toolbox Pamphlet	F													X			
Guidance for the Use of Portable Changeable Message Signs in Work Zones	G	X	X	X	X												
Guidance on the Use of Automated Flagger Assistance Devices	G													X	X	X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 13. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 5 to 8). (continued)

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies															
		Portable Changeable Message Signs				Arrow Panels				Shadow Vehicle				Enhanced Flagger or AFADs			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Guidance: Use of Work Zone Clear Zones, Buffer Spaces, and Positive Protection Deflection Distances	F											X					
Guidelines for the Use of Automated Flagger Assistance Devices	T													X			
Guidelines on Ensuring Positive Guidance in Work Zones	G					X		X	X								
Guidelines on Payment for Temporary Traffic Control	G		X				X										
Guidelines on the Use of Positive Protection in Temporary Traffic Control Zones	G									X	X	X					
Identifying Effects and Applications of Fixed and Variable Speed Limits	G				X												
Introduction to Positive Protection	T									X		X					
Maintenance and Short Duration Activities	T					X											
Manual on Uniform Traffic Control Devices	G	X		X		X		X		X		X		X		X	
Minimizing Worker Exposure in Highway Work Zones Through the Use of Positive Protection and Other Strategies	T									X	X	X	X				
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G													X	X	X	
Night Work Flagging Toolbox Pamphlet	F													X			

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

**Table 13. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 5 to 8).
(continued)**

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies															
		Portable Changeable Message Signs				Arrow Panels				Shadow Vehicle				Enhanced Flagger or AFADs			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Overview of Part VI of the Recently Revised Manual on Uniform Traffic Control Devices Webinar Work Zone Fatality Reduction Strategies	T			X													
Proper Inspection of Temporary Traffic Control: Program, Process, and Projects	P			X	X			X	X							X	X
Portable Changeable Message Signs to Control Speeding in Work Zones	P	X															
Portable Positive Protection: A Guide for Short Duration and Short Term Work Zones	G											X					
Positive Protection in Work Zones Training Modules	T			X													
Roadside Design Guide (4th Edition)	G									X	X	X					
Safety Considerations for Mobile Work Zone Operations	P									X							
Shadow Vehicles for Work Zones	T	X	X	X						X	X	X					
Strategies on Improving Worker Safety in Work Zones	G													X			
Utility Work Zone Presentation and Instructors Guide	T					X											
Work Zone Operations Best Practices Guidebook (Third Edition)	G			X												X	
Work Zone Positive Protection Toolbox	G									X	X	X					
Work Zone Safety: Temporary Traffic Control for Maintenance Operations	F							X				X					

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 14. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 9 to 11).

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies														
		Temporary Traffic Signals				Work Area Lighting				High-Visibility Apparel for Workers						
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE			
Guidelines on Ensuring Positive Guidance in Work Zones	G	X		X												
Guidelines on Payment for Temporary Traffic Control	G		X				X									
High-Visibility Apparel in Work Zones – Characteristics of High-Visibility Safety Apparel	F										X					
High-Visibility Safety Apparel	T										X	X	X			
High-Visibility Safety Apparel in Highway Work Zones	G										X	X	X			
Increasing the Work Zone Worker’s Visibility Through High-Visibility Safety Apparel	G										X	X	X			
Law Enforcement and High Visibility Personal Protective Equipment	T										X	X	X			
Manual on Uniform Traffic Control Devices	G	X		X		X		X			X		X			
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G										X	X	X	X		
Night Work Flagging Toolbox Pamphlet	F					X										
Night Work High-Visibility Toolbox Pamphlet	F										X					
Night Work Risks Toolbox Pamphlet	F					X										
Night Work Temporary Lighting Toolbox Pamphlet	F					X		X								
Nighttime Lighting for Work Zones	T					X		X								
Nighttime Lighting Guidelines for Work Zones	G					X	X	X								
Lighting the Way to Safety: Warning Lights and Illumination for Vehicles, Traffic Control Devices, and the Work Area	P					X	X	X								
Optimizing Work Zone Lighting	G					X	X	X								
ROADWAY SAFETY+	T					X	X	X								

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 14. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 1, mitigation strategies 9 to 11). (continued)

Goal 1: Improve Work Zone Design/Travel Path Delineation	Type of Resource	Mitigation Strategies														
		Temporary Traffic Signals				Work Area Lighting				High-Visibility Apparel for Workers						
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE			
Strategies on Improving Worker Safety in Work Zones	G	X											X			
Vehicle Lighting in Work Zones: Safety Through Increased Visibility	P					X										
Work Zone Operations Best Practices Guidebook (Third Edition)	G									X						

Table 15. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 2).

Goal 2: Alert Driver of Travel Path Derivation	Type of Resource	Mitigation Strategies															
		Temporary Rumble Strips				Warning lights				Intrusion Alarms				ITS Technology			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Advanced Work Zone Management and Design	T													X			
Effective Practices for the Use of Portable Rumble Strips in Work Zones	P	X			X												
Effectiveness of End-of-Queue Warning Systems and Portable Rumble Strips on Lane Closure Crashes	A		X		X												
Evaluating Work Zone Intrusion Alert Technology: Recommendation for Future Development	A									X		X					
Guidance for the Use of Temporary Rumble Strips in Work Zones	G	X	X	X	X												
Guidelines on Ensuring Positive Guidance in Work Zones	G									X		X					

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 15. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 2). (continued)

Goal 2: Alert Driver of Travel Path Derivation	Type of Resource	Mitigation Strategies															
		Temporary Rumble Strips				Warning lights				Intrusion Alarms				ITS Technology			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Highway Work Zone Intrusion Alert Systems Implementation Guide	G											X					
Manual on Uniform Traffic Control Devices	G					X		X									
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G													X	X	X	
Overview of Part VI of the Recently Revised Manual on Uniform Traffic Control Devices Webinar	T			X													
Preventing Intrusions into Highway Work Zones	F	X	X	X													
Smarter Work Zone Intelligent Transportation Systems	T													X	X	X	
Wake Up! Using Temporary Rumble Strips in Work Zones to Improve Driver Alertness	P	X	X	X													
Work Zone Intelligent Transportation Systems Implementation Tool v1.0	A														X	X	
Work Zone Intrusion Alert Technologies Assessment and Practical Guidance: Final Report	G									X	X						
Runovers/Backovers Toolbox Pamphlet for All Workers	F					X				X							
Strategies on Improving Worker Safety in Work Zones	G									X							
Development of Temporary Rumble Strip Specifications	A			X													
Work Zone Safety Performance Measures Training Module	T													X			

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 16. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 3).

Goal 3: Improve Driver Compliance	Type of Resource	Mitigation Strategies											
		Law Enforcement Presence				Automated Enforcement				Increased Penalties for Violations			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Automated Speed Enforcement in Work Zones	G					X	X	X					
Automated Speed Enforcement in Work Zones	P					X							
Automated Speed Enforcement in Work Zones	T					X	X						
Guidelines on Managing Speeds in Work Zones	G	X		X									
Guidelines on Use of Law Enforcement in Work Zones	G	X	X	X									
Strategies to Enhance Large Truck Safety in Work Zones (Webinar)	T		X	X							X	X	
Law Enforcement and High Visibility Personal Protective Equipment	T	X	X	X									
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X		X	X	X		X	X	X	
Overview and Summary of the 2006 and 2011 FHWA Work Zone Safety Grants	P	X											
Road Safety Program	T	X		X									
Safe and Effective Use of Law Enforcement Personnel in Work Zones	T	X											
Using Portable Changeable Message Signs to Control Speeding in Work Zones	G	X		X									
Safe Practices for Law Enforcement Personnel Operating in Highway Work Zones	G	X		X									
Work Zone Fatality Reduction Strategies	T			X									

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 16. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 3). (continued)

Goal 3: Improve Driver Compliance	Type of Resource	Mitigation Strategies											
		Law Enforcement Presence				Automated Enforcement				Increased Penalties for Violations			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Work Zone Operations Best Practices Guidebook (Third Edition)	G			X				X				X	
Work Zone Training Program Development and Implementation	T			X									

Table 17. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 4).

Goal 4: Decrease Work Zone Encroachment Incidents	Type of Resource	Mitigation Strategies											
		Temporary Traffic Barriers				Moveable Barrier Systems				Reduced Speed Limit			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
2009 Manual on Uniform Traffic Control Devices Compliance Dates and Definition of Standard Statements	T			X									
Advanced Work Zone Management and Design	T	X											
Guidance on Managing Speeds in Work Zones	T									X			
Guidance: Use of Work Zone Clear Zones, Buffer Spaces, and Positive Protection Deflection Distances	F	X		X		X		X					
Guidelines on Ensuring Positive Guidance in Work Zones	G									X		X	
Guidelines on Managing Speeds in Work Zones	G									X	X	X	
Guidelines on the Use of Low-Profile Portable Concrete Barrier in Low to Moderate Speed Work Zones	G	X		X									
Guidelines on the Use of Positive Protection in Temporary Traffic Control Zones	G	X	X	X		X	X	X					
Identifying Effects and Applications of Fixed and Variable Speed Limits	G									X		X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 17. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 4). (continued)

Goal 4: Decrease Work Zone Encroachment Incidents	Type of Resource	Mitigation Strategies											
		Temporary Traffic Barriers				Moveable Barrier Systems				Reduced Speed Limit			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Installing and Maintaining Crashworthy Work Zone Traffic Control Devices	G	X	X	X									
Introduction to Positive Protection	T	X	X	X		X	X	X					
Length of Need for Free-Standing, F-Shape, Portable Concrete Barrier	A	X											
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X	X	X	X	X	X				
Portable Positive Protection: A Guide for Short Duration and Short Term Work Zones	G					X	X						
Positive Protection in Work Zones Training Modules	T	X		X		X		X					
Road Safety Program	T	X	X										
Roadside Design Guide (4th Edition)	G	X	X	X		X	X	X					
Roadway Safety Plus How-To Video	T	X											
Safe Installation and Removal of Traffic Control Devices	T			X									
Temporary Traffic Control for Building and Maintaining Single and Multi-Lane Roundabouts	T	X											
Utility Work Zone Presentation and Instructors Guide	T	X				X							
Work Zone Fatality Reduction Strategies Webinar	T							X				X	
Work Zone Operations Best Practices Guidebook (Third Edition)	G		X					X					
Work Zone Positive Protection Toolbox	G	X	X	X		X	X	X					
Work Zone Strategies	T	X				X							

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 18. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 5).

Goal 5: Improve WZ Access/ Egress	Type of Resource	Mitigation Strategies							
		ITS Technology				Large Static Signs			
		SA	SS	SI	SE	SA	SS	SI	SE
Advanced Work Zone Management and Design	T	X				X			
Design and Operation of Work Zone Strategies to Improve Large Truck Safety	G	X				X			
Developing and Implementing Transportation Management Plans for Work Zones	G					X			
Guidelines on Payment for Temporary Traffic Control	G						X		
Guidelines on Work Zone Access and Egress	G	X							
Manual on Uniform Traffic Control Devices	G					X		X	
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X					
Smarter Work Zone Intelligent Transportation Systems	T	X	X	X					
Smarter Work Zones Toolkit for Everyday Counts Initiative – Technology Applications	G	X	X						
Work Zone Intelligent Transportation Systems Peer Exchange	G	X							
Work Zone Operations Best Practices Guidebook (Third Edition)	G				X				

Table 19. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 6).

Goal 6: Reduce Conflict Points	Type of Resource	Mitigation Strategies			
		Internal Traffic Control Plan			
		SA	SS	SI	SE
Design and Operation of Work Zone Strategies to Improve Large Truck Safety	G	X	X	X	
Developing Internal Traffic Control Plans for Work Zones	G	X	X	X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 19. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 6). (continued)

Goal 6: Reduce Conflict Points	Type of Resource	Mitigation Strategies			
		Internal Traffic Control Plan			
		SA	SS	SI	SE
Guidance: Managing Flagging Operations on Low-Volume Roads	G	X		X	
Guidance: Temporary Traffic Control for Work Zones on Unpaved Roads	G	X		X	
Guidelines on Work Zone Access and Egress	G	X			
Installing and Maintaining Crashworthy Work Zone Traffic Control Devices	G	X	X	X	
Preventing Runovers and Backovers	T		X	X	
ROADWAY SAFETY+	T	X	X	X	
Runovers/Backovers Toolbox Pamphlet for All Workers	F	X			
Runovers/Backovers Toolbox Pamphlet for Contractors	F	X			
Runovers/Backovers Toolbox Pamphlet for Operators/Drivers	F	X			
Webinar: The New ANSI A10.47 Standard (Work Zone Safety for Highway Construction)	T	X			

Table 20. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 7).

Goal 7: Enhance Temporary Traffic Control Effectiveness at Rural, Low-Volume Work Zones	Type of Resource	Mitigation Strategies							
		Flagging on Low-Volume Roadways				Temporary Traffic Control on Low-Volume Roadways			
		SA	SS	SI	SE	SA	SS	SI	SE
Guidance: Managing Flagging Operations on Low-Volume Roads	G			X					
Guidance: Temporary Traffic Control for Work Zones on Unpaved Roads	G							X	
Temporary Traffic Control – Layout Selection by Maintenance Activity	G	X	X	X					

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 21. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 8).

Goal 8: Worker Situational Awareness	Type of Resource	Mitigation Strategies							
		Backing Alarms				Worker Training			
		SA	SS	SI	SE	SA	SS	SI	SE
Electrical Hazards Toolbox Pamphlet	F					X			
Emergencies Toolbox Pamphlet	F					X			
Fall Hazards Toolbox Pamphlet	F					X			
Fall Prevention Fact Sheets	F					X	X	X	
Guidance: Hazard Communications and The Globally Harmonized System of Classification and Labeling	F					X			
Guidelines on Ensuring Positive Guidance in Work Zones	G	X							
Health Hazards Toolbox Pamphlet	F					X			
Highway Work Zone Safety Checklist	F	X	X	X					
National Cooperative Highway Research Program Synthesis 509: Highway Worker Safety	G	X	X	X					
Noise Hazards Toolbox Pamphlet	F					X			
Operator Safety Toolbox Pamphlet	F					X			
Preventing Intrusions into Highway Work Zones	F					X	X	X	
Preventing Runovers and Backovers	T						X	X	
Reducing Worker Fatigue and Distraction Risks	T					X	X	X	
ROADWAY SAFETY+	T					X	X	X	
Runovers/Backovers Toolbox Pamphlet for All Workers	F					X			
Runovers/Backovers Toolbox Pamphlet for Contractors	F	X							
Runovers/Backovers Toolbox Pamphlet for Operators/Drivers	F					X			
Safe Backing and Spotting	T					X	X	X	
Safe Driving Toolbox Pamphlet	F					X			
Safety Concepts for Workers from an Occupational Safety and Health Administration Perspective	F					X	X		X
Sprains and Strains Toolbox Pamphlet	F					X			

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 21. Emphasis Area 2 – Work zone design, driver safety, and worker safety (goal 8). (continued)

Goal 8: Worker Situational Awareness	Type of Resource	Mitigation Strategies							
		Backing Alarms				Worker Training			
		SA	SS	SI	SE	SA	SS	SI	SE
Strategies on Improving Worker Safety in Work Zones	G	X							
Student Work Safety Guidelines in Roadside Applications and Work Zones Safety Guidelines for Transportation Researchers	F					X	X	X	
Temporary Traffic Control Devices Trainee Booklet	F					X			
Toolbox Talk # 1: Electrical Safety	F					X	X	X	
Toolbox Talk # 2: How Can We Prevent Electrocutions While Using Power Tools?	F					X	X	X	
Toolbox Talk # 3: Be Aware of the Power Lines Where You Live and Work	F					X	X	X	
Toolbox Talk # 4: Electrical Safety and First Aid Assistance	F					X	X	X	
Toolbox Talk # 5: Working Near High Voltage Energized Electrical Lines	F					X	X	X	
Toolbox Talk # 6: Precautions When Using Extension Cords	F					X	X	X	
Toolbox Talk # 7: Arc Flash Protection and Considerations	F					X	X	X	
Traffic Control Technician	T					X			
Webinar: The New American National Standards Institute A10.47 Standard (Work Zone Safety for Highway Construction)	T					X			
Working Outdoors Toolbox Pamphlet	F					X			
Work Zone Worker Protection Field Guide	F					X		X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 22. Emphasis Area 3 – Congestion and traffic management plan (goal 1, mitigation strategies 1 to 3).

Goal 1 – Restrict Travel through WZ	Type of Resource	Mitigation Strategies											
		Road Closure				Ramp Metering/ Closure				Lane Shifts/ Closures			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Capacity Modeling and Control Optimization for a Two-Lane Highway Lane-Closure Work Zone	A		X		X								
Effects of Short-Term Lane Closures on the Traffic Flow of Freeways	A	X	X		X								
Evaluating and Updating the Kansas Department of Transportation Lane Closure Guide with Traffic Management Center Data	G		X		X								
Federal Highway Administration Work Zone Safety and Mobility Best Practices Fact Sheets	G			X									
Field Guide on Installation and Removal of Temporary Traffic Control for Safe Maintenance and Work Zone Operations	F									X		X	
Guidelines on the Use of Exposure Control Measures	G	X		X		X	X						
National Cooperative Highway Research Project Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X									
Work Zone Fatality Reduction Strategies Webinar	T											X	
Work Zone Operations Best Practices Guidebook (Third Edition)	G			X				X					
Work Zone Simulator Analysis: Driver Performance and Acceptance of Missouri Alternate Lane Shift Configurations	A												X
Work Zone Strategies	T	X											

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 23. Emphasis Area 3 – Congestion and traffic management plan (goal 1, mitigation strategies 4 to 6).

Goal 1 – Restrict Travel through WZ	Type of Resource	Mitigation Strategies											
		Median Crossovers				Rolling Roadblocks				Truck Restrictions			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Design and Operation of Work Zone Strategies to Improve Large Truck Safety	G									X			
Guidelines on Rolling Roadblocks for Work Zone Applications	G					X	X	X					
Guidelines on the Use of Exposure Control Measures	G	X	X			X		X					
Rolling Roadblocks for Work Zone Applications	P					X							
Talking Freight – Work Zone Design and Large Trucks	T									X			
Work Zone Operations Best Practices Guidebook (Third Edition)	G			X									
Work Zone Strategies	T											X	

Table 24. Emphasis Area 3 – Congestion and traffic management plan (goal 2).

Goal 2: Reduce Trips through WZ	Type of Resource	Mitigation Strategies							
		Diversions/ detours				Transit/ ride sharing service improvements/ incentives			
		SA	SS	SI	SE	SA	SS	SI	SE
Developing and Implementing Transportation Management Plans for Work Zones	G					X	X	X	
Developing Successful Transportation Management Plans for Work Zones	T							X	
Guidelines on Use of Exposure Control Measures	G	X		X					

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 24. Emphasis Area 3 – Congestion and traffic management plan (goal 2). (continued)

Goal 2: Reduce Trips through WZ	Type of Resource	Mitigation Strategies							
		Diversions/ detours				Transit/ ride sharing service improvements/ incentives			
		SA	SS	SI	SE	SA	SS	SI	SE
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G					X	X	X	
Regional Network Complexity Reduction for Estimating Diversion Effects from Large-Scale Work Zones - Motivation and Lessons Learned	A		X		X				
Work Zone Operations Best Practices Guidebook (Third Edition)	G							X	

Table 25. Emphasis Area 3 – Congestion and traffic management plan (goal 3).

Goal 3: Reduce less-desirable (delayed) trips	Type of Resource	Mitigation Strategies																			
		Night/ Weekend work				Construction Phasing				Project coordination with all stakeholders and other projects in the jurisdiction				Accelerated construction techniques				Accelerated contracting methods			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Best Practices in Accelerated Construction Techniques	G													X		X	X				
Construction Peer Network (with regional Peer Exchanges)	G															X				X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 25. Emphasis Area 3 – Congestion and traffic management plan (goal 3). (continued)

Goal 3: Reduce less-desirable (delayed) trips	Type of Resource	Mitigation Strategies																				
		Night/ Weekend work				Construction Phasing				Project coordination with all stakeholders and other projects in the jurisdiction				Accelerated construction techniques				Accelerated contracting methods				
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	
Developing and Implementing Transportation Management Plans for Work Zones	G					X	X	X	X	X	X	X	X									
Federal Highway Administration Work Zone Safety and Mobility Best Practices Fact Sheet	G														X							
Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction	G													X	X							
Guidelines on Use of Exposure Control Measures	G	X																				
Guide to Project Coordination for Minimizing Work Zone Mobility Impacts	G									X		X										
Highway Repair Consolidation Feasibility	A										X	X										
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X
Nighttime Lighting Guidelines for Work Zones	G	X	X	X	X																	
Occupational Safety and Health Administration 10-Hour Training for Roadway Construction	T	X																				

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 25. Emphasis Area 3 – Congestion and traffic management plan (goal 3). (continued)

Goal 3: Reduce less-desirable (delayed) trips	Type of Resource	Mitigation Strategies																			
		Night/ Weekend work				Construction Phasing				Project coordination with all stakeholders and other projects in the jurisdiction				Accelerated construction techniques				Accelerated contracting methods			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Sharing Work Zone Effective Practices for Design-Build Projects	G																	X	X	X	
Smarter Work Zones Toolkit for Everyday Counts Initiative – Project Coordination	G									X	X	X									
Techniques for Effective Highway Construction Projects in Congested Urban Areas	G									X											
Transportation Construction Work-Zone Safety Impact on Time-Related Incentive Contracting Projects	A																				X
Work Zone Fatality Reduction Strategies Webinar	T						X					X								X	
Work Zone Operations Best Practices Guidebook (Third Edition)	G		X				X					X			X					X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 26. Emphasis Area 3 – Congestion and traffic management plan (goal 4, mitigation strategies 1 to 3).

Goal 4: Congestion mitigation/ rear-end crash reduction	Type of Resource	Mitigation Strategies														
		ITS Technologies				Queue detection and warning system				Portable Changeable Message Signs						
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE			
Advanced Work Zone Management and Design	T	X											X			
Analyzing and Improving the Performance of Dynamic Message Sign Reporting Work Zone–Related Congestion	A	X	X													
Assessing the Impacts of Connected-Vehicle Technology on Work Zone Rear-End Collisions: Agent-Based Modeling Approach	A			X												
Developing and Implementing Transportation Management Plans for Work Zones	G		X		X								X			
Effectiveness of End-of-Queue Warning Systems and Portable Rumble Strips on Lane Closure Crashes	A		X		X											
Guidance for the Use of Portable Changeable Message Signs in Work Zones	G												X		X	X
Guidelines on Payment for Temporary Traffic Control	G													X		
Guidance on Using Traffic Management Centers for Work Zone Management	G	X	X	X												
Implementation of a Connected Data Smart Work Zone Management System to Provide Queue Alerts to Stakeholders	A	X	X													
Improving the Effectiveness of Smart Work Zone Technologies	A				X											
Innovative End-of Queue Warning System Reduces Crashes Up to 45%	G					X			X							
Manual on Uniform Traffic Control Devices	G												X		X	
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X												

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 26. Emphasis Area 3 – Congestion and traffic management plan (goal 4, mitigation strategies 1 to 3). (continued)

Goal 4: Congestion mitigation/ rear-end crash reduction	Type of Resource	Mitigation Strategies											
		ITS Technologies				Queue detection and warning system				Portable Changeable Message Signs			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Overview of Part VI of the Recently Revised Manual on Uniform Traffic Control Devices Webinar	T											X	
Portable Changeable Message Signs to Control Speeding in Work Zones	P									X			
Smarter Work Zones Toolkit for Everyday Counts Initiative – Technology Applications	G	X	X	X	X	X	X	X	X				
Treating Potential Back-of-Queue Safety Hazards	F					X							
Visibility and Work Zone Traffic Control	A	X	X										
Work Zone Fatality Reduction Strategies Webinar	T											X	
Work Zone Intelligent Transportation Systems Peer Exchange	G	X											
Work Zone Operations Best Practices Guide Book (Third Edition)	G			X				X				X	

Table 27. Emphasis Area 3 – Congestion and traffic management plan (goal 4, mitigation strategies 4 to 6).

Goal 4: Congestion mitigation/ rear-end crash reduction	Type of Resource	Mitigation Strategies											
		Variable Speed Limit				Dynamic Lane merge system				Incident Management			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Data Enhancement for Responsive Work Zone Safety Measures through Integration of Real-Time Incident Alerts and Lane Closure Records	A			X									
Guidance on Using Traffic Management Centers for Work Zone Management	G	X	X	X		X	X	X		X	X	X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 27. Emphasis Area 3 – Congestion and traffic management plan (goal 4, mitigation strategies 4 to 6). (continued)

Goal 4: Congestion mitigation/ rear-end crash reduction	Type of Resource	Mitigation Strategies											
		Variable Speed Limit				Dynamic Lane merge system				Incident Management			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Improving Road Safety through Integrated Process for Incident Traffic Management	A	X	X										
Optimal Variable Speed Limit Control System for Freeway Work Zone Operations	A	X	X										
Setting Work Zone Speed Limits	A				X								
Smarter Work Zones Toolkit for Everyday Counts Initiative – Technology Applications	G	X	X	X		X	X	X		X	X	X	
Synthesis of Variable Speed Limit Signs	G	X	X										
Treating Potential Back-of-Queue Safety Hazards	F	X											
Variable Speed Limit Control for Delay and Crash Reductions at Freeway Work Zone Area	A	X	X										
Work Zone Fatality Reduction Strategies Webinar	T							X					
Work Zone Operations Best Practices Guide Book (Third Edition)	G							X				X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 28. Emphasis Area 3 – Congestion and traffic management plan (goal 5).

Goal 5: Accommodate Pedestrians and ADA Requirements	Type of Resource	Mitigation Strategies																			
		Temporary Traffic Barriers				Channelizing Devices				ADA Compliant Wheelchair ramps and sidewalks				Audible Information Devices				Covered sidewalks/walkways to protect pedestrians			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Americans with Disabilities Act Requirements for Accessibility in Temporary Traffic Control Zones	P					X				X											
Americans with Disabilities Act Requirements for Accessibility in Temporary Traffic Control Zones	T									X											
Applying the Americans with Disabilities Act in Work Zones: A Practitioner Guide	G							X		X		X									
Designing Temporary Traffic Control Zones for Pedestrian Accessibility	T	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	
Guidance Sheet – Temporary Traffic Control Zone Pedestrian Access Considerations	G	X				X				X				X				X			
Guidelines on the Use of Positive Protection in Temporary Traffic Control Zones	G	X	X	X																	
Investigating Pedestrian Components in Temporary Traffic Control	R													X	X	X					
Manual on Uniform Traffic Control Devices	G	X		X						X		X		X		X					
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X	X	X	X	X													

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 28. Emphasis Area 3 – Congestion and traffic management plan (goal 5). (continued)

Goal 5: Accommodate Pedestrians and ADA Requirements	Type of Resource	Mitigation Strategies																			
		Temporary Traffic Barriers				Channelizing Devices				ADA Compliant Wheelchair ramps and sidewalks				Audible Information Devices				Covered sidewalks/walkways to protect pedestrians			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Pedestrian Accommodation in Work Zones: A Field Guide	F	X	X	X		X	X	X		X	X	X									
Pedestrian Checklist and Considerations for Temporary Traffic Control Zones	G	X				X				X				X				X			
Pedestrians and Americans with Disabilities in Work Zones	T									X											
Pedestrian Safety and Accessibility in Work Zones Roadside Design Guide (4th Edition)	T	X				X				X								X			
Roadside Design Guide (4th Edition)	G	X	X	X																	
Temporary Traffic Control – Layout Selection by Maintenance Activity	G		X	X																	
Temporary Traffic Control – Layout Selection by Maintenance Activity (Urban Supplemental Guide)	G		X	X																	
Understanding the New Federal Highway Administration Final Rule on Temporary Traffic Control Devices (Subpart K) Webinar	T					X															
Webinar: Accessibility in Work Zones	T									X											

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 29. Emphasis Area 3 – Congestion and traffic management plan (goal 6).

Goal 6: Urban Conflict Point Mitigation	Type of Resource	Mitigation Strategies															
		Static signs/ marked detours				Parking restrictions				Turn restrictions				Modified signal timing/ coordination			
		SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE	SA	SS	SI	SE
Estimation of Saturation Headway in Work Zones on Urban Streets	A																X
Evaluation of Work Zone Split Traffic Symbol Sign	A				X												
Introduction to Highway Work Zones in Urban Areas	T	X				X				X				X			
Model and Simulation of the Traffic of the Urban Signalized Intersection with Island Work Zone	A																X
Temporary Traffic Control Layout Selection by Maintenance Activity (Urban Supplemental Guide)	G		X	X			X	X									
Temporary Traffic Control Considerations for Urban Work Zones	T	X	X			X	X			X	X			X	X		
Urban Work Zone Design	T	X				X				X				X			

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

Table 30. Emphasis Area 4 – Road user complaints and negative feedback to work zones (goal 1).

Goal 1: Establish Public Relations	Type of Resource	Mitigation Strategies							
		Public relation, education, and outreach				Traveler Information			
		SA	SS	SI	SE	SA	SS	SI	SE
Construction Peer Network (with Regional Peer Exchanges)	G			X					
Design and Operation of Work Zone Strategies to Improve Large Truck Safety	G					X		X	
Developing and Implementing Transportation Management Plans for Work Zones	G	X	X	X	X	X	X	X	X
Federal Highway Administration Work Zone Safety and Mobility Best Practices Fact Sheets	G			X					
Guidance for the Use of Portable Changeable Message Signs in Work Zones	G	X							
In-Vehicle Work Zone Messages	A							X	X
National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions	G	X	X	X	X	X	X	X	X
Roadway Safety Plus How-To Video	T					X			
Safe Trucking Through Work Zones	G					X			
Techniques for Effective Highway Construction Projects in Congested Urban Areas	G	X							
Work Zone Fatality Reduction Strategies Webinar	T			X					
Work Zone Operations Best Practices Guide Book (Third Edition)	G			X				X	

Resource Types: G = Guidelines. P = Podcasts. F = Field Guides. T = Training. A = Analytical Tools.

Framework Steps: SA = Strategy Awareness. SS = Strategy Selection. SI = Strategy Implementation. SE = Strategy Evaluation

RESOURCE SYNOPSIS

Guidelines

1. A Guide for Work Zone Crash Data Collection, Reporting, and Analysis

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/wsu_wz_data_collection_guide.pdf

This guide describes the work zone crash data collection and reporting process, as well as the benefits and challenges in developing a unified system across the States. The quality and consistency of work zone crash data suffers from the variation in crash data elements collected by States and individual record keeping. This guide focuses on which work zone related attributes should be included on all State crash report forms, the justification for inclusion of work zone crash data elements, best practices among the 50 States, and how to overcome various challenges when implementing uniform work zone crash data elements. Recommendations are also provided in achieving the work zone related data element inclusion at the State level.

2. A Guide to Short-Term Stationary, Short-Duration, and Mobile Work Zone Traffic Control

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/wsu_STSDM_guide.pdf

This guide identifies and describes specific challenges and characteristics for short-term stationary, short-duration, and mobile work zones. Typically these work zones require special consideration in terms of temporary traffic control strategies. This guide outlines possible mitigation strategies and countermeasures that will assist in maintaining both safety and mobility through these types of work zones. Example plans are also provided within this document that highlight frequently encountered work zone scenarios.

3. A Primer on Work Zone Safety and Mobility Performance Measurement

<http://www.ops.fhwa.dot.gov/wz/resources/publications/fhwahop11033/>

This primer has been developed to assist agencies in establishing and monitoring a useful set of work zone safety and mobility performance measures. Work zone performance measures are metrics that help to quantify how work zones impact travelers, residents, businesses and workers. Work zone performance measures help agencies improve their understanding of how their decisions during planning, design, and construction affect work zone safety and mobility, and thus can help improve how they make decisions for future work zones. The primer describes possible work zone performance measures, and provides guidance to help agencies select and implement measures that make sense for their own work zone programs. The primer outlines the methods and technologies that are available to gather data to monitor the various possible measures and procedures for calculating specific performance measures from different types of work zone traffic monitoring data. This primer also discusses the use of measures across multiple projects to assess an agency's overall efforts and outcomes against its policies and goals.

4. Applying the Americans with Disabilities Act in Work Zones: A Practitioner Guide

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/ada_guide.pdf

Many practitioners are looking for guidance and examples of common solutions for complying with the American with Disabilities Act to assist them in the development of their designs and specifications for work zone projects. This guideline highlights the practices of State Departments of Transportation, including sample layouts for managing pedestrian travel through the work area, and provides specifications that will enable practitioners to meet American with Disabilities Act requirements. The guideline presents sample scenarios and existing U.S. *Manual on Uniform Traffic Control Devices* typical applications to demonstrate to practitioner's options for identifying and solving common ADA design challenges.

5. Automated Speed Enforcement in Work Zones

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_AutomatedSpeed_Guidance_Download.pdf

Excessive speeding and speed variability are primary factors contributing to work zone crashes. The use of traffic law enforcement is recognized as one of the most effective means of increasing speed limit compliance and decreasing speed variability. Law enforcement personnel may also be deployed to provide presence near the work area to protect workers and to slow down vehicles in locations with back of queue issues. However, active enforcement by police officers is not feasible in work zones where geometry is restricted since there are limited areas to perform traffic stops.

6. Best Practices for Managing Work Zone Data

https://intrans.iastate.edu/app/uploads/2018/08/work_zone_data_best_practices_w_cvr.pdf

This work investigated methods and best practices that agencies use to manage work-zone data. Information gathered from the survey includes types of data collected, methods used for data collection, data architecture, methods used for geo-referencing data, how work-zone data is currently being used, and additional data needs. The results of the survey were compiled and analyzed to develop recommendations to help agencies more effectively manage work-zone data, and to leverage that data for operational and safety analysis purposes.

7. Best Practices in Accelerated Construction Techniques

http://domesticscan.org/wp-content/uploads/2010/05/NCHRP20-68A-Domestic-scan-07-02_Final-Scan-Report_Nov-2009.pdf

This scan focused on construction operations and management practices to accelerate the delivery of construction projects. Visiting five States from the East to West Coasts, the scan team sought information from transportation agency staff and contractors on practices that accelerate project construction. The team visited with transportation leaders in: 1. Jacksonville and Pensacola, Florida; 2. Birmingham and Montgomery, Alabama; 3. Houston, Texas; 4. Salt Lake City, Utah; and 5. Sacramento and Oakland, California. Transportation agency representatives, contractors, suppliers, and engineering consultants having accelerated project experience shared

their viewpoints and knowledge at meetings with the scan team. The team then evaluated these practices for their potential application by other transportation agencies. The team found that, for every project examined, the primary factor leading to success was a spirited effort of partnership and collaboration between the agency and the contractor, together with a supportive design and/or design process.

8. Best Practices in Work Zone Assessment, Data Collection, and Performance Evaluation

Report: http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-68A_08-04.pdf

Webinar (overview of the findings, recommendations, and selected best practices from the scan): <https://connectdot.connectsolutions.com/n134083201009/>

On September 9, 2004, the Federal Highway Administration amended its regulation (23 CFR part 630) that governs traffic safety and mobility in highway and street work zones. One of the provisions of the rule is for States to collect and analyze both safety and mobility data to support the initiation and enhancement of agency-level processes and procedures addressing work zone impacts. Specifically, States are to develop and implement systematic procedures that assess work zone impacts in project development, and States need to manage safety and mobility during project implementation. Presently, many agencies have little experience in collecting, analyzing, and utilizing work zone performance data. It was believed that those agencies would benefit greatly by learning how other agencies are approaching this task. As a result, a domestic scan of practices pertaining to work zone assessment, data collection, and performance measurement was proposed and selected for funding under the NCHRP 20-68A Domestic Scan Program. The scan was designed to investigate best practices in work zone assessment, data collection, and performance measurement, and how practices are being employed to ensure safety and minimize congestion in work zones.

9. Big-Data-Driven Traffic Surveillance System for Work Zone Monitoring and Decision Supporting

<https://trid.trb.org/View/1438742>

This document presents a case-study on the Iowa Department of Transportation Traffic Critical Project program aiming to get a uniform, transparent and systematic performance visualization of on-going work zone projects based on the streaming data collected from radar sensors. These performance visualizations both help the DOT monitor traffic behavior in work zones on a daily basis as well as assist in the decision making to improve work zone performance. To accommodate the large amount of traffic surveillance data and perform analysis on the big data sets in a timely manner, this visualization system integrates several big-data techniques. Hadoop distributed file system is used to provide a large-capacity and fault-tolerant data storage as well as a distributed computing environment. The data processing speed of major tasks such as filtering, grouping, and aggregating is boosted up by distributed computing under the MapReduce framework. The pre-processed data are finally converted to a column-oriented database which optimizes data reading speed to support interactive data queries. Tableau workbooks are used to design the graphical visualization of the traffic characteristics and work zone performance measures. Then a web-based interface is created for safe and convenient access. This big-data-driven traffic surveillance system provides the Iowa Department of Transportation a tool to understand the sensor working condition and the impact the Traffic

Critical Project work zones have on traffic and the decision-making to improve mobility and safety.

10. Considering Work Zone Impacts: Planning for Safety, Mobility and Constructability

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_imp_assess_072908.pdf

This tri-fold brochure gives readers a quick introduction to the concept of work zone impacts assessment without their having to open and tackle the longer Federal Highway Administration Work Zone Impacts Assessment Guide as a first step. This brochure covers the topics of what work zone impacts assessments are, why they are important, impacts considerations, and where to go for more information. Planners, designers, construction engineers, and inspectors will find this an instructive overview of work zone impacts assessment.

11. Construction Peer Network (with Regional Peer Exchanges)

<https://www.fhwa.dot.gov/construction/cpn/cpn2011.pdf>

This flyer describes the purpose, benefits of participation, and how to get involved with the Construction Peer Network.

12. Design and Operation of Work Zone Strategies to Improve Large Truck Safety

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_LargeTruckSafety_TechAdviseDoc_Download.pdf

This document summarizes available methods for transportation agencies and road contractors to design and operate work zones to reduce the risk of large truck crashes. Large trucks include vehicles commonly referred to as commercial motor vehicles, semi-tractor trailers, 18-wheelers, or semis as well as single-unit trucks larger than 10,000 lbs. gross vehicle weight. The document includes the significance of large truck safety issues, the overrepresentation of large trucks in work zone crashes, ways to design practices to better accommodate large trucks, and ways to help truck drivers better negotiate work zones.

13. Developing and Implementing Transportation Management Plans for Work Zones

http://www.ops.fhwa.dot.gov/wz/resources/publications/trans_mgmt_plans/trans_mgmt_plans.pdf

This document is a compendium of guidance material, available resources, and suggested practices to help agencies develop, implement, and assess transportation management plans.

Work zone objectives, needs, and issues vary from project to project. Therefore, it is ultimately up to agencies to establish procedures and implement transportation management plans that best serve the safety and mobility needs of the traveling public, highway workers, businesses, and community. This Guide is not intended to present the only possible approach to develop and implement transportation management plans. Rather, this Guide sets forth some basic guiding principles and describes a general approach for developing, implementing, and assessing

transportation management plans in order to assist agencies with developing their own procedures. This document also provides support to agencies in their efforts to implement the recently updated work zone regulations in 23 CFR part 630, subpart J.

14. Developing Internal Traffic Control Plans for Work Zones

<https://www.workzonesafety.org/publication/guidance-developing-internal-traffic-control-plans-itcps-for-work-zones/>

This document was created to explain the concept of Internal Traffic Control Plans or ITCPs, as applied in roadway construction work zones. An ITCP involves coordination of construction traffic inside the activity area of a temporary traffic control zone. The purpose of an ITCP is to separate—to the extent possible—work vehicles and equipment from workers on foot.

15. Development and Application of Work Zone Crash Modification Factors

<https://www.workzonesafety.org/publication/development-and-application-of-work-zone-crash-modification-factors/>

A crash modification factor provides the expected change in crash frequency due to the implementation of a countermeasure or a change in a particular site condition. State and local transportation agencies determine crash modification factor values by utilizing the Highway Safety Manual. The Highway Safety Manual provides crash modification factor values for various types of facilities and treatments. However, the Highway Safety Manual's coverage of work zone-related crash modification factor values is limited. This report introduces practitioners to: the procedure for evaluating work zone countermeasures using existing crash modification factors and the procedures for developing new work zone crash modification factors. Once derived, crash modification factors can be used for selecting countermeasures and scheduling lane closures.

16. Development of a Moving Automatic Flagger Assistance Device for Moving Work Zone Operations

<http://www.dot.state.mn.us/research/reports/2017/201709.pdf>

The use of traditional automatic flagger assistance devices in a moving operation is difficult due to the towing requirements of the devices. In order to capture the benefits of automatic flagger assistance devices in a moving work zone, a stationary automatic flagger assistance device must be modified to allow for self-propelled motion to follow the moving operation. A review of existing devices already on the market found no devices that would meet all the required operational needs. Discussions were initiated with a manufacturer to determine if a moving automatic flagger assistance device could be manufactured. The initial discussions led to the development of a device prototype, which was ultimately developed into the final moving automatic flagger assistance device. Operational features of the moving automatic flagger assistance devices include:

- Operated with wireless remote, wired remote, or handle controls
- Uses the original remote control from the AF-76 device for the flagging components
- On-board batteries and battery charger
- Moves in forward and reverse directions at speeds up to 5 feet per second
- Towed to the work site using standard towing hitch
- Will operate for a minimum of 6 hours on initial charge

The moving automatic flagger assistance device is operated by one person located off the roadway and out of traffic flow locations. Setup and take down require more effort than traditional flagging but are still considered reasonable.

17. Development of a Precast Slim Temporary Concrete Safety Barrier STCSB 50 for Work Zone Applications

<http://www.tandfonline.com/doi/abs/10.1080/19439962.2017.1402837?journalCode=utss20>

This paper summarizes performance requirements and development details of a precast slim temporary concrete safety barrier, designated STCSB 50, mainly utilized to guide the traffic flow and safely divide lanes on motorways. The design was crash tested according to EN 1317 requirements and its performance clearly demonstrated its robustness as a state of the art safety barrier for work zone applications. Its implementation is therefore recommended to protect both road users and construction site workers at work zone areas.

18. Estimating the Safety Effects of Work Zone Characteristics and Countermeasures: A Guidebook

<http://www.trb.org/Main/Blurbs/177154.aspx>

This guidebook has been prepared to assist practitioners who develop phasing and staging plans for temporary traffic control through work zones to better evaluate the expected safety impacts of their plan decisions. The guidebook will also be useful to agencies, consultants, and contractors in their efforts to prepare and implement traffic management plans by providing a method for evaluating the potential benefits of certain safety countermeasures. After an introductory chapter, the second chapter describes planning-level work zone crash estimation approaches available to practitioners. Planning-level methods can provide a rough approximation of either (a) the total number of crashes expected to occur overall during a particular work zone or (b) the additional number of crashes expected to occur above those normally occurring on the roadway when the work zone is not present. Chapter 3 describes how trade-off analyses of the expected safety impacts of alternative work zone design features, operational strategies, and countermeasures can be performed. A trade-off analysis utilizes available crash modification factors together with planning-level estimates of overall work zone crashes to estimate the incremental changes in crashes that would be expected due to a change in a particular feature or the inclusion of a particular countermeasure. Examples are provided at the end of chapters 2 and 3 to illustrate how the methods can be applied to answer different types of “what if” questions that a practitioner might encounter when developing a set of work zone plans or deciding whether or not to implement a particular work zone safety strategy. Chapter 4 provides a comprehensive catalog of crash modification factors that are available for potential use in evaluating the expected safety

effects of work zone features and strategies. Each crash modification factor is described and its potential applicability to work zone analyses critiqued. Some features of interest do not yet have crash modification factors developed for them, but a discussion of the known operational effects is provided for these features.

19. Evaluating and Updating the Kansas Department of Transportation Lane Closure Guide with Traffic Management Center Data

<https://trid.trb.org/View/1495521>

Short and long-term work zones located on interstates and U.S. highways have a significant influence on travel demand, especially during peak hours when capacity of these roadways is sometimes operating at their limit. The Kansas Department of Transportation has developed a lane closure guide to assist engineers and contractors as to whether a lane, or a number of lanes, can be closed to maintain a capacity of 1,500 vehicles per hour per lane. This guide was originally developed based on limited data sources and many within Kansas Department of Transportation raised questions of the guide's effectiveness. The objective of this study was to evaluate the existing guide, survey the state of the practice as to what other highway agencies use for flow rates through temporary work zones, and update the guide with traffic management center data to reflect actual field conditions. The results of the study showed inconsistencies with traffic volume count, directional split, and adjustment factors. The research team utilized TMC data and developed a quality assurance/quality control process to ensure an update to this critical guide for the Kansas City metropolitan area will make work zones safer and more efficient by providing enough capacity at peak hours.

20. FHWA Work Zone Safety and Mobility Best Practices Fact Sheets

<http://www.ops.fhwa.dot.gov/wz/practices/factsheets/factsheets.htm>

The Work Zone Mobility and Safety Fact Sheet series showcases specific projects and practices used by one or more agencies to improve mobility and safety in work zones. The fact sheets are intended to:

- Share lessons learned from a project, practice, or application.
- Showcase innovative technologies and best practices.
- Support the Work Zone Best Practices Guidebook and its database of practices and technologies.
- Introduce new initiatives, products, and tools.

21. Guidance for Conducting Effective Work Zone Process Reviews

<http://ops.fhwa.dot.gov/publications/fhwahop15013/index.htm>

All State highway agencies receiving Federal-aid funds are required to perform work zone process reviews every two years. These reviews are an opportunity for the agency to reexamine how it is meeting Federal requirements in 23 Code of Federal Regulations 630 Subparts J and K in accomplishing work zone safety and mobility management. These reviews help an agency evaluate its work zone safety and mobility-related policies and procedures as well as the

effectiveness of its work zone impacts analyses and monitoring efforts, and ultimately, how well it manages those impacts. The intent of this document is to share good practices and methods that agencies have found worthwhile in conducting their process reviews. The goal is that this focused information will lead to more consistent and targeted improvements in agency work zone policies and procedures. This document includes tips for success in work zone process reviews, effective use of data and performance measures in process reviews, and insight for connecting process reviews with other work zone safety and mobility improvement efforts.

22. Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_574.pdf

TRB's National Cooperative Highway Research Program Report 574: Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction explores approaches to cost estimation and management designed to overcome the root causes of cost escalation and to support the development of consistent and accurate project estimates through all phases of the development process, from long-range planning, through priority programming, and through project design.

23. Guidance for the Use of Dynamic Lane Merging Strategies

https://s3.amazonaws.com/media.atssa.com/rsti/427365_ATSSA.pdf

Dynamic lane merging is defined as a merging system that switches from early-merging strategies to late-merging strategies depending on real-time traffic flow characteristics. This guidance document summarizes the available findings on implementation of dynamic merging strategies. This guide focuses on identifying when dynamic merging strategies are appropriate in addition to tips for successful implementation. It covers signing and switching recommendations for two-to-one lane closures and three-to-two lane closures. To assist in the planning and design stages, the appendix contains sample layouts and signing from previous implementations across the United States.

24. Guidance for the Use of Portable Changeable Message Signs in Work Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/pcms_wz.pdf

This document examines effective strategies for portable changeable message signs when used in work zones. The strategies address speeding, driver distraction, and demand management through work zones. This document is intended to provide guidance to agencies for appropriate uses of portable changeable message signs in their construction zones.

25. Guidance for the Use of Temporary Pavement Markings in Work Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/wz_tpm.pdf

This guide provides guidelines on the application of temporary markings in highway work zones. It summarizes information from various sources when considering placement and removal of temporary pavement marking. This guide is designed for use by traffic control supervisors and

other contractor field staff and provides easy access to information from multiple sources. It will also be helpful for highway agency staff in evaluating temporary pavement markings.

26. Guidance for the Use of Temporary Rumble Strips in Work Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_temporary_rumble_strips.pdf

This document examines the effectiveness of temporary rumble strips when used in work zones. It summarizes information on different types and configurations of temporary rumble strips for work zones and their benefits and limitations. This document is intended to provide guidance to agencies on appropriate uses of temporary rumble strips in work zones and present key aspects to consider before and during implementation.

27. Guidance on Data Needs, Availability, and Opportunities for Work Zone Performance Measures

<http://ops.fhwa.dot.gov/wz/resources/publications/fhwahop13011/>

Current Federal Regulations (23 Code of Federal Regulations 630 Subpart J) encourage States to collect and analyze both safety and mobility data to support the initiation and enhancement of agency-level processes and procedures addressing work zone impacts. The purpose of this guidance document is to provide practitioners with the skills to identify current data sources (both existing data and data collected specifically for the work zone) for use in work zone performance measurement, as well as potential data sources that could be useful to work zone performance measurement in the near future. This document is also intended to assist practitioners in determining how to select and compute useful work zone performance measures, given the data sources available to them. For both current and potential data sources, guidance is presented on the viability of each source for work zone performance measurement, as well as on possibly leveraging opportunities to maximize the value of data collection and extraction efforts. In addition to information about data sources and opportunities, guidance is provided regarding work zone performance measures that the various data sources can support. Where appropriate, examples are provided as to how data assessment, collection, application, and interpretation can be accomplished. In this way, document users can obtain an overall perspective.

28. Guidance on the Use of Automated Flagger Assistance Devices

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_afad.pdf

This guideline outlines the use of automated flagging assistance devices (AFAD), mechanically operated temporary traffic control devices used to assist flaggers, by various departments of transportation and provides information to practitioners on scenarios for determining when to use automated flagging assistance devices; selecting an automated flagging assistance device, which may include determining the cost/benefit of using such devices; addressing safety concerns or limitations; and making the necessary adjustments when using automated flagging assistance devices. Automated flagging assistance devices may be an appropriate alternative that can potentially increase the safety of flaggers by removing them from the direct flow of traffic, especially when there is no viable escape route for a standard flagger position during operations. Within this guideline, a table summarizing 11 State standards on the use of automated flagging

assistance devices may assist other departments of transportation in developing their own policy during maintenance and construction activities. This guideline determines that the overall assessment of automated flagging assistance devices from workers and drivers is positive, and the use of these devices is recommended.

29. Guidance on Using Traffic Management Centers for Work Zone Management

<http://www.ops.fhwa.dot.gov/publications/fhwahop15032/index.htm>

This document presents guidance for departments of transportation to consider how traffic management center resources (staff, data, and tools) can be used to support all stages of a work zone, providing examples of where these resources are used today. A total of eight strategies are presented for utilizing traffic management center resources during the four stages of a work zone. Each strategy includes detailed descriptions and examples of use in practice.

30. Guidance Sheet – Temporary Traffic Control Zone Pedestrian Access Considerations

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_guidance_sheet.pdf

This fact sheet gives policy-makers, designers, and construction engineers developing temporary traffic control an overview of work zone pedestrian issues. It is also useful to those who are responsible for inspecting or maintaining the work zone.

31. Guidance: Managing Flagging Operations on Low-Volume Roads

<https://www.workzonesafety.org/publication/guidance-managing-flagging-operations-on-low-volume-roads/>

This document was created to supplement the 2009 Edition of the National *Manual on Uniform Traffic Control Devices* by providing commentary to assist decision makers in planning flagging operations on these roads. The document addresses evaluating site conditions, providing good visibility and stopping sight distance, choosing the correct type of flagging or alternate control, adjusting temporary traffic control installation and operation, ensuring safe flagger behavior, and contingency planning.

32. Guidance: Temporary Traffic Control for Work Zones on Unpaved Roads

<https://www.workzonesafety.org/publication/guidance-temporary-traffic-control-for-work-zones-on-unpaved-roads/>

This document was created to supplement the 2009 Edition of the National *Manual on Uniform Traffic Control Devices* by providing commentary to assist agencies responsible for maintenance and construction on unpaved roadways in identifying temporary traffic control for these activities. This document addresses temporary traffic control concepts for unpaved roads, types of work zone activities on unpaved roads, and temporary traffic control plans.

33. Guide to Project Coordination for Minimizing Work Zone Mobility Impacts

<http://www.ops.fhwa.dot.gov/publications/fhwahop16013/index.htm>

This new publication provides guidance on using work zone project coordination to minimize work zone impacts and produce time and achieve cost savings. This guide presents key concepts of project coordination, examples of useful tools to facilitate project coordination, and case studies of how project coordination was used to improve agency management of complex construction programs.

34. Guidelines on Ensuring Positive Guidance in Work Zones

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Positive_Guidance_Download.pdf

This document describes the importance of ensuring good positive guidance when implementing a work zone traffic control plan. Four key concepts are emphasized: ensuring that all driver information needs are met to allow them to navigate safely through the work zone, standardizing the information provided to drivers to meet their expectations, ensuring that information is spread out through the approach and work area to avoid driver overload, and ensuring that all work zone hazards are identifiable and visible to the motorist.

35. Guidelines on Managing Speeds in Work Zones

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Speed_Guidance_Download.pdf

This document summarizes available guidance on setting speed limits and managing speeds in work zones. Many factors impact the decision to reduce the regulatory speed limit in a work zone, implement speed limit management strategies and utilize speed reduction strategies. This guide is intended to aid agencies and highway contractors in understanding these factors and the interactions among them. This document addresses how slower speeds can improve safety, how drivers are told to slow down, when slower speeds are important, changing speeds to match conditions, voluntary speed reductions, law enforcement, other tools, a decision tool for managing speeds, and an example approach to managing speeds in work zones.

36. Guidelines on Motorcycle and Bicycle Work Zone Safety

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_MotorcyclesGuidance_Download.pdf

This document describes work zone conditions that can cause safety concerns for motorcyclists and bicyclists. This document offers recommended practices and describes effective strategies and techniques that can be used to help mitigate those concerns. These documents address the types of hazards, degradations in roadway pavement surface quality, degradations in pavement friction, pavement discontinuities and abrupt elevation changes, degradations in roadway geometrics, and methods of improving motorcycle and bicycle safety in work zones.

37. Guidelines on Payment for Temporary Traffic Control

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Payment_for_TTCs_Guidance_Download.pdf

This document describes good practices regarding payment methods for work zone traffic control. This document is intended to assist agencies in understanding the current regulation regarding temporary traffic control payment procedures, and in establishing policies and procedures that comply with these regulations.

38. Guidelines on Rolling Roadblocks for Work Zone Applications

<https://s3.amazonaws.com/media.atssa.com/WZGrant/431919.ATSSA.PDF>

This guideline outlines a suggested process for planning and executing a rolling roadblock for temporary traffic control applications, including the decision-making process on when to use this technique. The rolling roadblock is a practice that can be used to close all lanes of traffic with pacing vehicles to create a gap so that construction activities can be performed. A checklist is also included in this guide and outlines roles and responsibilities for each stakeholder involved to enhance communication and coordination and ensure safety for workers and motorists.

39. Guidelines on the Use of Low-Profile Portable Concrete Barrier in Low to Moderate Speed Work Zones

<https://www.workzonesafety.org/publication/guidelines-on-the-use-of-low-profile-portable-concrete-barrier-in-low-to-moderate-speed-work-zones/>

This guideline highlights the use of a low-profile concrete barrier in low to moderate speed work zones. The low profile barrier enhances line of sight for drivers, especially where work zones and driveways intersect on grades. Low-profile concrete barrier is a tool that can be specified for use on projects where deflection space is appropriate (up to 9 inches) and where traditional portable concrete barrier might limit line of sight and create safety concerns for motorists entering mainline traffic. Many urban and suburban work zones may not be good candidates for traditional portable concrete barrier, because of its size, installation requirements, room for placement, and impacts to motorists' line of sight. This guide outline examples of barrier use in Florida and Texas, especially at freeway exit ramps and intersections with secondary roadways.

40. Guidelines on the Use of Positive Protection in Temporary Traffic Control Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_positive_protection_guidelines.pdf

This guidance document is a companion to the American Traffic Safety Services Association "Work Zone Positive Protection Toolbox." It describes the characteristics of work zones where positive protection is most appropriate; highlights specific, applicable aspects of the Work Zone Rule Subpart K; and provides guidance on how to determine when to use different types of positive protection devices. The document is intended for planners, designers, and highway agency decision makers who develop their own policies/practices for implementation in the field.

41. Guidelines on Use of Exposure Control Measures

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Exposure_Controls_Guidance_Download.pdf

This guidance document summarizes the various types of exposure control measures and discusses how each can improve the safety of workers and motorists in work zones. This document addresses full road closures, full or partial detours or diversions, median crossovers, ramp closures, rolling roadblocks for traffic control set-up and takedown activities, working during nighttime hours, and accelerated contracting techniques.

42. Guidelines on Use of Law Enforcement in Work Zones

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Law_Enforcement_Download.pdf

This guide describes good practices for use of law enforcement to improve work zone safety and mobility. This document is intended to assist highway agencies and contractors in determining when enforcement should be used, how it should be used, and how a work zone enforcement program can be funded and managed. This document addresses regulatory language regarding law enforcement use in work zones, differences in enforcement philosophies, types of work zone enforcement strategies, determination of when and where to use enforcement in work zones, officer deployment within the work zone, enforcement considerations during work zone planning and design, and administration considerations of work zone enforcement.

43. Guidelines on Work Zone Access and Egress

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Access_Egress_Download.pdf

This guidance document describes concerns associated with work zone access and egress. This document offers recommended practices and describes effective strategies and techniques that can be employed during the planning, design, and construction phases to help mitigate concerns. This document addresses work zone access and egress problems, when to consider access and egress, acceleration and deceleration of construction vehicles, maintaining access and egress points, controlling traffic inside the work zone, and innovative ideas and best practices.

44. High-Visibility Safety Apparel in Highway Work Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_high_visibility.pdf

This brochure provides examples of performance safety apparel in different wear conditions, allowing readers to visually compare their apparel to the pictures in the brochure so they can determine when it is a good time to replace their safety apparel. This brochure is for individuals who wear performance safety apparel and their managers, but also provides guidelines on considerations for purchasers responsible for buying new safety apparel.

45. Highway Capacity Manual 2016, Chapter 11, Freeway Reliability Analysis

<http://trrjournalonline.trb.org/doi/book/10.5555/9780309441483>

Describes how the chapter 10 core methodology can be applied to evaluate the impacts of demand variation, severe weather, incidents, work zones, special events, and active traffic and demand management strategies on freeway operations and travel time reliability.

46. Highway Capacity Manual 2016, Chapter 17, Urban Street Reliability and ATDM

<http://trrjournalonline.trb.org/doi/book/10.5555/9780309441483>

Describes how chapter 16's facility methodology can be applied to evaluate the impacts of demand variation, severe weather, incidents, work zones, special events, and active traffic and demand management strategies on urban street operations and travel time reliability.

47. Highway Work Zone Intrusion Alert Systems Implementation Guide

<https://rosap.ntl.bts.gov/view/dot/32770>

Using wireless communications that incorporate various technologies and systems, work zone intrusion alert systems can notify highway work zone personnel when hazardous situations are detected. This guide provides recommendations and best practices for implementing proximity detection and alert systems for enhancing safety for workers in highway construction zones. This guide was created in an effort to effectively implement highway work zone intrusion alerts systems for Alabama Department of Transportation personnel.

48. Identifying Effects and Applications of Fixed and Variable Speed Limits

<https://doi.org/10.5703/1288284316358>

Distracted driving and unexpected queues have led to an increase in the amount of back-of-queue crashes, particularly on approach to work zones. This report presents new strategies for the assessment of both transportation safety and traffic operations using crowd-sourced probe vehicle data and a speed laser vehicle re-identification scheme. This report concludes by recommending strategies for the placement of variable speed limits adjacent to work zones and suggestions for future research.

49. Increasing the Work Zone Worker's Visibility Through High-Visibility Safety Apparel

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_worker_visibility.pdf

This poster illustrates apparel that can and cannot be used and provides helpful hints on situations when it is appropriate to use specific apparel through the use of sample pictures and easy to read bullets. The intended audience for this product includes anyone who plans on working in or near the roadway right-of-way.

50. Innovative End-of Queue Warning System Reduces Crashes Up to 45%

<https://www.workzonesafety.org/publication/innovative-end-of-queue-warning-system-reduces-crashes-up-to-45/>

This fact sheet details the application of an innovative end-of-queue warning system developed by the Texas Agricultural & Mechanical Transportation Institute to reduce the risk of crashes on a project to widen 96 miles of Interstate 35 (I-35) through central Texas. The system consists of a portable work zone queue detection and warning system combined with portable rumble strips. A preliminary evaluation of effectiveness found the system reduced crashes up to 45 percent and saved between \$1.4 million and \$1.8 million in society crash costs. This fact sheet includes an application diagram of the system setup.

51. Installing and Maintaining Crashworthy Work Zone Traffic Control Devices

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/artba_wz_rashworthin_ess_field_guide-508.pdf

A variety of traffic control devices are used to control and guide motorists approaching and traveling through a work zone. Ensuring that these devices are crashworthy is critical to the safety of both the motoring public and to the roadway workers who are on or near the roadway performing the necessary work. These devices must be properly installed and maintained in the field over the duration of the work zone to ensure that they will perform as designed if impacted by an errant vehicle. This document explains basic concepts and criteria regarding work zone device crashworthiness for field personnel. Information is provided on items to ensure various work zone devices typically used are indeed crashworthy. Resources are provided at the end of this document for more specific information regarding crashworthy work zone traffic control devices. Examples of improper installation or repairs to devices are highlighted, along with an explanation of why they are not crashworthy.

52. Manual on Uniform Traffic Control Devices

http://mutcd.fhwa.dot.gov/kno_2009r1r2.htm

The Manual on Uniform Traffic Control Devices defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public travel. The Manual on Uniform Traffic Control Devices is published by the Federal Highway Administration under 23 Code of Federal Regulations, Part 655, Subpart F.

53. National Cooperative Highway Research Program Report 500: Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan, Volume 17: A Guide for Reducing Work Zone Collisions

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v17.pdf

This guide provides strategies that can be employed to reduce work zone crashes.

54. National Cooperative Highway Research Program Research Report 869: Estimating the Safety Effects of Work Zone Characteristics and Countermeasures: A Guidebook

<http://www.trb.org/Main/Blurbs/177154.aspx>

This document provides practitioners who develop phasing and staging plans for temporary traffic control through work zones with guidance to evaluate the safety impacts of their plan decisions. There is limited data on work zone crashes and fatalities that address trends, causality, and the best use of resources to improve work zone safety. This guidebook provides clearer guidance to encourage the use of a data-driven, comprehensive, collaborative planning approaches for the selection and implementation of effective countermeasures to improve work zone safety. Accompanying the report, the National Cooperative Highway Research Program Web-Only Document 240: Analysis of Work Zone Crash Characteristics and Countermeasures documents the research results of multiple analyses focused on developing an improved understanding of work zone crash characteristics and countermeasure effectiveness.

55. National Cooperative Highway Research Program Synthesis 509: Highway Worker Safety

<http://www.trb.org/Main/Blurbs/176006.aspx>

This guide identifies how State departments of transportation implement policies using highway worker safety and health data to reduce injuries and manage risk. The report is a synthesis of current proactive safety practices that will be useful when developing or updating policies, programs, or tools to minimize injuries, fatalities, and risk. The study also identifies gaps in knowledge and future research needs.

56. Nighttime Lighting Guidelines for Work Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/night_lighting_guide.pdf

Many State departments of transportation use some form of nighttime work zone to conduct construction and maintenance activities on or near the travel portion of the road system. Roadway lighting eases the task of driving at night by illuminating the pavement to help drivers see the general direction of the roadway, aiding them in seeing structures alongside the roadway more clearly, and enabling them to see areas of the roadway where headlights do not provide adequate light. This document provides a procedure for designing a nighttime lighting system in work zones where no formal lighting plan exists. Engineers, designers, and contractor personnel can use this process without the need to be an expert in illumination.

57. Optimizing Work Zone Lighting

<http://www.state.nj.us/transportation/refdata/research/reports/NJ-2016-004.pdf>

The objective of this study was to identify the needs of workers and drivers in different work zone environments, and to review existing knowledge about ways in which lighting practices and technologies can be deployed to provide workers with sufficient illumination while minimizing glare and confusion to all individuals in and near the work zone. The results of technical analyses

led to the development of several preliminary guidelines for illumination system selection/layout, application of sign and delineation devices and materials, and the use and control of warning lights to provide workers and nearby drivers with visual information in work zones. Implementation of the preliminary guidance in the present report can assist the New Jersey Department of Transportation in improving visual conditions in several different types of work zones through lighting that maintains visual performance while reducing glare and distraction from excessively bright lights.

58. Pedestrian Checklist and Considerations for Temporary Traffic Control Zones

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_pedestrian_checklist.pdf

Designers, construction engineers, policy-makers, traffic control plan developers, inspectors, and contractors will find this detailed checklist invaluable for determining and accommodating the requirements of pedestrians in work zones, including specific Americans with Disabilities Act requirements for pedestrian routes.

59. Portable Positive Protection: A Guide for Short Duration and Short Term Work Zones

<https://www.workzonesafety.org/publication/portable-positive-protection-a-guide-for-short-duration-and-short-term-work-zones/>

This guideline covers various types of positive protection devices that can be easily placed and moved for short duration and short term work operations, especially compared with traditional portable concrete barrier systems. It provides guidelines on the use of steel barriers, protective vehicles such as advance warning, shadow, and barrier vehicles, and barrier trailers. This document also includes suggestions for planning for use of portable positive protection along with a related typical application.

60. Roadside Design Guide (4th Edition)

https://bookstore.transportation.org/collection_detail.aspx?ID=105&gclid=CInC2_Gq6s8CFQgxaQod244L6g

The Roadside Design Guide presents a synthesis of current information and operating practices related to roadside safety. It is intended to be used as a resource document from which individual highway agencies can develop standards and policies. It includes a synthesis of current information and operating practices related to roadside safety. It focuses on safety treatments that can minimize the likelihood of serious injuries when a motorist leaves the roadway. This guide was written for use by design engineers and professionals involved in roadside safety and is considered a significant toll that combines current research with practical experience.

61. Safe and Effective Work Zone Inspections

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_wz_inspections.pdf

This document examines program elements, operational improvements, and the value of documentation behind the development of a comprehensive work zone traffic control inspection program. This document is intended for use as a gauge or completeness for agencies with programs in place or as a roadmap for establishing a program if one does not presently exist.

62. Safe Practices for Law Enforcement Personnel Operating in Highway Work Zones

<https://www.workzonesafety.org/publication/safe-practices-for-law-enforcement-personnel-operating-in-highway-work-zones/>

This guideline highlights safe practices for law enforcement personnel operating in work zones. It lists and compares common practices, such as presence versus enforcement, and also includes checklists for items to consider in the field. Safe cruiser positioning suggestions are also included to assist in developing plans for work zone detail as well as policies on the owner-agency side. This pocket-sized guide is also available in hard copy.

63. Safe Trucking through Work Zones

<https://www.workzonesafety.org/publication/safe-trucking-through-work-zones/>

This brochure offers safety tips for trucking through work zones. Statistics and the most commonly occurred types and locations of large truck crashes in work zones are also provided.

64. Sharing Work Zone Effective Practices for Design-Build Projects

<http://www.ops.fhwa.dot.gov/publications/fhwahop16049/fhwahop16049.pdf>

The specific objectives of this project are to identify and share best practices and guidance on work zone management, quality assurance, and transportation management plan development for design-build projects. This information is packaged within this report as a series of lessons learned, best practices, tools for developing transportation management plans, and sample checklists. This material is presented in five chapters briefly summarized as follows: “Chapter 2: Lessons Learned and Best Practices in Design-Build Projects” presents bulleted lists of lessons learned and best practices in design-build projects, organized around a variety of pertinent issues and subjects in design-build processes; “Chapter 3: Transportation Management Plan Development Tools for Design-Build Projects” presents development tools for the development of transportation management plans in general as well as for the development of transportation management plan components including Temporary Traffic Control Plans, Traffic Incident Management Plans, and Public Information and Outreach Plans; “Chapter 4: Quality Assurance Tips for Work Zones in Design-Build Projects” presents a concise, bulleted tip list for managing work zones in design-build projects; “Chapter 5: Quality Assurance Checklists for Work Zones in Design-Build Projects” presents a series of sample inspection checklists to aid design-builders and owners/agencies in conducting quality assurance for work zones in various phases of design-build projects; and “Chapter 6: Additional Checklists to Support Design-Builders and

Owners/Agencies” presents an additional series of sample checklists to support design-builders and owners/agencies in various processes of design-build projects.

65. Smarter Work Zones Toolkit for Everyday Counts Initiative – Project Coordination

<https://www.workzonesafety.org/swz/swzproject-coordination/>

This website provides links to a range of information regarding project coordination strategies.

66. Smarter Work Zones Toolkit for Everyday Counts Initiative – Technology Applications

<https://www.workzonesafety.org/swz/swztechnology-application/>

This website provides links to a range of information regarding work zone intelligent transportation system technologies that can be applied to work zones to reduce safety and mobility impacts.

67. Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process

http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R11-RW-1.pdf

The Transportation Research Board’s second Strategic Highway Research Program report *Strategic Approaches at the Corridor and Network Level to Minimize Disruption from the Renewal Process* documents the development of the work zone impact and strategy estimator (WISE) is a decision-support software system designed to help evaluate the impact of work zones and determine strategies to reduce those impacts. In addition, second Strategic Highway Research Program Renewal Project R11 produced the Work Zone Impact and Strategy Estimator Software Users Guide, which explains how to use the software. A project brief summarizes the results of the study.

68. Strategies on Improving Worker Safety in Work Zones

https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Worker_Safety_Guidance_Download.pdf

This guidance document describes traffic control measures that can be appropriate in work zones to further improve the safety of highway workers. This document addresses enhanced flagger station set-ups, intrusion alarms, pace or pilot vehicles, and temporary traffic signals.

69. Synthesis of Variable Speed Limit Signs

<https://ops.fhwa.dot.gov/publications/fhwahop17003/index.htm>

Based on a comprehensive literature review along with agency interviews to gather information on existing, deactivated and planned variable speed limit systems, this synthesis provides a comprehensive review of current practices on variable speed limit operations, particularly experiences from deployments in the United States, and to identify successful and best practices from the following perspectives: planning and policy, design, deployment, and standards, operations and maintenance, and outcomes.

70. Techniques for Effective Highway Construction Projects in Congested Urban Areas

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_413.pdf

Highway construction in congested urban areas is a challenge owing to high-traffic volumes, utility conflicts, complex right-of-way acquisition issues, a diverse stakeholder base, and watchful news media. This study focused on techniques used by transportation agencies to deal with these and other challenges. A highly diverse set of techniques were discovered, suitable for different needs. Four case studies are included to illustrate effective construction practices in congested urban areas.

71. Temporary Traffic Control Layout Selection by Maintenance Activity (Urban Supplemental Guide)

<http://www.dot.state.mn.us/research/TS/2016/2016RIC09B.pdf>

This guidance was developed to aid in selecting appropriate temporary traffic controls for maintenance work on streets commonly referred to as residential streets. While the Minnesota Manual on Uniform Traffic Control Devices and Minnesota Statutes do not specifically define these streets, these guidelines were developed for streets with a speed limit of 30 mph or less, that have a traffic volume less than 400 average daily traffic, and have few if any businesses or commercial development. Many of these residential streets have limited pavement width and consideration should be given to working with local law enforcement to restrict parking on the streets where work is being planned. This will facilitate being able to provide safe passage of vehicles while providing work space exclusively for workers, equipment and materials. The Minnesota Manual on Uniform Traffic Control Devices contains requirements to provide a minimum of 10 foot wide lanes for the passage of vehicles.

72. Temporary Traffic Control – Layout Selection by Maintenance Activity

<http://www.dot.state.mn.us/research/TS/2016/2016RIC09.pdf>

The intent of this document is to help local agencies identify the appropriate work zone layout based on the maintenance activity that will be performed. This document focuses on low volume roads only and includes both a rural and urban guide that are intended to be used as supplemental guidance to the Temporary Traffic Control Work Zone Layouts Field Manual (dated January 2014). The information presented here does not replace or override anything within the field manual. Agencies must follow the standards and guidance contained in the Minnesota Manual on Uniform Traffic Control Devices, including the Field Manual. This document also includes a copy of a letter that was written and submitted to the MUTCD Committee in April 2016, requesting changes for low volume roadways. A summary of training opportunities is included as well. Rural Maintenance (Low Volume Rural Street or Highway) – Supplemental Guidebook
<http://www.dot.state.mn.us/research/TS/2016/2016RIC09A.pdf>

73. Temporary Traffic Control (TTC) Tool Kit

<https://www.workzonesafety.org/research/record/10923>

The Temporary Traffic Control Tool Kit contains interactive tools on temporary traffic control and a presentation, both based on the Federal Highway Administration's 2009 *Manual on Uniform Traffic Control Devices*. The presentation details the four parts of a temporary traffic control zone, defines all types of tapers and interactively explains taper spacing and length and advance warnings spacing. The toolkit includes a Typical Applications tool that enables users to select any Typical Application and then change highway type and speed to see sign spacing, taper spacing and buffer lengths. The module closes with an interactive drag and drop quiz on the parts of a temporary traffic control zone.

74. Temporary Traffic Control for Building and Maintaining Single and Multi-Lane Roundabouts

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/roundabts.pdf

Although roundabouts have recently gained popularity and use in the United States, minimal guidance is available for constructing roundabouts or installing, maintaining, and removing temporary traffic control devices in work zones where roundabouts are constructed. These guidelines provide considerations and typical applications to assist field staff in setting up temporary traffic control for both new construction and maintenance activities. The traffic control guidelines outlined in this document can be used during various maintenance and construction activities such as pavement repair, striping, signing, delineation, landscaping, and intersection repair as well as during the construction of new roundabouts.

75. Traffic Analysis Toolbox Volume VIII: Work Zone Modeling & Simulation: A Guide for Decision Makers

http://ops.fhwa.dot.gov/wz/traffic_analysis/tatv8_wz/index.htm

This document is intended to provide guidance to decision makers at agencies and jurisdictions considering the role of analytical tools in work zone planning and management. It is often unclear what kind of analytical approach may be of most value, particularly in light of complex data requirements and staff training. The decision to create an analytical capability to support decision-making can be a significant investment, and deserves careful consideration. In the end, work zone analysis should never be used to make key decisions but instead developed as a trusted resource for understanding the potential mobility impacts and using this information to inform key decisions. This document serves as Volume VIII in the Federal Highway Administration Traffic Analysis Toolbox.

76. Traffic Analysis Toolbox Volume IX: Work Zone Modeling and Simulation: A Guide for Analysts

http://ops.fhwa.dot.gov/wz/traffic_analysis/tatv9_wz/index.htm

This document is the second volume in the Federal Highway Administration Traffic Analysis Toolbox: Work Zone Analysis series. Whereas the first volume provides guidance to decision

makers at agencies and jurisdictions considering the role of analytical tools in work zone planning and management, this volume provides specific guidance to the analyst, researcher, or manager in charge of conducting a specific work zone analysis project or who has been charged with developing an overall work zone modeling program or approach. This volume includes numerous case study examples, discussion and analysis designed to provide the prospective work zone analyst with information pertaining to the selection of a transportation modeling approach (including the identification of opportunities for use, managing technical risk and examples) as well as specific project applications (including constructability, scheduling and transportation management plan design and evaluation). This document serves as Volume IX in the Federal Highway Administration Traffic Analysis Toolbox.

77. Traffic Analysis Toolbox Volume XII: Work Zone Traffic Analysis - Applications and Decision Framework

<http://ops.fhwa.dot.gov/publications/fhwahop12009/index.htm>

The Federal Highway Administration developed this document to assist analysts and decision makers involved in work zone impact assessment, evaluation of mitigation strategies, and selection of maintenance of traffic alternative(s). This document outlines key steps involved in work zone traffic analysis and includes several examples/case studies to demonstrate various analytical methods and applications. It provides an overview of key considerations and concepts related to work zone traffic analysis. This document also includes several multi-criteria decision-making approaches that can be used in alternatives analysis.

78. Using Modeling and Simulation Tools for Work Zone Analysis (leaflet)

http://ops.fhwa.dot.gov/wz/traffic_analysis/wza_leaflet/wza_leaflet.htm

This synopsis provides an overview of work zone impact analysis, Federal Highway Administration Traffic Analysis Toolbox resources available, and guidance on how to use those resources to perform a work zone impact analysis.

79. Using Portable Changeable Message Signs to Control Speeding in Work Zones

<https://www.workzonesafety.org/training/using-portable-changeable-message-signs-to-control-speeding-in-work-zones/>

The relatively large and conspicuous message displays of portable changeable message signs make them effective for providing work zone guidance and warning messages to drivers. This brief podcast looks at the important role portable changeable message signs can have in both active and passive speed control strategies within a work zone.

80. Utility Work Zone Traffic Control Guidelines

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/wsu_tcp_guidelines.pdf

This guidance document provides an introduction to utility work zone operations and presents recommendations for several important aspects of safety related to utility work, including the

establishment of a safety culture in the organization, the use of uniform and consistent traffic control devices and systems, and the development of a set of typical temporary traffic control plans that are appropriate for specific types of work sites.

81. Work Zone Free Flow Speed Calculation Issues in HCM 2016

<https://trid.trb.org/View/1497192>

Capacity and free flow speed are the two most important traffic characteristics that determine traffic flow conditions in work zones. Work zone capacity and free flow speed are also important because they directly affect queue length and delay. Delay and queue length are commonly used in performance evaluation, design, and planning of freeway work zones. Number of queued vehicles influences queue length and delay, heavily relies on work zone capacity and speed of vehicles in the work zone. Highway Capacity Manual 2016 developed new procedures to calculate work zone capacity and free flow speed (1). Work zone capacity and free flow speed are independently calculated to create a speed-flow curve, which represents the traffic operation in the work zone. The Highway Capacity Manual 2016 free flow speed calculations provide acceptable results for some work zones, but it computes counter-intuitive free flow speed for some realistic work zone conditions. The first counter-intuitive result is when the work zone capacity becomes higher than the capacity of the corresponding basic freeway section (non-work zone). The second is when the estimated work zone free flow speed becoming higher than the free flow speed for non-work zone basic freeway section. The last one is when work zone free flow speed are not consistent with posted speed limit in the work zone and show an opposite trend. It is sensible to expect that work zone capacity to be lower than the capacity of upstream non-work zone freeway section; work zone free flow speed should be lower than the free flow speed of a comparable basic freeway section; and work zone free flow speed should be consistent with work zone speed limit. These issues are examined in this paper, and 5 modified free flow speed equations are suggested to provide intuitive and acceptable free flow speed for work zones.

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

http://ops.fhwa.dot.gov/wz/resources/final_rule/wzi_guide/index.htm

This document provides guidance on developing procedures to assess and manage work zone impacts of road projects, as well as examples of how agencies are currently assessing and managing work zone impacts. The assessment process described in this Guide mirrors the typical program delivery process of transportation agencies. The assessment process includes:

- 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; traffic management plan; and plans, specifications, and estimates.
- Implementing the traffic management plan during construction, monitoring actual work zone impacts in the field, and managing the impacts by making adjustments (as needed) to the traffic management plan.
- Conducting performance assessments to develop recommendations for improving work zone policies, processes, and procedures.
- Incorporating work zone impacts assessment and management in maintenance and operations.

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 Federal Highway Administration staff with oversight responsibilities, contractors, highway workers, and consultants also may find this Guide useful.

83. Work Zone Intelligent Transportation Systems (ITS) Implementation Guide

<http://www.ops.fhwa.dot.gov/publications/fhwahop14008/>

Intelligent transportation systems is a broad range of communications-based information and electronics technologies used to enhance transportation. Work zone intelligent transportation systems enhance transportation and improve safety and mobility in and around work zones. A work zone intelligent transportation systems deployment can be focused around safety or mobility, but often supports both goals, and can also enhance productivity. The systems are portable and temporary in most cases, although some deployments may use either existing fixed infrastructure or become a permanent system.

The purpose of this document is to provide guidance on implementing intelligent transportation systems in work zones to assist public agencies, design and construction firms, and industry, including developers, manufacturers, distributors, packagers, and providers of devices, systems, and programs. Work zone intelligent transportation systems are one possible operational strategy of many potential solutions that an agency can include in a transportation management plan. This document summarizes key steps for successfully implementing intelligent transportation systems in work zones, using a systematic approach to provide a technical solution that accomplishes a specific set of clearly defined objectives. This document illustrates how a systems engineering process should be applied to determine the feasibility and design of work zone intelligent transportation systems for a given application, regardless of its scale, by walking through the key phases, from project concept through operation. These steps include assessment of needs; concept development and feasibility; detailed system planning and design; procurement; system deployment; and system operation, maintenance, and evaluation.

84. Work Zone Intrusion Alert Technologies Assessment and Practical Guidance: Final Report

<https://rosap.ntl.bts.gov/view/dot/32574>

The goal of this study is to scientifically assess the effectiveness of currently available work zone intrusion alert technologies and to provide recommendations for use of the technologies in future Oregon Department of Transportation construction and maintenance work zones. Researchers collected information about work zone intrusion alert technologies, gained experiential input and advice from Oregon Department of Transportation staff and industry practitioners, and tested technologies under controlled conditions and in active work zones. Findings indicate that aspects of intrusion alarms via visual, audio, and haptic means can be effective warning mechanisms in a work zone. This report identifies recommended minimum standards for each of the aforementioned means of alert.

85. Work Zone Intelligent Transportation Systems Peer Exchange

<http://www.ops.fhwa.dot.gov/wz/p2p/itswkshop052113/>

The purpose of this peer exchange was to bring together representatives from State departments of transportation, Federal Highway Administration, academia, and vendors to discuss work zone intelligent transportation systems challenges, barriers, and deployment successes. This peer exchange includes presentations and discussion sessions.

86. Work Zone Operations Best Practices Guidebook (Third Edition)

<http://ops.fhwa.dot.gov/wz/practices/best/documents/bpguidebook.pdf>

This guide provides an easily accessible compilation of work zone operations practices used and recommended by various States and localities around the country for effectively managing work zones and reducing the impacts of work zones on mobility and safety. The Third Edition includes updates made through ongoing cooperation between Federal Highway Administration and State agencies to keep pace with the evolving state of the practice.

Best Practices are organized into 11 focus area categories, and cross-referenced by six descriptive parameters that let users find best practices applicable to their own situation. A subject index offers over 50 topics and subtopics for more specific searches.

These best practices are provided as references, not requirements — they are descriptive, not prescriptive. They describe approaches that have been successfully used by transportation agencies, along with contact information to find out more from the agency using the practice. Each organization must determine which of these practices are best suited for its particular situation, considering all the site-specific factors that affect work zone operations, and apply at their own discretion.

87. Work Zone Positive Protection Toolbox

https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_wz_positive_guidance_toolbox/

This brochure highlights five positive protection countermeasures, including (1) portable concrete barriers, (2) movable concrete barriers, (3) ballast filled barriers, (4) shadow vehicles, and (5) vehicle arresting systems. The toolbox describes how to use each countermeasure. It also describes the various types of positive protection countermeasures currently in use and provides guidance on where and how each is typically used. This toolbox is intended to be a reference for designers, policy makers, specification writers, and field personnel.

88. Work Zone Process Review Toolbox

http://ops.fhwa.dot.gov/wz/prtoolbox/pr_toolbox.htm

Periodic evaluation of work zone policies and procedures and work zone impacts aids in the process of addressing and managing the safety and mobility impacts of work zones. Process reviews help agencies to assess the effectiveness of a program and/or a set of policies and procedures. They enable the agency and respective Federal Highway Administration Division Office to confirm that a problem does not exist, and to make recommendations to improve situations where shortcomings might exist. This toolbox contains tools to help you conduct an effective work zone process review. The first section of the toolbox has information to help you determine the purpose/goals and scope of a review, expected outcomes, team members, and possible data sources. This section also contains sets of potential questions that can be used to assess various work zone program areas while doing a work zone process review. The resources section provides information on training, and includes examples and tips that share what other peers have done. The frequently asked questions provides answers to some commonly-asked questions about work zone process reviews.

89. Work Zone Road Safety Audit Guidelines and Prompt Lists

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_wz_RSA_guide.pdf

This document provides a process to individuals or agencies for performing formal work zone safety examinations to improve the safety of workers and all roadway users. This document includes guidance on conducting Road Safety Audits at all phases of work zone planning, design and deployment, and considerations for each project phase. The guidelines and prompt lists explain the importance of the work zone Road Safety Audits and navigate the practitioner through the Road Safety Audits process.

90. Work Zone Road User Costs - Concepts and Applications

<http://www.ops.fhwa.dot.gov/wz/resources/publications/fhwahop12005/index.htm>

On-site construction activities can result in significant mobility and safety impacts to road users. The presence of work zone can also result in inconvenience to local business and community, noise and environmental impacts. Minimizing the adverse impacts of work zones has become a

higher priority especially since the inception of the Federal Highway Administration Rule on Work Zone Safety and Mobility (23 Code of Federal Regulations 630 Subpart J). Work zone road user costs provide the economic basis for quantifying these adverse impacts which can then be used for effective decision-making to improve work zone mobility and safety. This report provides practitioners with information on work zone road user cost analysis concepts and their applications using case studies drawn from real world projects.

Work zone road user costs primarily refers to monetized components of mobility and safety impacts; increasingly, non-monetary and qualitative components, such as environmental, business, and societal impacts, are being utilized. In this report, each of the monetary components is explored and the computations of these components are illustrated using examples. It presents step-by-step procedures to derive unit costs for monetary components. It lists the cost sources for each cost component as well as the ways to update those using economic indices. It also explores input requirements and various tools available for use in work zone road user cost analysis.

This report presents the application of both monetary and qualitative components of work zone road user cost in maintenance-of-traffic alternative analysis using a decision analysis framework. Another key application of work zone road user costs is in selecting appropriate project delivery/contracting strategies to minimize work zone road user costs and related impacts through early project completion. Approaches for determining an appropriate level of incentives and disincentives are also discussed. Three “real-world” case studies from the Federal Highway Administration’s Highways for LIFE program are presented to demonstrate the applications of work zone road user costs in selecting the preferred maintenance-of-traffic alternatives and project delivery/contracting strategies.

91. Work Zone Safety Data Collection and Analysis Guide

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_wz_safety_data_collection.pdf

This guide is designed to assist highway agencies in developing techniques and strategies to successfully collect and analyze work zone safety-related data to make work zones safer. The guide shares work zone safety-related data analysis methods that are effective in identifying problems, choosing safety strategies and developing work zone crash reduction programs. Methods that are currently being implemented in the United States are included in the guide to empower practitioners to effectively reduce work zone crashes, injuries, and fatalities.

92. Work Zone Safety Performance Measures Guidance Booklet

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/atssa_performance_measures_guide.pdf

This booklet introduces the concept of performance measures and performance data collection for work zone safety. It defines performance measures, discusses reasons for using performance measures for work zone safety, provides a process and test for developing good performance measures, provides sample performance measures, discusses defining how and when to measure

performance and what to do with the resulting data, and provides real-world lessons learned. The audiences for this fact sheet are planners, designers, construction engineers, and inspectors.

Podcasts

1. Americans with Disabilities Act Requirements for Accessibility in Temporary Traffic Control Zones

<https://www.workzonesafety.org/training/americans-with-disabilities-act-requirements-for-accessibility-in-temporary-traffic-control-zones/>

This podcast discusses designing and setting up solutions for temporary traffic control areas that meet the needs of disabled pedestrians and comply with Federal accessibility requirements under the Americans with Disabilities Act. The goal is to help listeners familiarize themselves with pedestrian accessibility considerations and to provide guidance on minimum parameters. This podcast is a companion to the document, “Applying the Americans with Disabilities Act in Work Zones: A Practitioner Guide,” which was also developed under the Work Zone Safety Grant. This document is available, along with an accompanying video, at workzonesafety.org. For a more extensive and detailed discussion on this topic, please review this companion document.

2. Automated Speed Enforcement in Work Zones

<https://www.workzonesafety.org/training/automated-speed-enforcement-in-work-zones/>

The purpose of this podcast is to help practitioners familiarize themselves with the types of automated speed enforcement currently used in work zones and to discuss considerations for those practitioners who are interested in learning more about these systems or are considering whether a new automated speed enforcement program is viable in their State or local jurisdiction.

3. Effective Practices for the Use of Portable Rumble Strips in Work Zones

<https://www.workzonesafety.org/training/podcast-12-wake-up-using-temporary-rumble-strips-in-work-zones-to-improve-driver-alertness/>

This podcast is an introduction to the concept of portable rumble strips and serves as a companion to the guidance document entitled “Guidance for the use of Temporary Rumble Strips in Work Zones.” The focus will be on how portable rumble strips are different from permanent rumble strips and how they are applied in work zones in a temporary capacity. This podcast will outline the benefits of portable rumble strips and how they can be an effective safety device and function as a work zone crash countermeasure. This podcast will highlight applications and best practices.

4. Lighting the Way to Safety: Warning Lights and Illumination for Vehicles, Traffic Control Devices, and the Work Area

<https://www.workzonesafety.org/training/podcast-10-lighting-the-way-to-safety-warning-lights-and-illumination-for-vehicles-traffic-control-devices-and-the-work-area/>

This podcast serves as a companion resource to the American Traffic Safety Services Association document “Nighttime Lighting Guidelines for Work Zones: A Guide for Developing

a Lighting Plan for Nighttime Work Zones.” The primary focus of this podcast is nighttime warning lights and work zone illumination, although some guidance is also applicable to daytime work zone warning lights as well. This podcast is presented in three parts: warning lights for work vehicles, warning lights for traffic control devices, and work area lighting.

5. Overview and Summary of the 2006 and 2011 Federal Highway Administration Work Zone Safety Grants

<https://www.workzonesafety.org/training/overview-and-summary-of-the-2006-and-2011-fhwa-work-zone-safety-grants/>

This podcast is intended to help practitioners familiarize themselves with the many guidance and training products developed, published, and taught with funding from the 2006 and 2011 Work Zone Safety Grants.

6. Portable Changeable Message Signs to Control Speeding in Work Zones

<https://www.workzonesafety.org/training/using-portable-changeable-message-signs-to-control-speeding-in-work-zones/>

The relatively large and conspicuous message displays of portable changeable message signs make them effective for providing work zone guidance and warning messages to drivers. This brief podcast looks at the important role portable changeable message signs can have in both active and passive speed control strategies within a work zone.

7. Proper Inspection of Temporary Traffic Control: Program, Process, and Projects

<https://www.workzonesafety.org/training/podcast-8-proper-inspection-of-temporary-traffic-control-program-process-and-projects/>

This podcast is a companion to the Safe and Effective Work Zone Inspections guidance document. Its purpose is to explain the importance of work zone inspections for saving lives, reducing cost, and protecting against liability. This podcast also introduces some of the elements necessary for a successful project-level work zone inspection.

8. Rolling Roadblocks for Work Zone Applications

<https://www.workzonesafety.org/training/rolling-roadblocks-for-work-zone-applications/>

This podcast has been designed to help work zone practitioners learn more about what a rolling roadblock is and how it can be used in a work zone environment to balance work zone safety with improved work zone mobility. It was developed as a companion to the “Guidelines on Rolling Roadblocks for Work Zone Applications,” along with a web-based training module of the same title.

9. Safety Considerations for Mobile Work Zone Operations

<https://www.workzonesafety.org/training/safety-considerations-for-mobile-work-zone-operations/>

This podcast has been designed to help work zone practitioners learn more about the differences between moving and intermittent operations and how to maintain a safe operation when conducting both types of work zone operation. Its purpose is to discuss the hazards, safety considerations, and strategies associated with mobile work zone operations using a conversational format.

10. Vehicle Lighting in Work Zones: Safety through Increased Visibility

<https://www.workzonesafety.org/training/podcast-10-lighting-the-way-to-safety-warning-lights-and-illumination-for-vehicles-traffic-control-devices-and-the-work-area/>

This podcast serves as a companion resource to the American Traffic Safety Services Association document “Nighttime Lighting Guidelines for Work Zones: A Guide for Developing a Lighting Plan for Nighttime Work Zones.” The primary focus of this podcast is nighttime warning lights and work zone illumination, although some guidance is also applicable to daytime work zone warning lights as well. The podcast is presented in three parts: warning lights for work vehicles, warning lights for traffic control devices, and work area lighting.

11. Wake Up! Using Temporary Rumble Strips in Work Zones to Improve Driver Alertness

<https://www.workzonesafety.org/training/podcast-12-wake-up-using-temporary-rumble-strips-in-work-zones-to-improve-driver-alertness/>

This podcast is an introduction to the concept of portable rumble strips and serves as a companion to the guidance document entitled “Guidance for the use of Temporary Rumble Strips in Work Zones.” The focus will be on how portable rumble strips are different from permanent rumble strips and how they are applied in work zones in a temporary capacity. This podcast will outline the benefits of portable rumble strips and how they can be an effective safety device and function as a work zone crash countermeasure. This podcast will highlight applications and best practices.

12. Work Zone Data Collection & Analysis: What, Why, and How

https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_wz_data_collection_pcast/

This podcast is based on work supported by the Federal Highway Administration under the 2011 Work Zone Safety Grant. It is the first of three segments on the topic of work zone data collection and analysis and will focus on collecting data in preparation for developing work zone strategies, designing a safe work zone, and creating an effective plan for managing traffic in and around work zones. This podcast is a companion to the “Work Zone Safety Data Collection and Analysis Guide,” which was also developed under the Work Zone Safety Grant. For a more extensive and detailed discussion on this topic, please review this companion document, which is

available at workzonesafety.org. In addition, throughout this podcast we will make reference to additional guidance and information resources. Links to these and other resources are listed in the script that accompanies this podcast.

13. Work Zone Hazard Assessment: Identifying and Maintaining the Work Zone Clear Zone

<https://www.workzonesafety.org/training/work-zone-hazard-assessment-identifying-and-maintaining-the-work-zone-clear-zone/>

This podcast is derived from the American Traffic Safety Services Association’s “Positive Protection Guidelines Training Module” and the Federal Highway Administration Work Zone Safety Grant-sponsored “Traffic Control Design Specialist” training course. It has been designed to help work zone practitioners learn more about what the work zone clear zone is, what it does, and why it’s important for both worker and road user safety. This podcast also identifies potential hazards that may exist in the work zone clear zone and outlines best practices for treatment.

14. Work Zone Road Safety Audits: Teaming up To Improve Safety

<https://www.workzonesafety.org/training/podcast-11-work-zone-road-safety-audits-teaming-up-to-improve-safety/>

This podcast is an introduction to the concept of a work zone road safety audit and serves as a companion to the guidance document entitled “Work Zone Road Safety Audit Guidelines and Prompt Lists.” The focus will be on how RSAs are different from inspections, which seems to be a common question among practitioners. It will outline the benefits of RSAs at the various stages of construction and will highlight project characteristics that make a project a good candidate for a work zone RSA. This podcast will highlight the main functions of RSAs and note any data we have on where they have been used effectively to improve WZ safety.

Field Guidelines

1. Electrical Hazards Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-electrical-hazards-toolbox-pamphlet/>

The Electrical Hazards toolbox pamphlet covers explosion, fire and electrocution. Also presented are basic safe practices around above-ground and buried lines and what to do if contact happens.

2. Emergencies Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-emergencies-toolbox-pamphlet/>

The Emergencies toolbox pamphlet presents common examples of work zone emergencies, the steps to take during and after an emergency, and how to prepare for an emergency.

3. Excavation Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-excavation-toolbox-pamphlet/>

The Excavation toolbox pamphlet defines “trench” and explains why trenches are dangerous. Cave-in preventions and utility contact are presented. Duties of the competent person are also detailed.

4. Fall Hazards Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-fall-hazards-toolbox-pamphlet/>

The Fall Hazards toolbox pamphlet quantifies the problem of falls in road work and then details where falls happen. Special emphasis is given to falls from elevations, falls from equipment and falls on the same level.

5. Fall Prevention Fact Sheets

<https://www.workzonesafety.org/training-resources/fall-prevention-fact-sheets/>

This item includes the following fact sheets on fall prevention developed by American Road and Transportation Builders Association Work Zone Safety Consortium:

- [Fall Protection for Bridge Contractors in 4 Main Steps](#)
- [Employee Fall Protection Training Record](#)
- [Sample Fall Protection Plan for Bridge Work](#)
- [Fall Protection Systems for Bridge Work](#)
- [Horizontal Lifelines in Bridge Construction, Inspection, and Maintenance](#)
- [Selecting Lanyards and Connectors for Personal Fall Arrest Systems in Bridge Work](#)
- [Occupational Safety and Health Administration Fall Protection Standards Bridge Contractors Must Know](#)
- [Sample Fall Rescue Plan for Bridge Work](#)
- [Guide to Selecting Fall Protection Systems for Bridge Work](#)
- [Advantages of Self Retracting Lifelines for Bridge Work](#)
- [Preventing Suspension Trauma](#)
- [Preventing Swing Falls in Bridge Work](#)
- [Suspension Trauma Medical Emergency Wallet Card](#)
- [Technical Advice: Fall Protection in Bridge Construction, Inspection, and Maintenance](#)

6. Field Guide for the Use and Placement of Shadow Vehicles in Work Zones

<https://www.workzonesafety.org/publication/field-guide-for-the-use-and-placement-of-shadow-vehicles-in-work-zones/>

This 4-inch by 6-inch, easy-to-carry field guide provides guidelines on the use of shadow vehicles in highway work zones. It summarizes information from various sources into an easy-to-use, compact format for use when considering placement of shadow vehicles in advance of workers, equipment, or work vehicles. This guide is designed for use by traffic control

supervisors and other contractor field staff and provides easy access to information from multiple sources. It will also be helpful for highway agency staff in developing procedures and standards for shadow vehicle use.

7. Field Guide on Installation and Removal of Temporary Traffic Control for Safe Maintenance and Work Zone Operations

<https://www.workzonesafety.org/publication/field-guide-on-installation-and-removal-of-temporary-traffic-control-for-safe-maintenance-and-work-zone-operations/>

This 4-inch by 6-inch pocket guide illustrates the proper setup and takedown procedures for temporary traffic control devices and is designed to highlight common sense steps for maintaining a safe environment through a “safety first” attitude. Contractors, field personnel, traffic control services firms, construction supervisors, inspectors, and law enforcement will find this product particularly useful.

8. Flagger Safety Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-flagger-safety-toolbox-pamphlet/>

This pamphlet quantifies risk for flaggers, presents an interactive stopping distance demo, describes proper clothing, lists best practices, and warns of behaviors to avoid.

9. Guidance: Hazard Communications and the Globally Harmonized System of Classification and Labeling

<https://www.workzonesafety.org/publication/guidance-hazard-communications-and-the-globally-harmonized-system-of-classification-and-labeling/>

This document summarizes available guidance on the revised Hazard Communication Standard, known as HCS 2012, that aligns with the United Nations’ Globally Harmonized System of Classification and Labeling of Chemicals. The purpose of this document is to help companies, managers, and supervisors in the road building industry understand the HCS 2012 requirements and to provide guidance on meeting those requirements.

10. Guidance: Use of Work Zone Clear Zones, Buffer Spaces, and Positive Protection Deflection Distances

<https://www.workzonesafety.org/publication/guidance-use-of-work-zone-clear-zones-buffer-spaces-and-positive-protection-deflection-distances/>

This document summarizes available guidance on the use of work zone clear zones, buffer spaces, and positive protection deflection distances. The purpose of this document is to help work zone designers and workers understand the role of separation distances and positive protection device deflection distances in safety for workers and motorists and how properly to install, maintain, and use these methods in various types of work zones. The document is organized into the following sections: Introduction, Types of Separation Distances, Clear Zones-Buffer Spaces, How Large Should Clear Zones and Buffer Spaces Be, Clear Zones and Lateral

Buffer Spaces Without Positive Protection, Lateral Buffer Spaces When Barrier Are Used, and Longitudinal Buffer Spaces-Buffer Spaces for Short-Duration Maintenance Work Zones.

11. Health Hazards Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-health-hazards-toolbox-pamphlet/>

This pamphlet explains routes of entry and acute and chronic effects. It focuses on silica, asphalt, wet concrete, lead and other health hazards.

12. High-Visibility Apparel in Work Zones – Characteristics of High-Visibility Safety Apparel

<https://www.workzonesafety.org/publication/high-visibility-apparel-in-work-zones-characteristics-of-high-visibility-safety-apparel/>

This field guide provides contractors, field personnel, inspectors, and transportation agency construction engineers with guidance on characteristics of high-visibility safety apparel. This easy-to-use field reference outlines different apparel and the appropriate situations where each type of apparel is required or recommended.

13. Highway Work Zone Safety Checklist

<https://pubs.lhsfna.org/index.cfm?method=product.showTopicItem&topicID=27&productID=5135>

This pocket-sized guide to highway work zone safety includes seven checklists covering the major hazards in highway work as well as information on traffic control and flagging procedures.

14. Maintenance Work Zone Safety: Pocket Guide of Manual on Uniform Traffic Control Devices Guidance on Temporary Traffic Control

<https://www.workzonesafety.org/publication/maintenance-work-zone-safety-pocket-guide-of-mutcd-guidance-on-temporary-traffic-control/>

This 4-inch by 6-inch reference guide provides information on the typical applications that apply to short-term and mobile operations for maintenance, providing useful graphics and detailed descriptions of the applications. This product will be useful for maintenance crews, utility crews, construction inspectors, construction personnel, survey crews, and State and local agency staff who will be in or near highway rights of way.

15. Night Work Flagging Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-night-work-flagging-toolbox-pamphlet/>

This pamphlet explains how night flagging differs from daytime flagging and shows night flagging applications. It includes proper illumination of a flagger.

16. Night Work High-Visibility Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-night-work-high-visibility-toolbox-pamphlet/>

This pamphlet defines the characteristics of “high visibility” and details American National Standards Institute requirements for Class 1, 2 and 3 garments. It includes garment inspection and vehicle visibility.

17. Night Work Risks Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-night-work-risks-toolbox-pamphlet/>

This pamphlet presents the many hazards of night work, discusses nighttime temporary traffic control, reviews safety enhancements including high visibility clothing, recommends best practices, and gives tips for minimizing sleep loss.

18. Night Work Temporary Lighting Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-night-work-temporary-lighting-toolbox-pamphlet/>

This pamphlet covers the goals of temporary lighting and emphasizes illumination of work, control of glare and minimization of shadows. It details how to set up temporary lighting and includes equipment-mounted and balloon lights.

19. Noise Hazards Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-noise-hazards-toolbox-pamphlet/>

This pamphlet presents the dangers of noise including distraction and hearing damage. Noise sources are listed. Protections are presented including PPE.

20. Operator Safety Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-operator-safety-toolbox-pamphlet/>

This pamphlet reviews safe practices for equipment operation and entering/exiting equipment. It covers general safety such as personal protective equipment, cell phone avoidance, and lockout/tagout. This pamphlet emphasizes work zone awareness and methods for protecting workers on foot.

21. Pedestrian Accommodation in Work Zones: A Field Guide

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/artba_pedestrian_accommodation_wz.pdf

This guide identifies common issues adversely affecting pedestrians that field personnel should be regularly checking for and correcting when working on or near sidewalks or walking paths. These issues are categorized according to the type of pedestrian accommodation that the work activity requires:

- Working near the sidewalk or walking path, but the sidewalk/path remains open.
- Diversion of sidewalk or path around the work space.
- Sidewalk or path is temporarily closed, pedestrians detoured to an alternate existing sidewalk or path.

A number of resources are available that describe how to properly design and implement these accommodations and are referenced at the end of this guide.

22. Preventing Intrusions into Highway Work Zones

<https://pubs.lhsfna.org/index.cfm?method=product.showItem&categoryID=7&productID=5247>

This tri-fold pamphlet explains steps employers can take to protect workers in highway work zones.

23. Runovers/Backovers Toolbox Pamphlet for Agency/Owners

<https://www.workzonesafety.org/publication/rsp-runoversbackovers-toolbox-pamphlet-for-agencyowners/>

This pamphlet presents traffic monitoring and management systems, Intelligent Transportation System technologies, positive separation, and regulatory or program controls.

24. Runovers/Backovers Toolbox Pamphlet for All Workers

<https://www.workzonesafety.org/publication/rsp-runoversbackovers-toolbox-pamphlet-for-all-workers/>

This pamphlet defines runovers and backovers and quantifies the scope of the problem. It makes workers aware of the specific hazards and how to avoid them, including what to wear, where to be, how to communicate, and how to place traffic control devices.

25. Runovers/Backovers Toolbox Pamphlet for Contractors

<https://www.workzonesafety.org/publication/rsp-runoversbackovers-toolbox-pamphlet-for-contractors/>

This pamphlet reviews proper temporary traffic control device set up, protective clothing, positive separation, access/egress, internal traffic control plans, prevention devices such as back up alarms, and best practices for supervisors.

26. Runovers/Backovers Toolbox Pamphlet for Operators/Drivers

<https://www.workzonesafety.org/publication/rsp-runoversbackovers-toolbox-pamphlet-for-operatorsdrivers/>

The pamphlet focuses on the Internal traffic control plan and on protections such as back up alarms, video cameras, radar and spotters.

27. Safe Driving Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-safe-driving-toolbox-pamphlet/>

This pamphlet provides safe driving tips for traveling to and from the work zone.

28. Safety Concepts for Workers from an Occupational Safety and Health Administration Perspective

<https://doi.org/10.13023/KTC.RR.2017.14>

To help the Kentucky Transportation Cabinet improve employee safety, researchers at the Kentucky Transportation Center analyzed the frequency and causes of workplace injuries for 10 essential Cabinet maintenance operations. Most incidents were attributable to human factors or ergonomics. Based on this analysis, the leading causes of incidents, and a review of best practices related to workplace safety, Kentucky Transportation Center designed and built a pre-task safety tool applicable to the 10 Kentucky Transportation Cabinet maintenance operations. Developed in Microsoft Excel, the tool addresses the most frequent hazards encountered on jobs sites, and can potentially be expanded to encompass all maintenance operations (once sufficient data are available). The tool contains three sections: 1) an introductory sheet with user instructions; 2) statistical summaries of previous injuries suffered by Kentucky Transportation Cabinet maintenance workers for each operation; and 3) examples of incidents that have resulted from each of the most frequent causes of injury and recommended safety practices to minimize or eliminate potential hazards.

29. Sprains and Strains Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-sprains-and-strains-toolbox-pamphlet/>

This pamphlet presents common types of injuries and quantifies the problem before then explaining the causes. Prevention methods are detailed.

30. Struck or Crushed Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-struck-or-crush-toolbox-pamphlet/>

This pamphlet is a short introduction to the specific ways in road workers are struck or crushed, the causes of these events, and how to control tools/particles, loads/materials and trees/bushes.

31. Student Work Safety Guidelines in Roadside Applications and Work Zones Safety Guidelines for Transportation Researchers

http://www.oregon.gov/ODOT/Programs/ResearchDocuments/304-731_Student_Safety_Guidelines.pdf

This document provides a resource for safety training to student research assistants and other personnel who conduct research on roadways near or in traffic. It is designed to accompany the video titled “Goal One: A Safe Return Each and Every Day.” After reading the manual and watching the video, student researchers will: (1) understand the likely hazards present in roadway work areas; (2) know how to prepare for working on roadway work sites; and (3) know

how to conduct their work on roadways safely. Departments of transportation and universities are encouraged to use the manual for training students on how to work safely on roadways when performing research.

32. Temporary Traffic Control Devices Trainee Booklet

<https://www.workzonesafety.org/publication/rsp-temporary-traffic-control-devices-trainee-booklet/>

This booklet explains how workers and motorists can be harmed during set up, removal, and use of temporary traffic control devices. It describes safe equipment and work practices and closes with best practices for contractors.

33. Toolbox Talk # 1: Electrical Safety

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk1.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

34. Toolbox Talk # 2: How Can We Prevent Electrocutions While Using Power Tools?

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk2.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

35. Toolbox Talk # 3: Be Aware of the Power Lines Where You Live and Work

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk3.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

36. Toolbox Talk # 4: Electrical Safety and First Aid Assistance

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk4.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

37. Toolbox Talk # 5: Working Near High Voltage Energized Electrical Lines

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk5.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

38. Toolbox Talk # 6: Precautions When Using Extension Cords

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk6.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

39. Toolbox Talk # 7: Arc Flash Protection and Considerations

https://www.workzonesafety.org/files/documents/training/toolbox_talks/osha_focus_4/electrical_toolbox_talk7.pdf

Developed under the Occupational Safety and Health Administration's Focus 4 campaign.

40. Treating Potential Back-of-Queue Safety Hazards

<https://www.workzonesafety.org/publication/treating-potential-back-of-queue-safety-hazards/>

This fact sheet is designed to highlight common pitfalls in estimating potential impacts that can result from implementing a traffic control plan as well as strategies that can help reduce work zone congestion and back-of-queue crash risk. Planners, designers, construction engineers, and inspectors are the intended audience for this product.

41. Work Zone Road Safety Audits: Common Items of Note

https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_wz_audits/

This fact sheet is designed to be an easy to read guideline on the main aspects of a safety audit. Essentially it points out all of the most common items that should be immediately addressed upon entering a safety work zone area.

42. Work Zone Safety: Temporary Traffic Control for Maintenance Operations

<https://www.workzonesafety.org/publication/work-zone-safety-temporary-traffic-control-for-maintenance-operations/>

This tri-fold brochure provides highlights from the "Pocket Guide of the Manual on Uniform Traffic Control Devices Guidance on Temporary Traffic Control." The audience for this brochure consists of contractors, field personnel, traffic control services firms, supervisors, inspectors, and law enforcement personnel.

43. Work Zone Worker Protection Field Guide

<https://www.workzonesafety.org/publication/work-zone-worker-protection-field-guide/>

The purpose of this field guide is to discuss highway worker safety considerations and provide practical how-to information to help workers improve their safety in a variety of commonly encountered situations. This handy reference presents information on the options available to workers on highway construction sites.

44. Working Outdoors Toolbox Pamphlet

<https://www.workzonesafety.org/publication/rsp-working-outdoors-toolbox-pamphlet/>

The Working Outdoors toolbox pamphlet covers the hazards of sun exposure. It addresses heat stress, heat exhaustion, heat stroke, cold stress, hypothermia, and frost bite – including symptoms and treatment. It includes hazardous plants and animals.

Training – Instructor-Led

1. Advanced Work Zone Management and Design

<https://www.workzonesafety.org/training/advanced-work-zone-management-and-design/>

This course provides participants with advanced levels of knowledge and competencies with technical and non-technical aspects of work zone traffic control practices including work zone planning, design, project management, and contract issues. The course is designed to provide maximum flexibility by including core, recommended, and optional lessons. Each participant receives a copy of the “Advanced Work Zone Management and Design” reference manual and a participant workbook that contains all lesson materials.

2. Construction Zone Safety Inspection

<https://www.workzonesafety.org/training/construction-zone-safety-inspection-1-day/>

This course provides training in the management of traffic control plans and the inspection of construction zone safety devices. Participants receive instruction in traffic control plan review, inspection of traffic control procedures and safety devices, and the resolution of discrepancies from the traffic control plan, as well as on deficiencies in safety hardware maintenance. The following major topics are covered: Inspection of traffic control plan operation, maintenance of work zone signs and markings, inspection of construction safety hardware, and resolution of discrepancies from contract requirements.

3. Designing Temporary Traffic Control Zones for Pedestrian Accessibility.

<http://www.atssa.com/WorkZoneSafetyGrant/GrantCourses>

One-day instructor-led course intended to make participants aware of the pedestrian accessibility requirements of the American with Disabilities Act and their applicability to highway work zones. The course will focus on practical solutions to real-world situations. This course is intended for both designers and field personnel. Upon completion of this course, participants will be able to:

1. Identify applicable laws, regulations, guidelines, and standards pertaining to accessibility for persons with disabilities.
2. Discuss their application in temporary traffic control zones.
3. Identify some of the challenges in the public right-of-way faced by persons with disabilities.
4. Review design elements necessary for achieving accessibility in the public right-of-way.

5. Identify contractors' best practices and provide real-world examples under various conditions

4. Developing and Implementing Successful Transportation Management Plans

<http://www.atssa.com/WorkZoneSafetyGrant/GrantCourses>

This one-day training course is intended to assist transportation agencies in understanding and developing an effective and complete work zone transportation management plan. Topics discussed in this course include the work zone safety and mobility rule, the content of a transportation management plan, roles and responsibilities, work zone impacts assessment, selecting transportation management plan strategies, and transportation management plan implementation. The course includes exercises to help students apply the concepts learned throughout the course. This course is intended for transportation agency staff, including technical staff (planners, designers, traffic engineers, highway/safety engineers, construction, 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.

5. Flagger Instructor Training

<https://www.workzonesafety.org/training/flagger-instructor-training-course-grant-fit/>

Participants in this training will discuss the basic training skills necessary to effectively present the American Traffic Safety Services Association's Flaggers Course and discuss proper flagging techniques.

6. Improving Large Truck Safety through the Design and Operation of Work Zones

https://artba.adobeconnect.com/_a843172164/p17aj6brj98/?launcher=false&fcsContent=true&pbMode=normal

Work zones can create special challenges for drivers of large vehicles, such as commercial motor vehicles, due to space restrictions. Road work must take place within highway rights-of-way and, often, within reduced numbers of lanes. Understanding how work zones can be designed to maintain the efficient movement of large freight transportation vehicles within the restricted right-of-way space and to ensure that State transportation agency and public works staff and highway contractors' employees can safely work within work zones can provide significant benefits for all work zone users.

7. Maintenance and Short Duration Activities

<https://www.workzonesafety.org/training/temporary-traffic-control-during-maintenance-and-short-duration-activities-msda/>

After completing this course, students should know:

- Basic standards and guidelines that govern temporary traffic control during maintenance and short duration activities.

- How to apply these in the installation and maintenance of traffic control devices during maintenance and short duration activities.
- How to make maintenance and short duration activities safer for workers and road users.

8. Minimizing Worker Exposure in Highway Work Zones Through the Use of Positive Protection and Other Strategies

<http://www.atssa.com/WorkZoneSafetyGrant/GrantCourses>

This two-day course covers issues related to the application of positive protection devices in highway work zones, including a review of standards and specific guidance on when and where to use positive protection devices. This course is intended for highway agency decision makers that would take it and develop their own individual policies and practices to make design decisions for implementation in field as well as traffic control supervisors and other contractor field staff. It is also intended for use by highway agency staff to develop procedures and standards for shadow vehicle use. Upon completion of this course, participants will be able to:

1. Identify the different types of positive protection devices and their features.
2. Recognize design principles and concepts and how they relate to potential field issues.
3. Identify the characteristics of projects that are most suited for consideration of positive protection devices.
4. Recognize the components of the Work Zone Rule (Subpart K).
5. Understand how installation and removal of positive protection devices affects constructability and safety.
6. Use an assessment tool to provide insights into whether positive protection should or should not be used.
7. Describe alternative exposure control methods.

9. NHI Course: Construction Zone Safety Inspection

https://www.nhi.fhwa.dot.gov/course-search?tab=0&sf=0&course_no=133114A

This course provides training in the management of traffic control plans and the inspection of construction zone safety devices. Participants receive instruction in traffic control plan review, inspection of traffic control procedures and safety devices, and the resolution of discrepancies from the traffic control plan, as well as on deficiencies in safety hardware maintenance. The following major topics are covered: Inspection of traffic control plan operation, maintenance of work zone signs and markings, inspection of construction safety hardware, and resolution of discrepancies from contract requirements.

10. Occupational Safety and Health Administration 10-Hour Training for Roadway Construction

<https://www.workzonesafety.org/training/osha-10-hour-training-exclusively-for-the-roadway-construction-industry/>

This revolutionary program for owners, safety managers, supervisors, and workers is focused directly on the hazards and situations that roadway construction workers face every day. From work zones to night work, this training sets the standard for the entire industry. This course

addresses 12 key construction work zone related safety and health topics: introduction to the Occupational Safety and Health Administration; electrical safety; roadway work zones; excavations and trenching; personal protective equipment; confined spaces; night work; fall prevention & protection; mechanized equipment; occupational health; collisions; and management commitment.

11. Preventing Runovers and Backovers

<https://www.artba.org/artbamembers/get-involved/request-safety-training/>

This 3-hour course is sponsored by the Occupational Safety and Health Administration, and helps to reduce fatalities and accidents in the roadway construction industry by separating trucks and heavy machines from workers on foot in the work zone and creating an internal traffic control plan. Attendee surveys show that this course substantially improves organization and safety behavior in the work zone. No less than 20 and no more than 40 students are allowed per class.

12. Roadway Safety Plus How-To Video

<https://www.workzonesafety.org/training/roadway-safety-plus-how-to-video/>

A brief video tour with specific navigation instructions for the Roadway Safety Plus Macromedia Instructor Presentation Program.

13. Safe and Effective Use of Law Enforcement Personnel in Work Zones

<https://www.workzonesafety.org/publication/safe-and-effective-work-zone-inspections-2013/>

The document examines program elements, operational improvements, and the value of documentation behind the development of a comprehensive work zone traffic control inspection program. The document is intended for use as a gauge or completeness for agencies with programs in place or as a roadmap for establishing a program if one does not presently exist.

14. Safe Backing and Spotting

<https://www.artba.org/artbamembers/get-involved/request-safety-training/>

This 4 hour certificate program is focused on training workers to avoid dangerous traffic areas on roadway construction sites, to recognize hazards surrounding equipment, and to provide clear communication between drivers/operators and spotters through the use of standardized signals and communication.

15. Smarter Work Zone Intelligent Transportation Systems

www.atssa.com/WorkZoneSafetyGrant

Smarter Work Zones is an Federal Highway Administration Every Day Counts initiative that is assisting State transportation agencies in effectively managing traffic during construction. The Smarter Work Zones initiative involves both enhanced project coordination as well as the use of work zone intelligent transportation systems. By coordinating across agencies, combining

projects, and effectively planning for minimal impacts from utility work and right-of-way acquisition, stakeholders can improve performance. This course is intended for transportation agency staff, including technical staff (planners, designers, traffic engineers, highway/safety engineers, construction, 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 for the use of intelligent transportation systems and project coordination. Upon completion of this course, participants will be able to:

1. Define Smarter Work Zones.
2. Understand technology and the use of intelligent transportation systems to support effective work zone management and operations.
3. Discuss the Work Zone Intelligent Transportation Systems Implementation Guide.
4. Provide a comprehensive overview of corridor and project work zone coordination.

16. Strategies for Developing Work Zone Traffic Analyses

https://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&key=Conducting+Effective+Work+Zone+Process+Reviews&sf=0&course_no=133109

This one-day instructor-led course uses lecture and small-group collaborative exercises to educate participants on how to develop effective transportation modeling strategies to support work zone-related decision-making. The course is designed to instruct users on characterizing a work zone with respect to a prospective analysis, classes of analytical tools and their capabilities within the context of work zones, and selecting an appropriate transportation modeling approach maximizing insight into potential impacts and mitigating technical risk. The course educates participants on the constraints and opportunities inherent in work zone analysis associated with available transportation modeling tools. It also builds familiarity with the various factors influencing the development of a transportation analysis plan. Finally, it provides the participants with practical experience in developing analysis plans in a collaborative process taking into account work zone characteristics, performance measurement, technical risk assessment and resource constraints.

17. Strategies to Enhance Large Truck Safety in Work Zones (Webinar)

<https://www.workzonesafety.org/training/strategies-to-enhance-large-truck-safety-in-work-zones/>

The webinar presented how various Federal agencies—including the Federal Highway Administration, Federal Motor Carrier Safety Administration, and National Highway Traffic Safety Administration, were trying to increase safety and mobility for large trucks in work zones. Each agency provided an overview of their program’s initiatives to tackle this important issue. Additionally, other stakeholders highlighted their local efforts in Iowa, Alabama, and Vermont to increase safety and mobility. Iowa deployed a vehicle entering warning system that detects construction tractor-trailer units hauling materials out of the median of the work zone and alerts motorists when trucks are entering the highway. In Vermont, the commercial vehicle enforcement section was working with other State agencies, private contractors and the motoring public to address work zone safety concerns in their State. In Alabama, they were working on

several projects for the Alabama Work Zone Notification System and this presentation described the goals, objectives, areas of concern and how they plan to measure user behavior.

18. Temporary Traffic Control Considerations for Urban Work Zones

<https://www.workzonesafety.org/training/temporary-traffic-control-considerations-for-urban-work-zones-grant-course/>

This course addresses work zones in more populated and congested areas, particularly the considerations (substantive safety) necessary to address work zones in urban environments. These environments may involve restricted spaces, parking issues, limited sight distance, business access, pedestrian, Americans with Disabilities Act requirements, and bicyclist considerations. This course addresses instances when standards cannot be met and how to address these situations on urban streets.

19. Temporary Traffic Control Design Specialist (For Traffic Control Supervisors)

<https://www.workzonesafety.org/training/temporary-traffic-control-design-specialist-for-traffic-control-supervisors>

After completing this course, students should be able to:

- Recognize the design elements of work zone traffic control.
- Apply these to real-world scenarios.
- Design basic traffic control plans.
- Know techniques and procedures for designing effective, efficient and safe traffic control plans.

20. Traffic Control Design Specialist

<http://www.atssa.com/WorkZoneSafetyGrant>

This one- or two-day course addresses the entire process for designing, installing, maintaining, and evaluating temporary traffic control in work zones. Topics include: applicable standards and guidelines, fundamental principles of temporary traffic control, human factors, component parts of a traffic control zone, traffic control devices, constructability, and development of a transportation management plan. Students will breakout into small groups for hands-on exercises. Certification is also available for this course. This course is intended for traffic engineers, engineering technicians, consultants, and other individuals responsible for traffic control plan approval. Please note that this course does not grant authority to individuals to approve design plans. Upon completion of this course, participants will be able to:

1. Understand the engineering concepts necessary to properly design effective traffic control plans.
2. Understand the fundamental principles of temporary traffic control needed to make discretionary decisions and adjustments.
3. Cite the sources of standards, guidelines, and specifications governing the design of traffic control plans.

4. Design traffic control plans that would facilitate the inspection and maintenance functions of the traffic control systems.
5. Know the proper processes and procedures for making traffic control plan adjustments, disposition of actions generated, and their legal implications.

(Note: The one-day course requires successful completion of the Traffic Control Supervisor course, while the two-day course provides more comprehensive traffic control supervisor information and does not require any pre-requisites.)

21. Traffic Control Supervisor

<https://www.workzonesafety.org/training/traffic-control-supervisor-tcs/>

This course is designed to train those who will be actively involved in designing or setting up and maintaining temporary traffic control in a work zone. It moves from the concepts and techniques taught in the Traffic Control Technician course to the implementation of traffic control plans and techniques for installation and removal. Students are taught how to read and interpret plans and specifications and implement them in the field. Workshops included in the course are designed to provide real world examples in designing temporary traffic control setups and also recognizing, analyzing and correcting deficiencies. An additional, vital objective of this course is teaching students the skills necessary to become an effective supervisor, capable of leading a team in the field.

22. Traffic Control Technician

<https://www.workzonesafety.org/training/traffic-control-technician-grant-tct/>

After completion, students should know:

- Basic temporary traffic control standards/guidelines applicable in roadway work zones.
- Workable concepts, techniques and practices in the installation & maintenance of temporary traffic control devices.
- How to make the temporary traffic control areas safer for workers, motorists, bicyclists, and pedestrians.

23. Urban Work Zone Design

<https://www.workzonesafety.org/training/urban-work-zone-design-grant-course/>

Review temporary traffic control standards and guidelines and discuss issues and considerations related to the application (design) of those standards and guidelines in urban areas.

24. Utility Traffic Control

<https://www.workzonesafety.org/training/utility-traffic-control/>

After completing this course, students should be able to:

- Apply workable concepts, techniques and practices in the installation and maintenance of temporary traffic control during utility operations.

- Make utility operations safer for workers, motorists and pedestrians.

25. Work Zone Safety and Mobility Peer-to-Peer Program

<https://ops.fhwa.dot.gov/wz/p2p/index.htm>

The Work Zone Safety and Mobility Peer-to-Peer Program can provide short-term assistance to agencies interested in the application of methods, tools, and strategies to improve work zone safety and mobility. The Work Zone Safety and Mobility Peer-to-Peer Program provides State and Local transportation agencies easy access to knowledgeable peers across a range of work zone issues, at no cost to these agencies. Assistance is available from practitioners who have expertise in work zone topic areas and have lessons learned and success stories to share from their own experiences. This assistance will in turn help agencies and the traveling public realize the benefits of improved safety and mobility in and around work zones.

26. Work Zone Strategies

<https://www.workzonesafety.org/training/work-zone-strategies-grant-course/>

After completing this course, students should be able to: discuss various strategies available to work zone designers, to provide guidance to help you identify, evaluate and select work zone strategies, and discuss strategies as related to transportation management plans.

27. Work Zone Traffic Impact Analysis

<https://www.workzonesafety.org/training/work-zone-traffic-impact-analysis-grant-course/>

After completing this course, students should be able to:

- To provide guidance to agencies and/or individuals considering work zone traffic impact analysis.
- To provide a broad, fundamental understanding of how analytical tools can be used to support work zone traffic impact analysis.
- To list and discuss some available tools for work zone impact analysis, including: strengths, weaknesses, and level of detail.

28. Work Zone Traffic Management Analysis Using Analytical Methods

Course materials:

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/Work_Zone_Traffic_Management_Analysis.zip

Registration for in-person training: <https://publish.illinois.edu/workzone-traffic-management/register-now/>

The course provides hands-on training on basic analytical methods (sketch planning methods) to compute work zone performance measures. The work zone performance measures includes the following factors: capacity, speed, queue length, delay, and users' costs. The capabilities and limitations of the analytical tools are discussed and basic guidance on how to use them is

presented. The course is composed of 5 main modules. It covers stopped and moving queues in work zones. Module 1 briefly reviews the necessary background material for this course. It presents basic principles of traffic flow in work zones, transportation management plans, and other topics. Module 3 discusses the work zone capacity estimation procedures in the recently published Highway Capacity Manual (2016). Module 2 and 4 cover two (or three) different analytical methods and step-by-step procedure for computing work zone performance measures. Module 5 discusses how to select and use the appropriate methods to evaluate various traffic management strategies in their impacts work zone performance measures.

Training – Web-Based

1. 2009 Manual on Uniform Traffic Control Devices Compliance Dates and Definition of Standard Statements

<https://www.workzonesafety.org/training/2009-mutcd-compliance-dates-and-definition-of-standard-statements/>

On September 27, 2011, Hari Kalla of the Federal Highway Administration discussed the two proposed rules that are currently open for public comments. He provided information on the proposed rule on the definition of standard statements, the use of engineering judgment, and the proposed rule on Manual on Uniform Traffic Control Devices compliance dates.

2. A Tutorial on Establishing Effective Work Zone Performance Measures Webinar (regarding Primer)

<https://www.workzonesafety.org/training/a-tutorial-on-establishing-effective-work-zone-performance-measures/>

Held on October 27, 2011, this webinar introduced the participant to the reasons that work zone performance measures should be established, describe a general process that agencies can follow to establish work zone performance measures that are useful to them, and provide several examples of how agencies can start computing work zone performance measures from the data they may have available or can easily collect.

3. Americans with Disabilities Act Requirements for Accessibility in Temporary Traffic Control Zones

<https://www.workzonesafety.org/training/americans-with-disabilities-act-requirements-for-accessibility-in-temporary-traffic-control-zones/>

This podcast discusses designing and setting up solutions for temporary traffic control areas that meet the needs of disabled pedestrians and comply with Federal accessibility requirements under the Americans with Disabilities Act. The goal is to help listeners familiarize themselves with pedestrian accessibility considerations and to provide guidance on minimum parameters. This podcast is a companion to the document, “Applying the Americans with Disabilities Act in Work Zones: A Practitioner Guide,” which was also developed under the Work Zone Safety Grant. This document is available, along with an accompanying video, at workzonesafety.org. For a more extensive and detailed discussion on this topic, please review this companion document.

4. Anatomy of a Work Zone, Safety and Liability Exposure in Improperly Prepared Work Zones Webinar

<https://www.workzonesafety.org/training/anatomy-of-a-work-zone-safety-and-liability-exposure-in-improperly-prepared-work-zones-webinar/>

On March 24, 2009 Speaker Scott Wolf of Dicke Safety Products presented on a case study of an actual crash and resulting law suit involving a temporary utility work zone on a low volume/low speed road. What was done and what should have been done according to the current Manual on Uniform Traffic Control Devices were examined. Lessons learned from the resulting liabilities and the other outcomes in the case were also discussed.

5. Automated Speed Enforcement in Work Zones

<https://www.workzonesafety.org/training/automated-speed-enforcement-in-work-zones/>

The purpose of this podcast is to help practitioners familiarize themselves with the types of automated speed enforcement currently used in work zones and to discuss considerations for those practitioners who are interested in learning more about these systems or are considering whether a new automated speed enforcement program is viable in their State or local jurisdiction.

6. Complying with the New FHWA Regulations on High Visibility Garments Webinar

<https://www.workzonesafety.org/training/complying-with-the-new-fhwa-regulation-on-high-visibility-garments-webinar/>

On September 4, 2008, over 1,500 viewers logged on live to gain insight to the new Federal Highway Administration regulation that takes effect November 24, 2008. During this hour long session Speakers Hari Kalla, Manual on Uniform Traffic Control Devices Team Leader for the Federal Highway Administration's Office of Operations and Janice Bradley, Technical Director of the International Safety Equipment Association gave crucial information for understanding this new standard that requires the use of high visibility clothing (as defined by the American National Standards Institute/ International Safety Equipment Association 107 standard) when working in the right-of-way on Federal-aid highways. If you were unable to attend or would like to review the presentation and video, these are now available online for viewing at any time.

7. Developing Successful Transportation Management Plans for Work Zones

<https://www.workzonesafety.org/training/developing-successful-transportation-management-plans-for-work-zones/>

The Wisconsin Department of Transportation, Rhode Island Department of Transportation, and Michigan Department of Transportation have developed hundreds of transportation management plans and recognized benefits from doing so. This webinar includes presentations from those three State departments of transportation. The presentations include examples of effective transportation management plans, successful transportation management plan strategies, and how these agencies have integrated transportation management plan development into their project development process.

8. Federal Highway Administration Webinar on Road User Cost Analysis for Work Zone Applications

<https://www.workzonesafety.org/training/fhwa-webinar-on-road-user-cost-analysis-for-work-zone-applications/>

Road user costs provide the economic basis for quantifying work zone traffic impacts for use in agency decision-making, such as development of transportation management plans as required by the Federal Highway Administration Rule on Work Zone Safety and Mobility (23 CFR part 630, subpart J), use of accelerated construction techniques, and use of alternative contracting strategies to minimize work zone impacts. This webinar provided practitioners with information on work zone road user cost analysis concepts and their applications using examples drawn from real world projects.

9. Guidance on Managing Speeds in Work Zones

<https://www.workzonesafety.org/publication/guidelines-on-managing-speeds-in-work-zones-2/>

This document summarizes available guidance on setting speed limits and managing speeds in work zones. Many factors impact the decision to reduce the regulatory speed limit in a work zone, implement speed limit management strategies and utilize speed reduction strategies. This guide is intended to aid agencies and highway contractors in understanding these factors and the interactions among them. The document addresses how slower speeds can improve safety, how drivers are told to slow down, when slower speeds are important, changing speeds to match conditions, voluntary speed reductions, law enforcement, other tools, a decision tool for managing speeds, and an example approach to managing speeds in work zones.

10. Guidelines for the Use of Automated Flagger Assistance Devices

<https://www.workzonesafety.org/training/guidelines-for-the-use-of-automated-flagger-assistance-devices/>

This learning module outlines the use of automated flagging assistance devices, mechanically operated temporary traffic control devices used to assist flaggers. The module is based on the guidance document, and provides information to practitioners on scenarios for determining when to use automated flagging assistance devices; selecting an automated flagging assistance device, which may include determining the cost/benefit of using such devices; addressing safety concerns or limitations; and making the necessary adjustments when using automated flagging assistance devices.

11. High-Visibility Safety Apparel

<https://www.workzonesafety.org/training/high-visibility-safety-apparel-in-work-zones-training-module/>

Provides guidance on selecting high-visibility safety apparel including appropriate situations where each type of apparel is required or recommended.

12. In the Work Zone: A Look into the Safety of Speed Limits and Work Zone Devices under Manual for Assessing Safety Hardware Testing

<https://www.workzonesafety.org/training/in-the-work-zone-a-look-into-the-safety-of-speed-limits-and-work-zone-devices-under-mash-testing/>

This webinar is part of the Mid-America Transportation Center webinar series. Researchers Dr. Ronald Faller and Dr. Ghulam Bham feature their research and provide lessons learned about work zone sign crash standards and driver behavior.

13. Introduction to Highway Work Zones in Urban Areas

<https://www.workzonesafety.org/training/introduction-to-highway-work-zones-in-urban-areas/>

This two-day course will introduce participants to temporary traffic control in urban work zones. It is designed to give participants a complete overview of temporary traffic control in urban work zones, including applicable standards, devices used, component parts and their requirements, and installation/removal considerations. Emphasis will be given to considerations and issues that affect urban work zones, such as restricted space, reduced visibility, signals, businesses, pedestrians, utility operations, and others, and potential adjustments.

14. Introduction to Positive Protection

<https://www.workzonesafety.org/training/introduction-to-positive-protection/>

Summarizes available guidance on when to use positive protection in work zones.

15. Law Enforcement and High Visibility Personal Protective Equipment

https://learning.respondersafety.com/Training_Programs/Law_Enforcement_and_High_Visibility_PPE.aspx

Anecdotal evidence, visual observation, and scientific studies have shown that many law enforcement officers do not consistently, or ever, wear a high visibility traffic safety vest or other apparel. This program summarizes the Federal regulations with regard to high visibility safety apparel, examines the objections of law enforcement officers to wearing this apparel, presents facts that address these objections, and details a set of solutions to address officers' objections and improve compliance with Federal regulations, State regulations, and local policies.

16. National Highway Institute Innovations: Work Zone Assessment, Data Collection, and Performance Measurement Webinar

<https://www.workzonesafety.org/training/nhi-innovations-work-zone-assessment-data-collection-and-performance-measurement/>

Managing traffic during construction is necessary to minimize traffic delays, maintain or improve motorist and worker safety, complete roadwork in a timely manner, and maintain access for businesses and residents. Work zone traffic management strategies need to be identified based on the project constraints, construction phasing/staging plan, type of work zone, and anticipated work zone impacts. But how would you know if your work zones are operating as

safely and efficiently as anticipated? A domestic scan was conducted during March 2010 to determine traffic monitoring, data usage and management practices being applied in the United States to address safety and congestion impacts in work zones. Four main themes were targeted during the scan: What measures are agencies using to assess the safety and efficiency of their work zones? How are agencies collecting the data for these measures? How are agencies using this data in assessing impacts? How are agencies using this data to evaluate and improve their processes and procedures? This session provides an overview of the findings and recommendations from the Scan. In addition, there are presentations providing more details on one or more specific practices/processes encountered during the Scan.

17. Nighttime Lighting for Work Zones

<https://www.workzonesafety.org/training/nighttime-lighting-for-work-zones/>

Roadway lighting eases the task of driving at night by illuminating the pavement to help drivers see the general direction of the roadway, aiding them in seeing structures alongside the roadway more clearly, and enabling them to see areas of the roadway where headlights do not provide adequate light. This module provides an introduction to specifications and types of lighting systems that are available. The module also introduces a procedure for designing a nighttime lighting system in work zones where no formal lighting plan exists. Engineers, designers, and contractor personnel can use this process without the need to be an expert in illumination.

18. Online Flagger Certification Training

<http://www.atssa.com/OnlineFlagger>

Learn how to be a safe and effective flagger:

- Understand why proper flagger operations are important.
- Learn the standard skillset of a good flagger.
- Apply standard flagger control references.
- Identify proper flagging signals and procedures.
- Learn standard flagger practices for various situations.

The American Traffic Safety Services Association Online Flagger Course is not accepted on State projects in the following States: CO, FL, IA, IL, MA, MN, MS, MT, NC (for recertification, only), NE, NJ, NV, OR, RI, SC, SD, TN, TX, UT, VA & WA.

19. Overview of Part VI of the Recently Revised Manual on Uniform Traffic Control Devices Webinar

<https://www.workzonesafety.org/training/overview-of-part-vi-of-the-recently-revised-mutcd-webinar/>

On December 16, 2009, the U.S. Federal Highway Administration released a new version of the Manual on Uniform Traffic Control Devices. This 2009 edition contains a significant number of revisions as compared to the 2003 version. Part VI of the Manual on Uniform Traffic Control Devices, covering temporary traffic control, contains changes related to tapers, high visibility

clothing, automated flagger devices, flagging procedures, signs and pavement markings, typical applications, and much more.

On January 28, 2010, Hari Kala (former Federal Highway Administration Manual on Uniform Traffic Control Devices Team Leader) and Ken Wood (Federal Highway Administration Office of Operations) provided an overview on the major changes to the Manual on Uniform Traffic Control Devices, specifically to Part VI and directed you to resources that would help you better understand all the changes to the full Manual on Uniform Traffic Control Devices.

20. Pedestrians and Americans with Disabilities in Work Zones

<https://www.workzonesafety.org/training/pedestrians-and-americans-with-disabilities-in-work-zones/>

This module discusses why pedestrian safety and accessibility must be provided in work zones. In this module participants will learn how pedestrians, including the disabled, should be considered and provided for during the development and implementation of the traffic control plan. This module also will show participants how to identify good practices and effective solutions to enhance pedestrian safety and accessibility.

21. Pedestrian Safety and Accessibility in Work Zones

https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_pedestrian_work_zones/

Outlines pedestrian considerations during each project phase including: planning, design, construction, and maintenance. Modules covered include:

- Why must pedestrian safety and accessibility be provided in work zones?
- How should pedestrians be considered and provided for during the development and implementation of the traffic control plan?
- What are good practices and effective solutions to enhance pedestrian safety and accessibility?

22. Positive Protection in Work Zones Training Modules

<https://www.workzonesafety.org/training/positive-protection-in-work-zones-training-modules/>

This course provides foundational knowledge on how to limit worker and motorist exposure in work zones. The course summarizes the factors that can influence the decision to use positive protection and other strategies to minimize worker exposure and incorporate the standards and guidelines set forth in the Temporary Traffic Control Devices Rule (Subpart K). Specifically, this course focuses on the different types of positive protection devices available, provides guidelines on their use, and identifies the characteristics of construction projects that are most suited for positive protection devices.

23. Reducing Worker Fatigue and Distraction Risks

<https://www.workzonesafety.org/topics-of-interest/reducing-worker-fatigue-and-distraction-risks/>

This webpage provides several resources and tips for mitigating safety risks caused by worker fatigue and from use of electronic devices to perform work activities.

24. ROADWAY SAFETY+

<https://www.workzonesafety.org/training-resources/rsp-program/>

The Roadway Safety Plus training program provides two levels of instructional modules: Basic Awareness modules presenting an overview of common hazards in highway and road construction and simple prevention measures and advanced modules for presentation to supervisors, managers, and others responsible for work zone design, set up, and control. Roadway Safety Plus is designed for use by supervisory personnel with safety and health experience or by safety and health personnel to orient new workers as they arrive on the jobsite. This training contains:

1. An Awareness Suite containing 16 hazard awareness modules with interactive demos on:

- Temporary traffic control devices.
- Flagger safety.
- Working outdoors.
- Struck/crushed.
- Excavation.
- Electrical hazards.
- Sprains/ strains.
- Noise hazards.
- Health hazards.
- Safe driving.
- Runovers/backovers.
- Operator safety.
- Fall hazards.
- Emergencies.

2. A Night Work Suite containing four night work modules with interactive demos on:

- Night work risks.
- High visibility.
- Lighting.
- Flagging.

3. A Temporary Traffic Control Toolkit including an introduction to the four parts of temporary traffic control zone with interactive demos, quizzes, and interactive Manual on Uniform Traffic Control Devices Typical Applications.

4. Runovers/Backovers+, which contains four modules with interactive demos targeting the following audiences:

- Workers on foot
- Operators/drivers
- Contractors
- Agency/owner

5. Advanced topics on several topics, including:

- Temporary traffic control tool kit.
- Access/egress.
- Speed management.
- Positive guidance.
- Exposure controls.
- Use of law enforcement.
- Traveler information.
- Payment for temporary traffic controls.
- Improving worker safety.
- Motorcycles/bicycles.

25. Road Safety Program

<https://www.workzonesafety.org/training-resources/rsp-program/>

This program provides two levels of instructional modules: basic awareness modules presenting an overview of common hazards in highway and road construction and simple prevention measures and advanced modules for presentation to supervisors, managers, and others responsible for work zone design, set up, and control. The Road Safety Program is designed for use by supervisory personnel with safety and health experience or by safety and health personnel to orient new workers as they arrive on the jobsite. The basic modules are available in English, Spanish, and Portuguese.

This program is not intended as a compliance guide. It is intended to help your company develop the worker and supervisor awareness needed to achieve best practices.

26. Safe Installation and Removal of Traffic Control Devices

<https://www.workzonesafety.org/training/safe-installation-and-removal-of-temporary-traffic-control-devices/>

Describes methods to safely install and remove temporary traffic control devices.

27. Shadow Vehicles for Work Zones

<https://www.workzonesafety.org/training/shadow-vehicles-for-work-zones-training-module/>

This training module provides criteria for the use of shadow vehicles and truck mounted attenuators in work zones. Module materials are based on the product “Field Guide for the Use and Placement of Shadow Vehicles in Work Zones.” It is also based on material from the Manual on Uniform Traffic Control Devices and the American Association of State Highway Transportation Officials Roadside Design Guide. The course will explore the different types of protective vehicles, show the proper use of shadow vehicles, define a truck mounted attenuator, and identify when to use a shadow vehicle or truck mounted attenuator.

28. Strategies for Developing Work Zone Traffic Analysis

http://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&key=133110133110&course_no=133110&res=1

The purpose of this course is to educate the participants regarding the constraints and opportunities of work zone analysis associated with available transportation modeling approaches, to build familiarity with the various work zone factors influencing the selection of a

transportation modeling approach, and to provide the participants with practical experience in developing a transportation modeling approach in a collaborative process that considers issues ranging from work zone characteristics, performance measurement, technical risk assessment, and resource constraints.

29. Strategies to Enhance Large Truck Safety in Work Zones

<https://www.workzonesafety.org/training/strategies-to-enhance-large-truck-safety-in-work-zones/>

The webinar will present how various Federal agencies—Federal Highway Administration, Federal Motor Carrier Safety Administration, and National Highway Traffic Safety Administration—are trying to increase safety and mobility for large trucks in work zones. Each agency will provide an overview of their program’s initiatives to tackle this important issue. Additionally, other stakeholders will highlight their local efforts in Iowa, Alabama, and Vermont to increase safety and mobility. Iowa has deployed a vehicle entering warning system that detects construction tractor-trailer units hauling materials out of the median of the work zone and alerts motorists when trucks are entering the highway. In Vermont, the commercial vehicle enforcement section is working with other State agencies, private contractors and the motoring public to address work zone safety concerns in their State. In Alabama, they are working on several projects for the Alabama Work Zone Notification System and this presentation will describe the goals, objectives, areas of concern and how they plan to measure user behavior.

30. Talking Freight – Work Zone Design and Large Trucks

<https://www.workzonesafety.org/training/talking-freight-work-zone-design-and-large-trucks/>

The reconstruction and rehabilitation of U.S. interstate highways and other major and minor roadways that are part of the overall roadway system network often require work zones that allow the necessary work to take place without totally closing the roadways to vehicular traffic. Completing the reconstruction and rehabilitation work is critical for keeping the roadways in a state of good repair and allowing the roadways to promote economic vitality through serving the people and companies who utilize the roadways. However, work zones can also create challenges for drivers, particularly drivers of large vehicles such as commercial freight trucks, due to the limited space departments of transportation and public works departments have to work with within the highways’ rights-of-way, and reduced number of lanes some work zones must have. Understanding how work zones can be designed to maintain the efficient movement of large freight transportation vehicles while functioning within the restricted right-of-way space available and ensuring State transportation agency and public works staff can safely work within the work zones can provide significant benefits for all work zone users.

31. Temporary Traffic Control for Building and Maintaining Single and Multi-Lane Roundabouts

<https://www.workzonesafety.org/training/temporary-traffic-control-for-building-and-maintaining-single-and-multi-lane-roundabouts/>

This learning module, based on Guidelines developed under this Grant, provide training to assist field staff in planning temporary traffic control for construction and maintenance of roundabouts.

The traffic control guidelines outlined in this module are intended for use during various maintenance and construction activities such as pavement repair, striping, signing, delineation, landscaping, and intersection repair as well as during the construction of new and existing roundabouts.

32. Transportation Research Board Webinar: Practices and Examples to Manage Sign Retroreflectivity in Compliance with the Manual on Uniform Traffic Control Devices

<https://www.workzonesafety.org/training/trb-webinar-practices-and-examples-to-manage-sign-retroreflectivity-in-compliance-with-the-mutcd/>

Agencies are currently seeking practices to help accelerate the implementation of a sign retroreflectivity maintenance policy. This webinar explores the Transportation Research Board's National Cooperative Highway Research Program Synthesis Report 431: Practices to Manage Traffic Signal Reflectivity. Webinar presentation highlights practices that agencies are using around the country. Presenters also share agency experiences and accomplishments with implementing sign retroreflectivity management programs.

33. Understanding the New Federal Highway Administration Final Rule on Temporary Traffic Control Devices (Subpart K) Webinar

<https://www.workzonesafety.org/training/understanding-the-new-fhwa-final-rule-on-temporary-traffic-control-devices-subpart-k-webinar/>

On December 5, 2007, the Federal Highway Administration published a Final Rule on Temporary Traffic Control Devices that addresses the use of, and appropriate payment for, uniformed law enforcement officers, positive protective measures between workers and motorized traffic, and installation and maintenance of temporary traffic control devices during construction, utility, and maintenance operations. This Rule, which applies to all Federal-aid highway projects, was issued as a supplement to the Work Zone Safety and Mobility Rule, and becomes effective on December 4, 2008. During this webinar, Federal Highway Administration Transportation Specialist Chung Eng provided an overview of the new Rule and how it relates to the Work Zone Safety and Mobility Rule. Eng highlighted the Rule's key requirements and its impacts on the transportation community. The webinar closed with a discussion of what will be expected as a result of the new Rule and a brief Q and A session.

34. Utility Work Zone Presentation and Instructors Guide

https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/instructor_guide.pdf

Utility work zones are fundamentally different from most highway construction work zones. Utility work is often of a shorter duration and involves smaller crew sizes, which makes a traffic control plan such as that utilized in highway construction sometimes impractical. As utility service providers often need to work on or near roadways, utility work zones pose unique challenges to the health and safety of both motorists and workers. In response to these challenges, the "Utility Work Zone Traffic Control Guidelines" document was developed, along with a training program aimed at management and safety officials, utility workers, foremen, and supervisors. This instructor's guide provides a set of PowerPoint slides and background material to aid in the presentation of this program to various audiences. The program provides an

introduction to utility work zone operations and presents recommendations for several important aspects of safety related to utility work, including the establishment of a safety culture in the organization, the use of uniform and consistent traffic control devices and systems, and the development of a set of typical temporary traffic control plans that are appropriate for specific types of work sites. Two software programs developed as a part of the project are also covered.

35. Utility Work Zone Traffic Control Planning Software

<https://www.workzonesafety.org/publication/utility-work-zone-traffic-control-instructors-guide-planning-software/>

Interactive software program has been developed that assists the user in identifying the most appropriate traffic control plan for the utility work zone in and around public thoroughfares. The program leads the user through a series of questions which determine the appropriate temporary traffic control elements based on the location of the utility work and geometric and traffic conditions.

36. Webinar: Accessibility in Work Zones

<https://www.workzonesafety.org/training/webinar-accessibility-in-work-zones/>

High-quality pedestrian and bicycle access in work zones begins with policy that is carried out consistently throughout planning, project development and construction. This webinar, sponsored by the Association of Pedestrian and Bicycle Professionals, presents best practices from Minnesota and Colorado on creating temporary pedestrian access routes in work zones.

37. Webinar: The New American National Standards Institute A10.47 Standard (Work Zone Safety for Highway Construction)

<https://www.workzonesafety.org/training/webinar-the-new-ansi-a10-47-standard-work-zone-safety-for-highway-construction/>

On February 24, 2010, a new American National Standards Institute standard on “Work Zone Safety for Highway Construction” became effective in the United States. This comprehensive standard covers practices including Flagger Safety, Runover/Backover Prevention, Equipment Operator Safety, Illumination, Personal Protective Equipment, and much, much more.

On April 21, 2010, the National Work Zone Safety Information Clearinghouse hosted a one-hour webinar on the new American National Standards Institute/American Society of Safety Engineers A10.47 American National Standard.

Scott Schneider, director of safety for the Laborers’ Health and Safety Fund of North America and chairman of the work group that developed the standard, provided a detailed overview and took questions at the end of his presentation.

38. Work Zone Analysis Tools – State Specific Tools Demonstration

<https://www.workzonesafety.org/training/work-zone-analysis-tools-state-specific-tools-demonstration/>

This webinar was held on November 18, 2010, and was sponsored by the Federal Highway Administration in partnership with Missouri, Wisconsin and Ohio Departments of Transportation. The three States demonstrated their work zone analysis tools and answered attendee questions.

39. Work Zone Fatality Reduction Strategies Webinar

<https://www.workzonesafety.org/training/work-zone-fatality-reduction-strategies/>

During this webinar, three States that have experienced reductions in work zone fatalities over the past several years shared their efforts in work zone planning, management, and outreach. Presenters from California, North Carolina, and Florida provided examples of how it takes a combination of strategies to make work zones safer and offered suggestions based on their experiences that may help other agencies enhance work zone safety.

40. Work Zone Process Reviews – Overview Webinar

<https://ops.fhwa.dot.gov/wz/prtoolbox/webinar103111/transcript/index.htm>

This webinar offers an overview of work zone process reviews and what they do and do not entail. It includes three presentations from Iowa, Colorado, and Louisiana on their experience with process reviews. The Federal Highway Administration and transportation agency representatives from these three States will discuss how they conducted their completed process reviews, their findings, and what worked well and what did not.

41. Work Zone Safety Performance Measures Training Module

<https://www.workzonesafety.org/publication/work-zone-safety-performance-measures-guidance-booklet/>

This booklet introduces the concept of performance measures and performance data collection for work zone safety. It defines performance measures, discusses reasons for using performance measures for work zone safety, provides a process and test for developing good performance measures, provides sample performance measures, discusses defining how and when to measure performance and what to do with the resulting data, and provides real-world lessons learned. The audiences for this fact sheet are planners, designers, construction engineers, and inspectors.

42. Work Zone Training Program Development and Implementation

Webinar transcript:

http://ops.fhwa.dot.gov/wz/resources/final_rule/webcast/020112wztpdi/transcript/2112wztpditranscript.pdf

Presentation (Uniformed Officer Use in Work Zones):

http://ops.fhwa.dot.gov/wz/resources/final_rule/webcast/020112wztpdi/calawa_pptx/calawa.htm

Presentation (Work Zone Traffic Control for Law Enforcement Personnel):

http://ops.fhwa.dot.gov/wz/resources/final_rule/webcast/020112wztpdi/whittaker_ppt/whittaker.htm

Training discusses why training is important, what is required of work zone training, some considerations to include when developing work zone training programs, and available work zone training resources.

Analytical Tools

1. A Deep Learning Approach to Predict Severity Levels of Work Zone Crashes

<https://trid.trb.org/View/1495572>

To help transportation agencies select more appropriate countermeasures to reduce crash risk in work zones, more comprehensive studies on work zone crash occurrences and the corresponding outcomes are needed. Existing research mainly seeks to use parametric models such as logistic regression to examine the causal relationship between potential contributing risk factors and accordingly work zone crash severity. However, the predictive performances of the deployed models have rarely been examined. This paper introduces a non-parametric model building upon deep learning approach to predict the severity levels of work zone crashes. A numerical study that uses massive work zone crash data obtained from a State crash database was conducted to test the predictive capability of the proposed approach. Compared with two baseline approaches, logistic regression and support vector machine, the proposed method achieved improved performance. Key findings, recommendations, and a sensitivity analysis are also provided that can help users consider suitable parameters when using the proposed approach to predict the severity of work zone crashes.

2. A New Analytic Neuro-Fuzzy Model for Work Zone Capacity Estimation

<https://trid.trb.org/View/1439417>

Implementation of regular maintenance and rehabilitation to roads often requires establishment of work zones, which usually result in closing of one or more lanes available for traffic. Closing of traffic lanes could engender disturbances in traffic flow that ultimately result in a reduction of road capacity and an increase of traffic delay. In this study, a new analytic Neuro-fuzzy model is proposed for estimation of work zone capacity incorporating the learning algorithms of Neural Networks into a Fuzzy logic model. Three different adaptive Neuro-fuzzy models are proposed that in each model some modifications are made to the former model. In the first model, fifteen input variables are used. However, in the second model three of variables, which had low correlation with work zone capacity, are not considered in modeling process and in the third model, some of datasets are eliminated. In the meantime, the empirical model proposed by Kim is selected for comparison of results of models proposed in this study, after updating its coefficients using the datasets used to develop the proposed models. The root-mean-square deviation of the first, second, third, and Kim model for testing datasets are respectively 27 percent, 15 percent, 10 percent, and 16 percent of average Work Zone capacity. Comparing these relative error percentages reckons that the third Neuro-Fuzzy model, which is developed by using 12 variables, is the most accurate model. The variables used in this model are: lane width,

heavy vehicle percent, work zone length, speed limit, number of closed lanes, number of open lanes, work intensity, night-time operation, continuous operation, ramp presence, work zone grade, and work zone duration.

3. Analysis of Work-Zone Crash Reports to Determine Factors Associated with Crash Severity

<https://trid.trb.org/View/1494615>

Highway work zones present an environment that leads to opportunities for traffic crashes that may not otherwise occur. To investigate the severity of work zone-related crashes and relationships between severity and other crash variables, a database of 5,410 work zone-related crashes that occurred in Alabama from 2007-2014 was developed. The database includes information from traffic crash reports, project traffic control inspector reports, and supporting documentation from contractors. The full range of variables included in the crash reports was reduced to a manageable set of 16 independent variables whose relationships to crash severity were then explored. This analysis involved the development of an ordered probit regression model and examination of frequency distributions. The five most statistically significant variables that affect crash severity were found to be primary contributing factor, manner of crash, first harmful event, highway classification, and work zone type. Specific factors that had a highly statistically significant effect on severity include evening and overnight time periods, open country locale, rain, no-passing zones, Federal and State highways, two-lane highways, head-on, rollover, and angle crashes, pedestrian and bicyclist involvement, single-vehicle crashes, excessive speed, improper lane use, and the presence of work on the shoulder or median.

4. Analyzing and Improving the Performance of Dynamic Message Sign Reporting Work Zone-Related Congestion

<https://doi.org/10.3141/2617-09>

Dynamic message sign systems aim to provide realistic, reliable, and real-time traffic information to roadway users. This study investigated the performance of a dynamic message sign present at a work zone that warns drivers of any imminent congestion. A work zone in Davenport, Iowa, was used as the test site to evaluate the performance and the proposed algorithm improvements. A typical automated dynamic message sign uses a dedicated sensor measuring speed or occupancy and simple thresholds to post messages warning drivers of the congestion by using a set of predefined messages such as "Traffic Delays Possible," "Slow Traffic Ahead," and "Stopped Traffic Ahead." On the basis of field observation, it was found that these simplistic algorithms lead to a significant number of very short messages, erroneous messages during nighttime, and groups of messages that continuously alternate between different displays. This study first developed performance metrics to report the issues with the existing dynamic message sign automated programming logic and then proposed a machine learning-based real-time algorithm for improved operations.

5. Assessing the Impacts of Connected-Vehicle Technology on Work Zone Rear-End Collisions: Agent-Based Modeling Approach

<https://trid.trb.org/View/1437690>

The objective of this paper is to assess the impacts of connected vehicle technology on work zone rear-end collisions through an agent-based modeling approach. This research is primarily motivated by the lack of a systematic evaluation platform to verify the safety benefits of connected vehicle technology in diverse settings such as a work zone, caused by a lane drop and speed reduction. The guiding research question is when the safety benefits will start to show as the market penetration of connected vehicles increase, and to what extent it reduces the occurrence probability of the rear-end collisions. Preliminary results hold promises in (1) the reduction of rear-end collisions in work zones; (2) reducing the variance of the time headway distribution; (3) the nonlinear relationship between safety benefits and market penetration; and (4) a potential path to “Vision Zero.” These results will inform the implementation of connected vehicle technologies at the State or Federal level to strike the delicate balance between costs and benefits.

6. Capacity Modeling and Control Optimization for a Two-Lane Highway Lane-Closure Work Zone

<http://dx.doi.org/10.1061/JTEPBS.0000078>

A two-lane highway lane-closure work zone is a unique work-zone type because of its traffic impact. When one lane of traffic is blocked, it is necessary to implement a traffic control strategy to effectively serve bidirectional traffic. In the sense that the right of way is allocated between two directions sequentially, traffic control at two-lane highway work zones is similar to signalized intersection traffic control. In order to analyze the problem, this study proposes two primary methodologies: (1) mathematical capacity and delay functions based on signalized intersection theory, and (2) a microsimulation model calibrated using field observed data. After fine-tuning the parameters, the mathematical functions were able to estimate delays with reasonable accuracy. The models developed in this study were applied in the optimization of a two-lane highway lane-closure work-zone control management plan. The resultant delay-capacity diagrams indicate that for pretimed control, roadway capacity should be maintained at a slightly higher level than the traffic demand, whereas the dynamic traffic control scheme is able to achieve lower delay results than the optimal pretimed signal control.

7. Dashboards for Closing the Loop on Monitoring Interstate Work Zone Maintenance of Traffic

<https://trid.trb.org/View/1437130>

Although most agencies have extensive processes in place for designing interstate construction work zones, there is very little quantitative assessment performed on how those work zones operate. Operational feedback is critical for ensuring the design assumptions reasonably reflect operational conditions. A weekly work zone report was developed for use by the Indiana Department of Transportation work zone traffic management personnel for the purpose of assessing their pre-construction work zone queue estimates, evaluating their maintenance of

traffic designs, and fine-tuning those designs. The report includes a number of graphs, figures, and statistics to present a comprehensive picture of performance. Six work zones were chosen as case studies for this initiative. Simulation results for expected queueing were compared to actual queues by using connected vehicle speed data. For one work zone, the median observed queue lengths were found to be at least 4.5 times greater than the expected queue length. The maximum observed congested approach among all six work zones was 17.89 miles. This weekly report provided a mechanism for Indiana Department of Transportation staff to maintain situational awareness of which work zones were most challenging for queues and during what periods those were likely to occur. These weekly reports provided the foundation for the development of an online Indiana Department of Transportation dashboard to provide real-time monitoring of work zone traffic performance.

8. Data Enhancement for Responsive Work Zone Safety Measures through Integration of Real-Time Incident Alerts and Lane Closure Records

<https://trid.trb.org/View/1438541>

Traditional work zone safety analysis and applications often rely on historical work zone and crash data. Those data are often in different formats and based on various location reference systems. It would cost agencies considerable amounts of time and resources to identify potential issues; by the time all of the different reference data sets are linked such that problems and issues can be identified, the project would be over. It is desirable to improve the data integration approach and push forward the level of work zone safety and mobility, especially for mega and long-term projects. Today, many agencies have information systems for work zone and crash data management, which can be of great help to speed up the data integration and therefore make responsive countermeasures possible. This study demonstrated a proof of concept to support real-time work zone orientated data integration, based on the fusion of the work zone data from a statewide work zone management system and a real-time traffic incident alert system from a State traffic operations center. This study is an attempt to integrate and share data with different operational systems used by different agencies. Although this study is based on systems developed and used by the State of Wisconsin, this approach is easy to be adopted by other States and agencies with similar systems.

9. Data Quality Review for Geographic Information System-based Crash and Work Zone Data Integration

<https://trid.trb.org/view/1438538>

Effective work zone safety analysis requires comprehensive data on crashes, work zones, and other environmental factors. Fundamental to such knowledge is the ability to correlate crash data with corresponding work zones, with the knowledge of the data quality. Previous research demonstrated the data integration and analysis capabilities based on a common Geographic Information System roadway network. However, there are cases where the construction zone flag in the crash reports contradicts with the output of the data integration. This study is to review the overall accuracy and completeness of a previously developed crash and work zone data integration algorithm. By examining the randomly selected crashes through the original crash report and the work zone records, the results confirmed the overall accuracy of the Geographic Information System-based integration algorithm. The further analysis implies that there are data

quality issues in the crash report and work zone records, which can also be identified using this algorithm. The findings can help improve work zone operations system data quality, and develop guidance for determining work zone crashes for police officers.

10. Data-Driven Traffic Impact Assessment Tool for Work Zones

<https://intrans.iastate.edu/app/uploads/2018/03/data-driven-traffic-impact-assessment-tool-w-cvr.pdf>

This project developed a prototype tool using historical data for work zones in the St. Louis region in Missouri. Data from 782 work zones on I-70, I-270, and MO 141 that occurred between January 2014 and October 2015 were used. Several data sources were utilized in this project. These included electronic alerts of work zone information such as start and end times, location, lane closure information, and travel times. Two delay measures were used for quantifying impact of work zones on freeway segments: travel time delay based on historical average travel times for the segment and travel time delay based on historical 15th percentile travel time values. A model was developed to estimate travel times for planned work zones at sites that may not have sufficient historical work zone data. The Random Forests technique was used to develop the model. Separate models were developed for interstate and arterial work zones using historical travel times and speed profiles, work zone and upstream segment lengths, lane closure information, and work zone schedule. The tool uses four types of input information: work zone location, roadway direction, work zone duration, and work zone type and lane closure information. The tool then uses this information to mine the historical data to identify any work zones that occurred at the same location in the past. If a match is found, the historical data is utilized to generate the expected delay measures. If a match is not found, the Random Forests prediction model is used to generate the expected delay measures.

11. Development of Rate-Based Statewide Safety Performance Measures of Work Zones Using Imperfect Exposure Data: A Virginia Case Study

<https://trid.trb.org/view/1437716>

Ideally, State departments of transportation would track work zone crashes over time while simultaneously accounting for traffic exposure using work zone vehicle miles traveled. Work zone vehicle miles traveled is often difficult to obtain, however, because of inconsistent logging of work zone locations and changes in traffic volumes during construction. As a result, the Virginia Department of Transportation was interested in developing reliable work zone safety performance measures that could account for exposure using data that were readily available to them from existing sources. This study developed statewide rate-based measures for Virginia by combining two data sources: the crash database and the VaTraffic database containing information on roadway activities such as work zones. Data from 2009-2013 were prepared for interstate and non-interstate highways at four temporal levels. A linearity condition, with the numerator and denominator of a rate being proportional, was used to develop recommended work zone safety performance measures. The analysis revealed several reliable rate-based measures that did not rely on having accurate work zone vehicle miles traveled. Rates based on the exposure reflecting all three output-aspects of work zones (count, duration, and length) were

better than those reflecting two of the three. It is worth noting that the study conclusions are valid for statewide annual safety performance measures and may not be valid for measures at different geographical and/or temporal levels. Although better results could likely be achieved if reliable work zone vehicle miles traveled were available, the developed measures appear to represent an improvement over pure crash count measures.

12. Development of Temporary Rumble Strip Specifications

<http://www.ksdot.org/Assets/wwwksdotorg/bureaus/KdotLib/KU-14-6.pdf>

The objective of this study was to develop specifications for portable reusable temporary rumble strips for their applications in different work zone settings in Kansas. A detailed literature review, a survey of practice, and a closed-course test were performed regarding temporary rumble strips. Additionally, data from permanent cut-in-place rumble strips at six locations in Kansas were collected. All commercially available portable reusable temporary rumble strips were tested at once in a closed-course setting using a standard dump truck and a full-size car. The rumble strips' rotational movement, linear movement, and sound produced by a traversing vehicle were chosen as parameters in developing the decision matrix. Measurements of the strips' linear and angular movements and sound generated due to the test vehicles passing over the rumble strips were collected for a total of 40 passes each at speeds of 22.5, 37.5, 57.5, and 67.5 mph. A matrix and a classification table were created with class intervals defining the classes based on the performance of temporary rumble strips at each of the speeds. Threshold limits for movements, rotation, and sound generation of the temporary rumble strips at each of the speeds were calculated for developing the classification table. Annual average daily traffic and average daily truck traffic were used in calculating threshold limits for movement and rotation, and sound threshold limits were based on cut-in-place strips' sound data. A matrix consisting of all the classes, which incorporates various work zone conditions ranging from low-speed, low-volume to high-speed, high-volume work zone conditions was developed. This matrix in combination with the classification table provides a basis for a recommended method of any vendor or a research team with information regarding the performance of a temporary rumble strip, the type of class it belongs to, and its applicability in various work zone conditions.

13. Effectiveness of End-of-Queue Warning Systems and Portable Rumble Strips on Lane Closure Crashes

<http://dx.doi.org/10.1061/JTEPBS.0000084>

The Texas Department of Transportation has been deploying work zone intelligent transportation systems in an effort to reduce the number of work zone crashes along the Interstate 35 (I-35) corridor. Road construction lane closures on I-35 are typically performed at night when traffic volumes are lower but driver awareness is often reduced. The two systems evaluated were temporary portable rumble strips alone and end-of-queue warning systems combined with temporary portable rumble strips. The end-of-queue warning systems consist of portable changeable message signs linked to radar speed sensors to proactively warn drivers of queueing and slowed conditions ahead. The temporary portable rumble strips alone were deployed for work zone lane closures where no queues were expected, and both end-of-queue warning system and temporary portable rumble strips were deployed for lane closures expected to cause queueing. The effectiveness of these systems was evaluated over 4 years of deployments

and compared to 1 year of no deployments. Both temporary portable rumble strips alone and the end-of-queue warning systems with temporary portable rumble strips were found to cause a significant reduction in the number of crashes under queued conditions, 60 and 53 percent, respectively. Additionally, the severity of the crashes that did occur was significantly reduced under queued conditions when either treatment was in place.

14. Effects of Short-Term Lane Closures on the Traffic Flow of Freeways

<https://trid.trb.org/View/1437185>

One of the main causes of congestion on freeways is lane closures due to short-term construction works or accidents. To avoid congestion due to these events, this study aims at analyzing traffic flow at such bottlenecks. The focus was to determine the effect of different traffic guidance measures on the capacity and take a closer look at the driven speeds and the traffic volumes on each lane. For the execution of this study, traffic data of the section control system on the German freeway A99 between interchange Munich-North and interchange Munich-South from 2012 and data of all lane closures in that period were available. Due to the amount of data, the field of this study was limited to closures of one out of three lanes. For those situations, it turned out that the capacity ranged between 2800 and 3000 vehicles per hour in case of closures of the right lane and between 3100 and 3300 vehicles per hour in case of closures of the left lane. Thus, the capacity is 10 percent lower for closures of the right lane. Furthermore, larger speed differences were determined in case of closures of the right lane than of the left lane. This may be caused by the high percentage of heavy vehicles on the right lane. Heavy vehicles changing from the right to the middle lane apparently affect the traffic flow more than cars changing from the left to the middle lane.

15. Enhancing Work Zone Travel Time Estimation Using Smart Work Zone Data

<https://trid.trb.org/view/1240760>

An increasing number of transportation agencies around the States have considered and/or implemented the smart work zone concept where sensors are deployed upstream of a lane closure to detect queue conditions and provide advanced warning to approaching travelers via portable changeable message sign. The travel time monitoring technology such as Bluetooth-based identification matching may also be deployed in conjunction with queue detection system at the smart work zone. This paper extends the utility of data collected from the smart work zone where both queue and travel time monitoring technologies are present to improve the accuracy of travel time estimation and estimate travel delay. The proposed algorithm utilizes historical and real-time traffic conditions collected from the smart work zone to estimate queue length and travel time when the smart work zone is active. The algorithm was evaluated and calibrated using a VISSIM simulation test bed for the southbound direction of a 29-mile segment along I-35 corridor from Hillsboro to Waco, Texas. Researchers simulated speed sensors and Bluetooth technology characteristics using VISSIM Vehicle-to-Device technology for the purpose of the algorithm evaluation. The evaluation results indicated that the proposed algorithm, once

calibrated with historical data, can provide significant improvement in real-time travel time and delay estimation especially where the volume-to-capacity ratio regularly exceeds 1.0 (unsteady queue condition).

16. Estimation of Saturation Headway in Work Zones on Urban Streets

<https://trid.trb.org/view/1440425>

Work zones and lane closures on urban arterials can cause significant disruptions to the traveling public, and methods are increasingly needed to estimate the reductions to saturation flow rates that result from work zones at signalized intersections. A set of statistical models that estimate saturation headways as a function of the presence and configuration of the work zone on signalized arterial streets is presented. More than 10,000 individual vehicular headway observations were collected from video observations in and after work zones at six study sites in North Carolina. Conventional multiple-regression and path-based-regression models (structural equation model) were used to develop the saturation headway models. Three models are provided at different aggregation levels of the collected data with identical work zone configurations. The proposed model incorporates the effects of lane configuration, pavement condition, turning percentage from shared lanes, work intensity, and number of closed exclusive turning lanes. Based on path analysis, the structural equation model satisfies all the rule-of-thumb criteria for goodness-of-fit indices. The model uses Highway Capacity Manual default values for turning-vehicle headway effect as its intercept coefficient value.

17. Estimation of Traffic Impacts at Work Zones: State of the Practice

https://www.workzonesafety.org/files/documents/database_documents/07-0255.pdf

The design phase of developing traffic control plans requires performing a traffic analysis to estimate queue lengths, travel times, and delays to determine lane closure times. This study was conducted to provide the Virginia Department of Transportation with the state-of-the-practice tools that are available and used by other State agencies for estimating the traffic impacts at work zones. The researcher found that all models based on the Highway Capacity Manual assume capacity as an exogenous variable that is given as input to the model; delay and queue length are dependent on capacity. A good estimate of the capacity of a work zone bottleneck is essential to obtain an accurate estimate of traffic impacts. The conclusions in this study should help the Virginia Department of Transportation choose the appropriate tool(s) for estimating the traffic impacts in and around work zones. This study made a comparison between the Highway Capacity Manual, QuickZone and Microscopic Simulation tools. Table-2 indicates the results.

18. Evaluating Work Zone Intrusion Alert Technology: Recommendation for Future Development

<https://trid.trb.org/View/1494501>

To help improve adoption potential, researchers developed and implemented a five-step evaluation protocol for assessing work zone intrusion alert technologies. The evaluation study focused on three commercially available intrusion alert technologies: SonoBlaster, Intellicone, and Worker Alert Technology. The study demonstrated that a rigorous scientific evaluation process for work zone intrusion alert technologies can be developed and implemented. In

addition, work zone intrusion alert technologies showed they have the potential to play a significant role in improving highway worker safety, and recommendations are provided to improve the effectiveness of work zone intrusion alert technologies.

19. Evaluation and Implementation of Traffic Simulation Models for Work Zones

http://www.ct.gov/dot/LIB/dot/documents/dresearch/NETCR80_05-8.pdf

The purpose of this paper is to present case studies that illustrate and evaluate the QUEWZ, QuickZone, CORSIM, and CA4PRS models in terms of their ease of use, data requirements, and ability to simulate and assess work zone strategies, shedding light on the relative reliability and accuracy of these simulation models as well as their user-friendliness and data requirements. This paper compares simulation results to actual work zones conditions in eight locations across New England. The results of this evaluation will be of interest to State and local transportation engineers responsible for planning and designing work zone strategies. This research has shown that some simulation models provide a low-risk, low-cost environment in which to test and analyze a variety of work zone alternatives. For example, QUEWZ and QuickZone were able to provide reasonable order of magnitude queue length estimates on interstate highways comparable to observations made in the field. In addition, such estimates required little data including hourly volume and roadway geometry information. The result of comparison between CA4PRS, QuickZone, QUEWZ and CORSIMA is presented in a highly accessible and easy to use tabular format.

20. Evaluation of Traffic Control Options in Work Zones

https://stride.ce.ufl.edu/wp-content/uploads/2017/03/STRIDE_2016-001S_Final_Report-1.pdf

Lane closures for work zones along freeways produce bottlenecks. These bottlenecks are problematic due to loss of capacity and excessive lane changes, which impact the facility performance represented by operational level of service, emissions, and travel time. This study utilized a comprehensive literature review, a national survey of practices, and microscopic simulation experiments to document and evaluate available traffic control strategies for work zone management. Using a corridor in Birmingham, AL as a testbed, the study quantified operational, environmental, and travel time reliability impacts of four temporary traffic control strategies for work zones. Also, a performance-based work zone scheduling approach was developed to provide decision support assistance for transportation agencies. The study provided evidence that the work zone length is insignificant with respect to facility level of service, environmental impacts, and delays. The study concluded that late merge and mainline merge metering hold great promise and should be considered for implementation in place of the early merge approach commonly used in practice today.

21. Evaluation of Work Zone Split Traffic Symbol Sign

<https://library.modot.mo.gov/RDT/reports/TR201613/cmr17-009.pdf>

Effective signage that is easy to understand facilitates safe driving through a work zone. While the guidance for work zone signage in the Manual on Uniform Traffic Control Devices is suitable for many conditions, there may be instances where alternative signage may be more effective at enhancing safety. This project evaluated the use of alternative signage for closure of

a middle lane in a freeway work zone on a bridge rehabilitation project on I-170 in St. Louis, Missouri. The alternative signage displays the lane arrangement in a single sign while the Manual on Uniform Traffic Control Devices signage shows the movements to the left and the right sides of the work area on separate signs. The evaluation of the alternative signage included stakeholder and driver surveys, operational and safety analyses, and the collection and analysis of field videos to assess driver behavior. The analysis of field videos showed that drivers may have adapted to the alternative signs as the rate of lane changes decreased between the early and late periods of construction. Stakeholder interviews found that personnel from the Missouri Department of Transportation and the contractor generally thought that the alternative sign communicated information more clearly but had mixed opinions on whether the use of the sign improved safety. Drivers did not express any concerns regarding the use of the alternative sign through a website that collects feedback on Missouri Department of Transportation work zones. A review of crash data found that crash patterns during the work zone period were similar to the crash patterns before the work zone was in place, and the use of the alternative sign did not appear to be a contributing factor in any work zone crashes. Analysis of Regional Integrated Transportation Information System traffic data found that the use of the alternative sign did not have an impact on travel times in the vicinity of the work zone. Overall, the evaluation found that the alternative sign communicates information clearly and does not cause any adverse impacts to work zone safety and operations.

22. Freeway Work Zone Free-Flow Speed Model Development

<http://worldcat.org/oclc/614107147>

The objective of this article is to present a predictive freeway-work-zone, free-flow speed model based on key variables that influence traffic operations: speed (under non work-zone and work-zone conditions), lane-closure-severity index, barrier type, day or night activity, and total number of ramps in the vicinity.

23. Highway Repair Consolidation Feasibility

<http://www.nj.gov/transportation/refdata/research/reports/FHWA-NJ-2016-002.pdf>

The main objective of this effort is to understand the types of projects that can be coordinated and to evaluate the effectiveness of coordinating short and long-term projects using a cost-benefit analysis approach to measure the efficiency of various combinations of projects relative to each other and the status quo. The team, after consulting with the project panel and the New Jersey Department of Transportation Mobility and Systems Engineering division, devised a work zone coordination framework that utilizes one common work zone database, including OpenReach and Capital Program Management project reporting system databases. Work Zone Coordination Spreadsheet tool was developed for providing New Jersey Department of Transportation with an easy-to-use tool to evaluate the feasibility and effectiveness of coordinating short and long term work zones and measure the benefits of various combinations of projects relative to each other and the status quo. This on-line tool is implemented with a web-based user interface. It integrates all scheduled and active construction projects from the OpenReach database and planned Capital Program Management projects from the project reporting system database. It then identifies conflicts between work zone projects and estimates the benefits of conflict mitigation.

24. Impact of Bottleneck Merge Control Strategies on Freeway Level of Service

<https://doi.org/10.1016/j.trpro.2016.06.049>

Freeway work zones typically mandate lane closures that often induce bottlenecks. Merge maneuvers and the accompanying increase in the rate of lane changes at these bottlenecks can become problematic resulting in undesirable mobility and safety impacts. Traditionally, merge control strategies are deployed to mitigate such impacts. Literature sources indicate that available merge control strategies fall into one of four categories, namely: early merge control, late merge control, temporary ramp metering, and mainline merge metering. However, little is known about the proper criteria for selecting and implementing one of the available merge control strategies. In addition, the impact of the various control strategies on freeway level of service is currently under-researched. The purpose of this study is to evaluate the operational impacts of the above-mentioned freeway merge control strategies. The goal is to provide work-zone-aware level of service indicators that would help transportation agencies in selecting the most appropriate merge control strategy to minimally impact the freeway operations. In order to meet the research goals and objectives, this study used the CORSIM micro-simulation platform to evaluate impacts of various merge control strategies at a freeway study corridor in Birmingham, AL. The 2010 Highway Capacity Manual methods for calculating level of service were considered and modifications were proposed to align the calculated level of service with the assessed impacts of each merge control strategy. This study is significant for its contribution to providing transportation researchers and professionals with tools and methods to evaluate freeway level of service under work zone conditions and assisting them in mitigating the adverse impacts of work zones on traffic operations.

25. Implementation of a Connected Data Smart Work Zone Management System to Provide Queue Alerts to Stakeholders

<https://trid.trb.org/View/1437129>

This paper reports on a connected vehicle data-based system for generating texts/emails to alert the Indiana Department of Transportation to interstate work zone queueing. Six work zones were identified for this study, with 10-mile upstream approach boundaries. When average speeds drop below 45 mph, queue monitoring algorithms are triggered. When this queue grows to be at least 1 mile long or has a speed drop of at least 15 mph at the back of the queue, a text/email alert is sent to individuals who have opted to receive alerts from that work zone. Still camera images, work schedules, and crash reports were used to ground-truth the alert system. The paper concludes by recommending the use of connected vehicle data for queue monitoring due to the scalable, cost effective nature of the technology and the ability to rapidly deploy monitored areas.

26. Improving Road Safety through Integrated Process for Incident Traffic Management

<http://acrs.org.au/publications/acrs-conference-papers/acrs-database/>

Austroroads has identified the lack of a mutually agreed incident management framework across the member organizations as a gap in the traffic incident management practice in Australia and New Zealand. A research project has been undertaken to develop such framework based on a

review of current local and international incident management techniques and understanding. This paper presents a review outcome and the proposed framework with a focus on advanced traffic incident management techniques to minimize traffic disruption and road safety risks while maintaining a safe workplace for responders.

27. Improving the Effectiveness of Smart Work Zone Technologies

<https://apps.ict.illinois.edu/projects/getfile.asp?id=5074>

This project evaluates the effectiveness of sensor network systems for work zone traffic estimation. The comparative analysis is performed on a work zone modeled in microsimulation and calibrated with field data from two Illinois work zones. Realistic error models are used to generate noisy measurements corresponding to Doppler radar sensors, remote traffic microwave sensors, and low-energy radar. The velocity, queue length, and travel time are estimated with three algorithms based on (1) interpolation, (2) spatiotemporal smoothing, and a (3) flow model-based Kalman filter. More than 700 sensor and algorithm configurations are evaluated, and the accuracy of the resulting traffic estimates are compared with the true traffic state from the microsimulation. The nonlinear Kalman filter provides up to 30 percent error reduction over other velocity estimators when the remote traffic microwave sensor spacing exceeds 2 miles and generally offers the best performance for queue and travel time estimation.

28. In-Vehicle Work Zone Messages

<https://www.dot.state.mn.us/research/reports/2017/201719.pdf>

This study investigated the potential effects of in-vehicle messages to communicate work zone events to the driver. The researchers conducted literature reviews on risks imposed by work zones, along with design guidelines for any in-vehicle messaging system. The researchers then conducted a work zone safety survey to illustrate driver attitudes in Minnesota toward work zones, along with smartphone use and in-vehicle messages through smartphones. The survey found that a significant number of drivers make use of smartphones in the automobile, and they placed these smartphones in various locations throughout the vehicle. The survey was followed by a driving simulation study that tested drivers in two different types of work zones. Participants drove through these work zones three times, each with different messaging interfaces to communicate hazardous events to the driver. The interfaces included a roadside, portable changeable message sign, a smartphone presenting only auditory messages, and a smartphone presenting audio-visual messages. Results showed improved driving performance on key metrics, including speed deviation and lane deviation, for the in-vehicle message conditions relative to the roadside signs. Furthermore, drivers reported significantly less mental workload and better usability, work zone event recall, and eye gaze behavior for the in-vehicle conditions relative to the roadside sign condition.

29. Investigating Pedestrian Components in Temporary Traffic Control

<https://static.tti.tamu.edu/tti.tamu.edu/documents/0-5237-1.pdf>

The report documents the research activities completed during the two years of this research project. The objectives of this research were:

- To examine how pedestrians with disabilities are being handled in temporary traffic control situations and identify if there are changes needed in this accommodation.
- To determine the information requirements of pedestrians (especially those with special needs) at temporary traffic control locations and gain input on how best to meet those requirements.
- To develop recommended guidance documents to provide Texas Department of Transportation with improved traffic control methods for pedestrians in temporary traffic control locations.

Researchers approached this project from two different angles to accomplish these objectives. First was establishing the current state-of-the-practice with regard to handling pedestrians in temporary traffic control areas and the second was the administration of several human factors studies that addressed public perception as pedestrians in or near work areas. This report contains specific findings and recommendations regarding each of these activities.

30. Investigation of Work Zone Crash Casualty Patterns Using Association Rules

<http://dx.doi.org/10.1016/j.aap.2016.03.017>

Investigation of the casualty crash characteristics and contributory factors is one of the high-priority issues in traffic safety analysis. In this paper, the authors propose a method based on association rules to analyze the characteristics and contributory factors of work zone crash casualties. A case study is conducted using the Michigan M-94/I-94/I-94BL/I-94BR work zone crash data from 2004 to 2008. The obtained association rules are divided into two parts including rules with high-lift, and rules with high-support for the further analysis. The results show that almost all the high-lift rules contain either environmental or occupant characteristics. The majority of association rules are centered on specific characteristics, such as drinking driving, the highway with more than 4 lanes, speed-limit over 40 mph and not use of traffic control devices. It should be pointed out that some stronger associated rules were found in the high-support part. With the network visualization, the association rule method can provide more understandable results for investigating the patterns of work zone crash casualties.

31. Length of Need for Free-Standing, F-Shape, Portable Concrete Barrier (PCB)

<https://trid.trb.org/View/1483045>

The objective of this research was to investigate and evaluate the safety performance of a previously developed F-shape portable concrete barrier system to determine minimum system length and the number of barriers required for the beginning and end of the length of need. LS-DYNA simulation modeling was applied to determine potential beginning and end of length of need points on reduced system lengths to select a configuration for full-scale testing and evaluation of a minimum length portable concrete barrier system. A 100-ft. long portable concrete barrier installation was selected, and full-scale crash testing was conducted at the beginning and end of length of need of the reduced length system. Test no. NELON-1 was conducted to the Manual for Assessing Safety Hardware's test designation 3-11 on the beginning of length of need of the 100 ft. long portable concrete barrier installation, and the vehicle was safely redirected. Test no. NELON-2 was conducted to Manual for Assessing Safety Hardware test designation 3-11 on the end of length of need of the 100-ft. long portable concrete barrier

installation, but the test was deemed a failure as the vehicle demonstrated a roll angle in excess of 75 degrees. Review of the crash test results suggested that a nine barrier or 112.5-ft long portable concrete barrier installation would perform acceptably.

32. Model and Simulation of the Traffic of the Urban Signalized Intersection with Island Work Zone

<https://trid.trb.org/View/1495353>

Work zones exist widely in cities of many countries and have a significant negative impact on city traffic; however, the majority of existing studies focused on freeway work zones, work zones on urban arterials have not been investigated carefully. For the first time, this paper focuses on a specific type of work zone that is located within the area of a signalized intersection, namely, island work zone, and a novel traffic flow model for the island work zone traffic flow is proposed by improving the existing social force model in the paper. Compared to the existing traffic flow models, such as the car-following and lane-changing models, the proposed model can capture the special traffic flow characteristics of the island work zone, including the heterogeneity, no lane division, and irregular boundary. Field data collected in Chengdu, China is used to calibrate and validate the proposed model. Simulations are also conducted to investigate the variations of the vehicle number and average speed for different work zone features and traffic flow characteristics. The results display that the model can replicate the heterogeneous traffic flow of the intersection with island work zone with high performance. When an island work zone is located close to the intersection exit, the entered vehicles are blocked before the exit, so the yellow time should be extended to ensure all the entered vehicles can pass the intersection. When a work zone occupies over one meter of the median divider, its impact on the traffic flow will become much significant.

33. Novel Method of Obtaining Critical Parameter in Safety Assessment for Maintenance Work Zone

<https://trid.trb.org/View/1495429>

Safety assessment of maintenance work zone is crucial for the safety of conservation personnel and traveling vehicles. To make up for the limitations of current methods to do timely safety assessment for maintenance work zones, this paper makes full use of the existing safety assessment theory, and proposes a method based on naturalistic driving study, automatic segmentation technology and spatial clustering analysis to obtain the critical parameter of a classic safety assessment model. Firstly, vehicle behavior data is collected by naturalistic driving method; secondly, using the automatic segmentation technology, the fragments containing traffic conflict information in the data are extracted; these fragments are then clustered by kernel density analysis to find the location of the high density point of traffic conflict; finally, the critical parameter is calculated, that is, the geometric relationship between the location and the maintenance work zone; then, input the critical parameter into the classic safety assessment method so as to achieve the purpose of safety assessment for maintenance work zone. Practice has proved that the key parameter obtaining method proposed in this paper fully takes into account the characteristics of maintenance work zones; it can collect the behavior data of vehicles passing through quickly and flexibly, then makes a timely safety assessment for the zone, thus can better meet the actual needs of maintenance.

34. Optimal Trade-Offs between Construction Cost and Traffic Delay for Highway Work Zones

[http://dx.doi.org/10.1061/\(ASCE\)CO.1943-7862.0001132](http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0001132)

Highway work zones often cause traffic congestion, resulting in increased road-user delays and vehicle emissions. These negative impacts of highway work zones can be minimized by a number of mitigating measures such as reducing the length of work zone segments, using the shoulder temporarily for traffic, and working during low-traffic nighttime hours. These work zone layout measures, however, cause an increase in highway construction cost. Accordingly, these tradeoffs between reducing work zone delays and minimizing construction cost need to be analyzed to establish an optimal balance between these two critical and conflicting objectives. This paper presents the development of a novel multi-objective optimization model for highway work zone layouts that is capable of generating optimal tradeoffs between minimizing traffic delays and construction cost. The model was developed in three main phases: formulation, implementation, and performance evaluation. First, the model was formulated to (1) identify all relevant work zone decision variables that affect mobility and cost, (2) model the two objective functions of minimizing work zone delay and construction cost, and (3) represent all practical constraints. Second, the model was implemented using a genetic algorithm to perform the multi-objective optimization computations and enable generating optimal tradeoffs among the two objectives in a single run. Third, the performance of the model was evaluated using an application example of a highway work zone. The results of the performance evaluation phase illustrate the novel capabilities of the model in optimizing work zone layout parameters and generating optimal tradeoffs between minimizing traffic delays and construction cost.

35. Optimal Variable Speed Limit Control System for Freeway Work Zone Operations

<https://ascelibrary.org/doi/10.1061/%28ASCE%29CP.1943-5487.0000610>

Improving operational safety and efficiency of variable speed limit systems are the two core control objectives at work zone areas. In response to such need, this study presents a proactive variable speed limit control model for freeway work zone operations. The proposed model uses an embedded macroscopic traffic flow model to predict the traffic state evolutions over the projected time horizon and to determine the optimal speed limits. In addition, the Kalman filter is adopted to correct the prediction inaccuracy in a timely manner. To improve the safety of operations, this study proposes a new control objective function to smooth speed transition along the target freeway sketch by minimizing the difference between actual speeds and ideal speeds. Also, the smoothness of speed transition can help prevent the formation of shockwave and consequently enhance system's operational efficiency. The authors' numerical experiment with a calibrated VISSIM simulator reveals that the proposed variable speed limit system can significantly reduce the speed variance among different freeway subsegments. The evaluation of several measures of effectiveness also shows the promising results of the variable speed limit system on the improvement of freeway operational efficiency.

36. Optimizing the Planning of Highway Work Zones to Maximize Safety and Mobility

[http://dx.doi.org/10.1061/\(ASCE\)ME.1943-5479.0000570](http://dx.doi.org/10.1061/(ASCE)ME.1943-5479.0000570)

To improve work-zone safety and mobility, the layout of highway work zones needs to be carefully planned and optimized to accomplish the multiple and often conflicting objectives of maximizing safety and mobility. This article presents the development of an innovative multi-objective optimization model to search for and identify a set of Pareto-optimal work-zone layouts that provide a wide range of optimal trade-offs between minimizing traffic delays and minimizing the probability of crashes. The performance of the developed optimization model was analyzed and verified using an application example of work-zone layout. The results illustrate the novel and unique capabilities of the developed model in searching for and identifying optimal work-zone layouts. These new and unique capabilities are expected to support State transportation agencies and construction planners in their ongoing efforts to maximize work-zone safety and reduce traffic delays in the work-zone area.

37. Optimizing Scheduling of Long-term Highway Work Zone Projects

<http://dx.doi.org/10.1016/j.ijtst.2016.06.003>

The impacts of work zone activities can be summarized into the following types: safety impact (on both motorists and workers), mobility impact, economic considerations, environmental concerns, user cost as well as contractor's maintenance cost. In this study, the impacts of scheduling long-term work zone activities are analyzed from the perspective of traffic agencies and jurisdictions. A bi-level genetic algorithm-based optimization model is formulated to determine the optimal starting date of each work zone project. The demand and the number of work zones as well as their durations are assumed to be fixed and given a priori. The proposed genetic algorithm model is applied to the Sioux Falls network, which has 76 links and 24 origin-destination pairs. The results of the numerical example indicate that the proposed model can effectively identify the near-optimal solution to the long-term work zone scheduling problem.

38. Predicting Freeway Work Zone Delays and Costs with a Hybrid Machine-Learning Model

<https://www.hindawi.com/journals/jat/2017/6937385/>

A hybrid machine-learning model, integrating an artificial neural network and a support vector machine model, is developed to predict spatiotemporal delays, subject to road geometry, number of lane closures, and work zone duration in different periods of a day and in the days of a week. The model is very user friendly, allowing the least inputs from the users. With that the delays caused by a work zone on any location of a New Jersey freeway can be predicted. To this end, tremendous amounts of data from different sources were collected to establish the relationship between the model inputs and outputs. A comparative analysis was conducted, and results indicate that the proposed model outperforms others in terms of the least root mean square error. The proposed hybrid model can be used to calculate contractor penalty in terms of cost overruns as well as incentive reward schedule in case of early work competition. Additionally, it can assist work zone planners in determining the best start and end times of a work zone for developing and evaluating traffic mitigation and management plans.

39. Regional Network Complexity Reduction for Estimating Diversion Effects from Large-Scale Work Zones - Motivation and Lessons Learned

<https://trid.trb.org/View/1439146>

Regional network modeling helps transportation agencies in estimating diversions caused by work zones and identifying key alternate routes to mitigate congestion. Dynamic traffic assignment-based mesoscopic models have been used to estimate effects of large scale work zones in an urban network. However, highly detailed regional network models fail to model driver route choice accurately, since they divert traffic through local roads, contradicting reality. In this paper, a procedure is developed to reduce the complexity and areal extent of a large regional network, using macroscopic modeling to simulate effects of a long-term work zone. The reduced network, after removal of lower category roads, is then simulated in a dynamic traffic assignment-based mesoscopic model, to estimate driver route choice and diversion rates. The methodology is also explained with an illustrative case study of an on-going large scale work zone close to a metropolitan area. Results from the macroscopic model helped in identification of key alternate routes and found 20 percent more diversions within a 2 mile radius of the work zone. In the reduced mesoscopic model, almost 10 percent more traffic was diverted through freeways than in the detailed network model. However, validation of this model showed that the removal of some important local roads led to problems in convergence of the model and enforces the need for traffic counts on arterial streets for calibration.

40. Safety Assessment Tool for Construction Zone Work Phasing Plans

https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1202&context=intrans_reports

A challenging question for practitioners is always how to use crash prediction models to make the best estimation of work zone crash count. To solve this problem, a user-friendly software tool was developed in a spreadsheet format to predict work zone crashes based on work zone characteristics. This software selects the best model, estimates the work zone crashes by severity, and converts them to monetary values using standard crash estimates. This study also included a survey of departments of transportation, Federal Highway Administration representatives, and contractors to assess the current state of the practice regarding work zone safety. The survey results indicate that many agencies look at work zone safety informally using engineering judgment. Respondents indicated that they would like a tool that could help them to balance work zone safety across projects by looking at crashes and user costs.

41. Safety at Road Worksites: Stage 1 Working Papers

<https://www.onlinepublications.austroads.com.au/items/AP-R544-17>

This report details contemporary practices to mitigate risk and improve safety at road worksites. This research involved three study components:

1. The safety performance at worksites in Australia and New Zealand was qualitatively benchmarked with comparable international jurisdictions.

2. Best practice in road worksite safety management was identified through a comprehensive literature review, including manuals from international jurisdictions with comparable or better safety performance, and consultation with 13 international experts.
3. The findings of the first two studies informed the development of recommendations for improving safety at Australian and New Zealand worksites.

The identified best practices are presented in six groups: regulation, traffic signs and informational controls; enforcement related controls; traffic related operational controls; worksite/worker related operational controls; physical protection and separation related controls; and driver education and awareness campaigns. Initial recommendations were discussed with Austroads member agencies to understand degrees of applicability, feasibility, expected potential impact, and level of support in and relevance to their jurisdictions. The final recommendations were developed based on the feedback obtained from these consultations.

42. Setting Work Zone Speed Limits

http://www.intrans.iastate.edu/research/documents/research-reports/setting_work_zone_speed_limits_w_cvr.pdf

Increasing travel demands and an aging highway infrastructure drive the need for extensive construction, maintenance, and utility work zones. The introduction of work zone environments creates risks for both drivers and construction workers due to changes from the normal driving environment. Temporary speed limit reductions are a common countermeasure aimed at improving work zone safety. In theory, reduced speed limits may serve at least three important functions: reduce variability in travel speeds and the potential for work zone crashes, reduce average travel speeds and the severity of crashes when they do occur, and enhance worker safety. Thus, understanding how reducing work zone speed limits impacts travel speeds is an important task. This project evaluates the impacts of speed limit reductions on drivers' speed selection at both aggregate and disaggregate levels. Data were collected from nine construction work zones in Iowa during 2014 and 2015. The lack of availability of data pertaining to the location, time, and type of activity significantly constrained the level of analysis that could be conducted for this research. Therefore, the crash analysis was not deemed reliable due to the inconsistency among the multiple data sets that were used to determine the location, time, and type of work zone activity. For the speed analysis, a quantile regression model was employed to examine the impacts of speed limit reductions on speed distribution quantiles before and during construction activities. The results show that speeds are consistently reduced when work zone speed limits are in place.

43. Simplified Web-Based Decision Support Method for Traffic Management and Work Zone Analysis

<https://www.ugpti.org/resources/reports/downloads/mpc17-317.pdf>

Traffic congestion mitigation is one of the key challenges that transportation planners and operations engineers face when planning for construction and maintenance activities. Commonly used analysis tools may not fully capture the dynamic nature of drivers' responses to traffic management techniques and significant changes in the transportation network. In this case, performing analyses with a dynamic traffic assignment engine, or a similar traffic estimation

method, may meet this need while providing additional analysis details (e.g., network, path, origin-destination, and link analyses) for local engineers to justify their decisions/actions. At the same time, technical expertise, data management, and software licensing often become significant barriers for incorporating this type of analysis into everyday operations. This research presents a dynamic traffic assignment-based tool that is designed to overcome the existing limitations in work zone simulation and analysis.

44. Simulation Guidance for Freeway Lane Closure Capacity Calibration

<http://dx.doi.org/10.3141/2553-09>

This study provides a methodology for calibrating freeway work zone capacity in a microsimulation environment and guidance for replicating field-observed freeway work zone capacity through simulation. From 81 field observations at 12 U.S. work zone sites, 90 work zone sites from literature archival sources, and a macroscopic capacity model developed in National Cooperative Highway Research Program Project 03-107, the authors show how to replicate field-observed or forecast capacity in the VISSIM simulation tool under various scenarios of freeway work zone lane closure. With guidance from an in-depth literature review, key car-following and lane-changing parameters are proposed as a result of the calibration effort and extensive sensitivity tests of numerous combinations of parameter values. Lane configuration specific guidance is provided for two key car-following parameters in VISSIM, cc1 and cc2. During the process of developing the guidance, every tested capacity scenario was verified by using a lane use volume balance that was obtained upstream of the lane closure point in order to replicate realistic freeway work zone conditions. The calibration methodology as well as default parameter guidance developed through this research are useful to practitioners who wish to model freeway work zone impacts accurately through microsimulation.

45. The Traffic Management Capability Maturity Framework: An FHWA [Federal Highway Administration] Tool to Help Agencies Advance Traffic Management Capability

<https://trid.trb.org/view/1438311>

In 2013, the Federal Highway Administration initiated a project to develop a series of six capability maturity frameworks based on the American Association of State Highway and Transportation Officials transportation systems management and operations capability maturity model. The intent was for the capability maturity frameworks to elaborate on, and be consistent with, the American Association of State Highway and Transportation Officials transportation systems management and operations capability maturity model, but which provide more focused assessment and suggested actions in each of the following operations program areas: traffic management, traffic incident management, planned special events, work zone management, road weather management, and traffic signal control. The concept of a capability maturity model for transportation operations emerged from the second Strategic Highway Research Program reliability projects L01 and L06, which promoted a process-driven approach to improve transportation systems management and operations. This paper discusses the process undertaken by the Federal Highway Administration to develop a capability maturity framework for traffic management, directly linked to the capability maturity model approach, and the potential benefits that can be realized by State and local agencies and stakeholder partners for their transportation

systems management and operations programs. Available online, the purpose of the framework is to build consensus among stakeholders regarding institutional changes at an agency or regional-level. The framework is utilized before any traffic management activities and strategies are implemented. It is not strategy-specific, but rather the framework is specific to process areas that are applicable to traffic management concerns.

46. Traffic Impact Assessment Tool for Moving Work Zone Operations

https://intrans.iastate.edu/app/uploads/2018/03/moving_work_zone_traffic_impact_assess_w_cv_r.pdf

Road maintenance activities involve both short-term stationary work zones and moving work zones. This research project sought to use field data from moving work zones to develop and calibrate a traffic impact analysis tool. This objective was accomplished through the fusion of multiple sources of work zone and traffic data. The operational analysis concluded that a moving work activity lasting one hour or more operates best when traffic volumes are under 1,400 vehicles per hour per lane, and preferably under 1,000 vehicles per hour per lane. Further, scheduling shorter duration moving activities on high-volume roads at multiple times (on the same day or on different days) works better than scheduling a longer duration activity. The safety analysis generated tradeoff plots between the number of conflicts and combinations of activity duration and traffic volume. A transportation agency can use these plots to determine, for example, if it should conduct a moving work activity for a short duration when the volume is high or for a longer duration when the volume is lower.

47. Transportation Construction Work-Zone Safety Impact on Time-Related Incentive Contracting Projects

<http://transweb.sjsu.edu/PDFs/research/1224-transportation-construction-work-zone-safety-impact-on-time-related-incentive-contracting-projects.pdf>

This research investigates the statistical relationship between time-related incentive road construction projects and frequency of vehicle crashes in California to understand the impact of time-related incentive provisions on project safety performance. The research team collected incentive and non-incentive project data from the California Department of Transportation. Additionally, vehicle crash data was collected from the California Statewide Integrated Traffic Records System. Using Geographic Information System software, the locations of construction projects and crashes at the project locations were then pinpointed on Geographic Information System centerline layers. The research team performed statistical analyses to test the relationship between the frequency and characteristics of crashes at incentive project sites and ones at non-incentive project sites before, during, and after construction. Finally, the analysis results for both time-related incentive projects and non-incentive projects were summarized to provide project planners and managers with a better understanding of the impact of time-related incentive contracting on project safety performance.

48. Using Simulation Models to Assess the Impacts of Highway Work Zone Strategies: Case Studies along Interstate Highways in Massachusetts and Rhode Island

<https://trid.trb.org/view/848429>

With significant increases in the amount of work zone activity, transportation officials and contractors are challenged with finding ways to reduce the negative impacts on driver mobility. The key to addressing this challenge is to recognize these impacts well in advance. One major tool used for this purpose is computer simulation. There are many simulation models in existence, some of which are designed specifically for work zone analysis. Examples of these models include QUEWZ, QuickZone, and CA4PRS. QuickZone and QUEWZ are designed to estimate delays, queues, and delay-related costs associated with traffic impacts created by work zones. CA4PRS estimates the maximum distance of highway that can be rehabilitated or reconstructed with various project staging plans and resource constraints. This paper includes two case studies that illustrate and evaluate these models in terms of their ease of use, data requirements, and ability to simulate and assess work zone strategies along Interstate 91 in Greenfield, MA and Interstate 95 in West Greenwich, RI. The evaluation sheds light on the relative accuracy of these simulation models as well as their user-friendliness and data requirements. The results of this evaluation will be of interest to State and local transportation engineers responsible for planning and designing work zone strategies.

49. Validating the Performance of Federal Highway Administration Work Zone Model Version 1.0: A Case Study along I-91 in Springfield, Massachusetts

<https://trid.trb.org/view/1496954>

Central to the effective design of work zones is being able to understand how drivers behave as they approach and enter a work zone area. States use simulation tools in modeling freeway work zones to predict work zone impacts and to select optimal design and deployment strategies. While simple and complex microscopic models have been used over the years to analyze driver behavior, most models were not designed for application in work zones. Using data collected from an instrumented research vehicle and model components from two doctoral dissertations, the Federal Highway Administration created the Work Zone Driver Model and programmed the Work Zone Driver Model Dynamic Link Library v1.0, a software that could override car-following in commercial microsimulation software packages so that practitioners can better predict work zone impacts. This paper demonstrates the capabilities of this software, interfaced with VISSIM, and tested on an interstate work zone in Springfield, MA. The Dynamic Link Library's performance is compared to field data collected using an instrumented research vehicle and to Weidemann 99 in VISSIM. Performance metrics were selected to align with State DOT work zone management efforts. Results showed acceptable performance from the Dynamic Link Library, as it predicted queue locations and travel speeds that were near field observations. Limitations of the Dynamic Link Library and interface are discussed, and opportunities for improving version 2.0 are described.

50. Variable Speed Limit Control for Delay and Crash Reductions at Freeway Work Zone Area

<http://dx.doi.org/10.1061/JTEPBS.0000099>

Improving operational efficiency and safety on freeway segments has long been recognized as a priority in traffic communities. This study presents a comprehensive variable speed limit control model for reducing both travel delays and potential crash risks at freeway work zones. The proposed strategy offers the responsible agency a reliable way to determine reasonable speed limits over the control time horizon in response to traffic fluctuations. The control objective of the proposed system is to minimize total operational cost by using embedded functions to estimate total cost with total travel delay and potential crash rate on the targeted freeway segment. This study used a field site in China for its case study to evaluate the effectiveness of the proposed variable speed limit control system. Based on the experimental results, it was observed that the proposed control model shows promise in reducing average delay, number of stops, and average stopped delay on the studied freeway segment. In addition, simulation experiments for sensitivity analysis indicate that the proposed variable speed limit control model is more effective when driver compliance rate exceeds a threshold of 60 percent and the user-defined benefit threshold ranges 10–20 percent.

51. Visibility and Work Zone Traffic Control

<http://www.trb.org/Main/Blurbs/176267.aspx>

This issue contains papers on visibility and work zone traffic control. Specific topics addressed in this issue include the following: pilot vehicles and portable traffic control signals; color changeable message signs; truck-mounted radar speed signs; nighttime overhead sign visibility; rapid auditing of in situ intersection illumination; work zone lighting; work zone impact assessment; work zone coordination software tool; dynamic message sign reporting of work zone congestion; special color pavement marking for highway work zones; and work zone safety performance.

52. Work Zone Coordination Tool

<http://amonline.trb.org/63532-trb-1.3393340/t021-1.3405667/733-1.3405725/17-05292-1.3400900/17-05292-1.3405730?qr=1>

The presented Work Zone Coordination Software tool was developed for providing the New Jersey Department of Transportation with an easy-to-use tool to evaluate the feasibility and effectiveness of coordinating short and long term work zones and measure the benefits of various combinations of projects relative to each other and the status quo. This on-line tool is implemented with a web-based user interface. It integrates all scheduled and active construction projects, identifies conflicts between work zone projects and estimates the benefits of conflict mitigation. The tool currently works with the New Jersey work zone database by automatically importing it to provide up-to-date information to its users. However, the tool is built on a flexible framework that allows the integration of any work zone database, provided that it includes all the required information.

53. Work Zone Impact Assessment Methods and Applications

<https://doi.org/10.3141/2617-07>

Two work zone impact assessment methods were developed and their applicability was illustrated using recent construction projects and actual data from the I-35 Central Texas corridor. The first method was developed for post-event analyses of the impacts of freeway construction activities, incidents, and special events. The impacts have been evaluated in terms of travel times and delays, and an interval estimate for maximum queue length was also provided. Delays and queues were estimated from travel time and speed data obtained by Bluetooth address matching. The method also can be, and has been, used for determining work zone mobility performance measures, verifying the suitability of deployed queue warning systems, and providing feedback for future deployment decisions. The second method was developed for determining the best closure schedule/start time for planned work zone lane closures. The best closure start time is the one that is expected to create the shortest queue lengths, and thus have the least negative impact on travelers. The method runs input-output analysis in a dual-loop framework to analyze the impact of all available closure schedule scenarios, and selects the best closure start time with the shortest expected queues.

54. Work Zone Intelligent Transportation System Implementation Tool v1.0

<https://www.itsforge.net/index.php/community/explore-applications#/40/150>

The [Work Zone Intelligent Transportation System Implementation Guide](#) presents a systems engineering framework for assessing the suitability of intelligent transportation systems as part of an agency's work zone management program. The Work Zone Intelligent Transportation System Implementation Tool serves as a software companion to the Guide, with features that enhance the data collection and quantitative assessments necessary to determine the suitability of intelligent transportation system solutions. This software is intended for use by agencies in support of independent decision-making regarding selection, design, procurement, deployment and evaluation of intelligent transportation systems for construction and maintenance projects.

55. Work Zone Management Capability Maturity Framework On-Line Assessment Tool

<https://ops.fhwa.dot.gov/tsmoframeworktool/tool/wzm/index.htm>

This framework assesses the capability for effective work zone traffic management including assessing work zone impacts and implementing strategies for minimizing or mitigating the impacts. The framework is intended for agencies or regions to assess current capabilities with respect to work zone management. When the current capabilities are determined, the tool provides a list of concrete actions for agencies to raise their capabilities to the desired levels.

56. Work Zone Performance Monitoring Application Development

http://ntl.bts.gov/lib/60000/60200/60259/MD-16-SP309B4C_Work-Zone-Performance-Monitoring_Report.pdf

The Federal Highway Administration requires State transportation agencies to (a) collect and analyze safety and mobility data to manage the work zone impacts of individual projects during

construction and (b) improve overall agency processes and procedures related to work zone safety and mobility. To help achieve these goals, the University of Maryland, in partnership with Maryland State Highway Administration and the Federal Highway Administration, developed a Work Zone Performance Monitoring Application that uses third party probe data for real-time monitoring and evaluation of work zones. The Work Zone Performance Monitoring Application was included as a tool within the Regional Integrated Transportation Information System. This report provides an overview of the Work Zone Performance Monitoring Application as well as methodology used to compute various work zone performance measures. Example applications of the Work Zone Performance Monitoring Application are also provided.

57. Work Zone Safety Performance: Comparison of Alternative Traffic Control Strategies

<https://doi.org/10.3141/2617-11>

This research examined the safety impacts of various temporary traffic control strategies on freeways, including shoulder closures, lane closures, and lane shifts. Data were collected for the periods during which these treatments were in effect and during similar non-construction periods from the preceding year. Safety performance functions were estimated that account for segment length, duration, traffic volume, and closure type. Random parameter count data models were estimated to accommodate segment-specific temporal correlation and unobserved heterogeneity. Crash rates were shown to vary roughly in proportion to traffic volumes. In contrast, segment length and project duration showed inelastic effects; this finding implies that crash rates increase more rapidly in work zones that are shorter in length or duration. Single-lane closures, multilane closures, and lane shifts were associated with an increase in crashes, whereas shoulder closures did not show a significant difference compared with similar, non-work-zone conditions. Ultimately, the study results provide important information that can be used to assess the crash risk for various temporary traffic control strategies.

58. Work Zone Simulator Analysis: Driver Performance and Acceptance of Missouri Alternate Lane Shift Configurations

<https://library.modot.mo.gov/RDT/reports/TR201612/cmr17-002.pdf>

The objective of this project is to evaluate Missouri Department of Transportation's alternate lane shift sign configuration for work zones. The single sign proposed by Missouri Department of Transportation provides the traveler with enough information to let them know that all lanes are available to shift around the work zone, whereas the Manual on Uniform Traffic Control Devices signs require drivers to see two signs. This research simulation project evaluates the drivers' lane shifting performance and acceptance of the alternate lane shift sign proposed by Missouri Department of Transportation to be used on work zones as compared to the Manual on Uniform Traffic Control Devices lane shift signs. Based on the study results, no difference was observed between Manual on Uniform Traffic Control Devices lane shift sign and Missouri Department of Transportation lane shift sign lane shift patterns with respect to driving patterns. In summary, statistical data analysis clearly demonstrated that there was not a noticeable, statistical difference between lane change patterns of drivers in the Missouri Department of Transportation alternate signs with Manual on Uniform Traffic Control Devices signs in the work zone.



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