COMPLIANCE TRAINING ONLINE

Cal/OSHA, DOT HAZMAT, EEOC, EPA, HAZWOPER, HIPAA, IATA, IMDG, TDG, MSHA, OSHA, and Canada OHS Regulations and Safety Online Training

Since 2008

This document is provided as a training aid and may not reflect current laws and regulations.

Be sure and consult with the appropriate governing agencies or publication providers listed in the "Resources" section of our website.

www.ComplianceTrainingOnline.com

Facebook LinkedIn Twitter Website

Reference Guide to Work Zone Traffic Control©

Texas Engineering Extension Service (TEEX)

Infrastructure Training & Safety Institute (ITSI)

TEEX

TRAIN ▪ SERVE ▪ RESPOND

OSHA TRAINING INSTITUTE SOUTHWEST EDUCATION CENTER

REGION VI

Material in this guide is largely extracted from the March, 2006 edition of the Manual on Uniform Traffic Control Devices (MUTCD). The user is referred to the MUTCD for all procedures which are not covered in this guide. This document's specific purpose is for quick reference by personnel who are familiar with all applicable laws, requirements, and ordinances. Again, the user is referred to the MUTCD for answers to all specific questions and for a complete listing of all requirements.

This training is provided under Susan B. Hardwood No. 5H-21004-10-60-F-8 awarded to the Texas Engineering Extension Service from the Occupational Safety and Health Administration, U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Revised January 2011

©2011
Infrastructure Training and Safety Institute
Texas Engineering Extension Service
The Texas A&M System

Table of Contents

Preface iii
Principles of Traffic Control Devices 1
Fundamental Principles of Temporary Traffic Control 1
Temporary Traffic Control Zones 3
Summary–Lane Closure on a Multi-lane Road 17
Lane Closure on a Two-Lane, Two-Way Road Using Flaggers 19
Summary – Lane Closure on a Two-Lane, Two-Way Road 27
Pedestrian and Worker Safety 29
Worker Safety Apparel 31
Signs 32
Barricades 38
Channelizing Devices 36
Pavement Markings 39
Arrow Panels 40
Portable Changeable Message Signs 41
Typical Applications 41
Traffic Incident Management Areas 63

Table 6C-2. Longitudinal Buffer Space……5, 21
Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones 7
Table 6C-4. Merging Taper Lengths and Spacing of Channelizing Devices 8
Table 6C-1. Suggested Advance Warning Sign Spacing 14
Table 6E-1. Stopping Sight Distance as a Function of Speed 21

Preface

In the March, 2006 edition of the TMUTCD, the headings ***Standard****,* ***Guidance****,* ***Option****, and* ***Support*** *are used to classify the nature of the text that follows. In addition, the text contains variations in type (*unbold *and* **bold type***) to classify the nature of the text. In the interest of brevity, these headings have been omitted in this Reference Guide, but the type variations (*unbold *and* **bold type***) have been maintained.*

1. Standard — a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device. The verb shall is typically used, *and* **the text appears in bold type.** *Standard text in the Reference Guide appears in bold type.*

2. Guidance — a statement of recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate. The verb should is typically used, *and* the text appears in unbold type.

3. Option — a statement of practice that is a permissive condition and carries no requirement or recommendation. Options may contain allowable modifications to a Standard or Guidance. The verb may is typically used, *and* the text appears in unbold type.

4. Support — an informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The verbs shall, should, and may are not used in Support statements, *and* the text appears in unbold type.

5. *Any narrative that was added for explanatory purposes to assist TEEX training efforts is shown in italics.*

6. Typical Applications (p. 43-94) were taken from the TxDOT website: http://www.dot.state.tx.us/TRF/mutcd.htm

7. Whenever the acronym "TTC" is used in this guide, it refers to "temporary traffic control."

Principles of Traffic Control Devices

To be effective, a traffic control device should meet five basic requirements:

A. Fulfill a need;
B. Command attention;
C. Convey a clear, simple meaning;
D. Command respect from road users; and
E. Give adequate time for proper response.

General

The needs and control of all road users (motorists, bicyclists, and pedestrians…including persons with disabilities in accordance with the Americans with Disabilities Act of 1990) through a TTC *(temporary traffic control)* **zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.**

Fundamental Principles of Temporary Traffic Control

Experience has shown that following the fundamental principles of Part 6 will assist road users and help protect workers in the vicinity of TTC zones.

Road user and worker safety and accessibility in TTC zones should be an integral and high-priority element of every project from planning through design and construction.

General plans or guidelines should be developed to provide safety for motorists, bicyclists, pedestrians, workers, enforcement/emergency officials, and equipment, with the following factors being considered:

- The goal should be to route road users through such zones using roadway geometrics, roadside features, and TTC devices as nearly as possible comparable to those for normal highway situations.
- A TTC plan….should be prepared and understood by all responsible parties before the site is occupied.

Road user movement should be inhibited as little as practical…

Motorists, bicyclists, and pedestrians should be guided in a clear and positive manner while approaching and traversing TTC zones and incident sites.

To provide acceptable levels of operations, routine day and night inspections of TTC elements should be performed….

Attention should be given to the maintenance of roadside safety during the life of the TTC zone….

Each person whose actions affect TTC zone safety, from the upper-level management through the field workers, should receive training appropriate to the job decisions each individual is required to make.

Good public relations should be maintained …

Before any new detour or temporary route is opened to traffic, all necessary signs shall be in place. All TTC devices shall be removed as soon as practical when they are no longer needed. When work is suspended for short periods of time, TTC devices that are no longer appropriate shall be removed or covered.

Temporary Traffic Control Zones

Most TTC zones are divided into four areas: the advance warning area, the transition area, the activity area, and the termination area.

Activity Area. The activity area is the section of the highway where the work activity takes place. It is comprised of the work space, the traffic space, and the buffer space.

The work space is that portion of the highway closed to road users and set aside for workers, equipment, and material, and a shadow vehicle if one is used upstream.

The optional buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area, and might provide some recovery space for an errant vehicle. Neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space.

Table 6C-2 may be used as a guide to determine longitudinal buffer space. The width of a lateral buffer space should be determined by engineering judgment.

Transition Area. The transition area is that section of highway where road users are redirected out of their normal path. Transition areas usually involve strategic use of tapers…**When redirection of the road users' normal path is required, they shall be channelized from the normal path to a new path.** The criteria for determining the taper length (L) is shown in Table 6C-3 and 6C-4 and should be the minimum used.

Figure 6C-1. Component Parts of a Temporary Traffic Control Zone

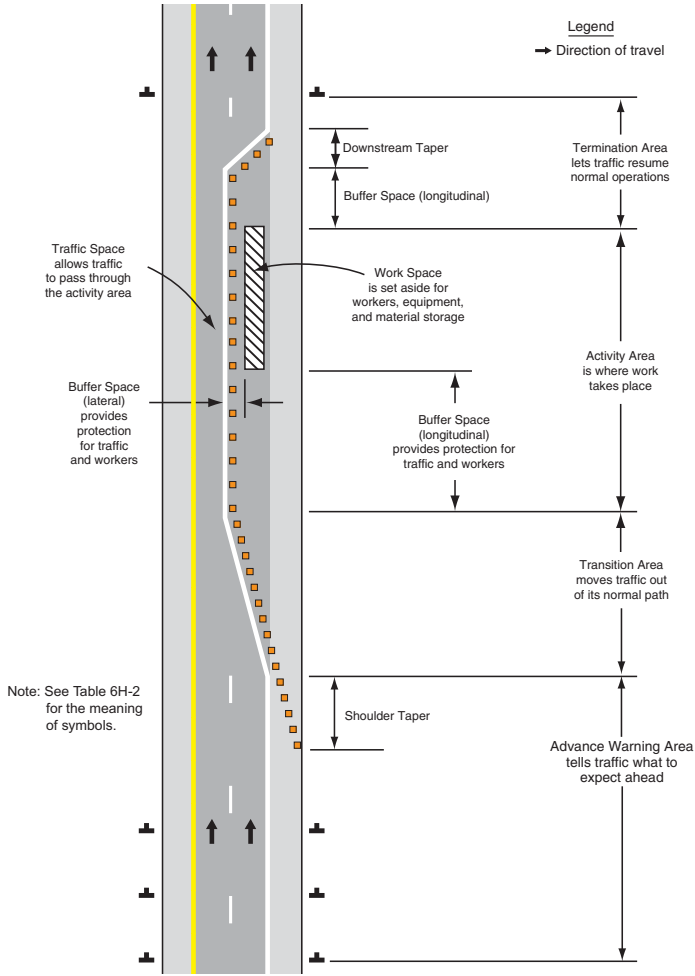


Table 6C-2. Stopping Sight Distance as a Function of Speed

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed

Figure 6C-2. Types of Tapers and Buffer Spaces

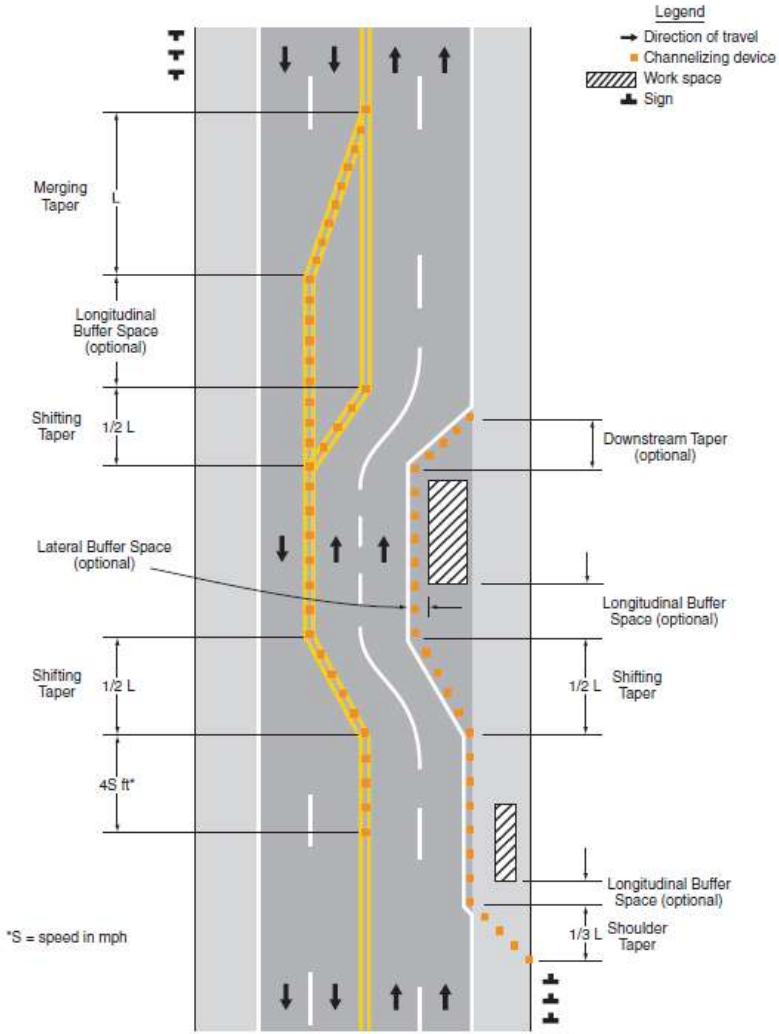


Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones

Type of Taper	Taper Length
Merging Taper	at least L
Shifting Taper	at least 0.5 L
Shoulder Taper	at least 0.33 L
One-Lane, Two-Way Traffic Taper	50 feet minimum, 100 feet maximum
Downstream Taper	50 feet minimum, 100 feet maximum

Note: Use Table 6C-4 to calculate L

Table 6C-4. Formulas for Determining Taper Length

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$

Where: L = taper length in feet
W = width of offset in feet
S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph

When a lane is closed on a multi-lane road for other than a mobile operation, a transition area containing a merging taper shall be used. A merging taper requires the longest distance because drivers are required to merge into an adjacent lane of traffic at the prevailing speed.

A shifting taper should have a length of approximately 0.5 L. A shifting taper is used when merging is not required, but a lateral shift is needed. When more space is available, a longer than minimum taper distance can be beneficial.

If used, shoulder tapers should have a length of approximately 0.33 L.

The one-lane, two-way taper is used in advance of an activity area that occupies part of a two-way roadway in such a way that a portion of the road is used alternately by traffic in each direction. *(Typically, traffic is controlled by a flagger.)* A taper having a length of at least 50 ft with channelizing devices at approximately 20 ft spacings should be used to guide traffic into the one-way section.

A downstream taper may be useful in termination areas to provide a visual cue to the driver that access is available back into the original lane or path that was closed. When used, a downstream taper should have a length of approximately 100 ft per lane with devices placed at a spacing of approximately 20 ft.

Example: Merging Taper Length and Spacing of Devices for Closure of a 12 ft. Lane, with a Posted Speed of 30 MPH.

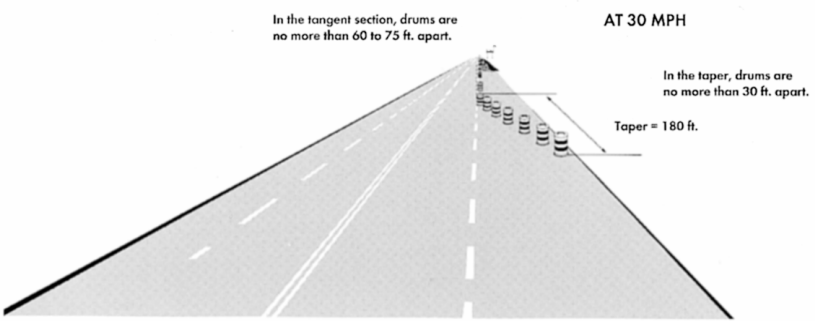


Table 6C-4. Formulas for Determining Taper Length

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$

Where: L = taper length in feet
W = width of offset in feet
S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph

Example: Merging Taper Length and Spacing of Devices for Closure of a 12 ft. Lane, with a Posted Speed of 55 MPH.

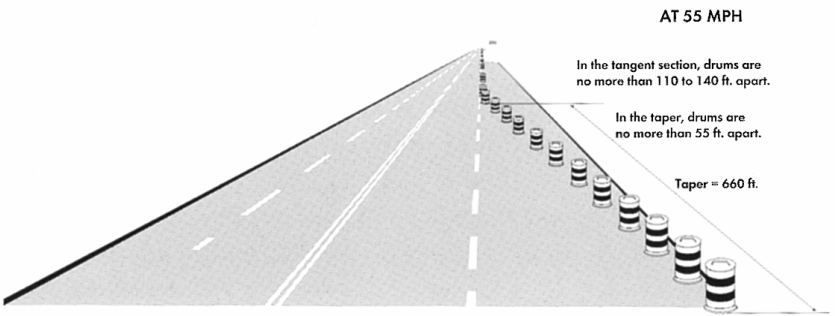


Table 6C-4. Formulas for Determining Taper Length

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$

Where: L = taper length in feet
W = width of offset in feet
S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph

The distance between cones or barrels should not be narrowed to less than 1 times the speed limit in miles per hour. The separation of devices on a tangent should not exceed a distance of 2 times the speed limit.

Advance Warning Area. The advance warning area is the section of highway where road users are informed about the upcoming work zone or incident area.

The Lanes(s) Closed sign shall be used in advance of that point where one or more through lanes of a multi-lane roadway are closed.

For a single lane closure, the Lane Closed sign shall have the legend RIGHT (LEFT, CENTER) LANE CLOSED. Where two adjacent lanes are closed, the CW20-5a sign shall have the legend RIGHT (LEFT) TWO LANES CLOSED.

Table 6C-1 contains information regarding the spacing of advance warning signs.

Table 6C-1. Recommended Advance Warning Sign Minimum Spacing

Road Type	Distance Between Signs**		
	A	B	C
Urban (low speed)*	100 feet	100 feet	100 feet
Urban (high speed)*	350 feet	350 feet	350 feet
Rural	500 feet	500 feet	500 feet
Expressway / Freeway	1,000 feet	1,500 feet	2,640 feet

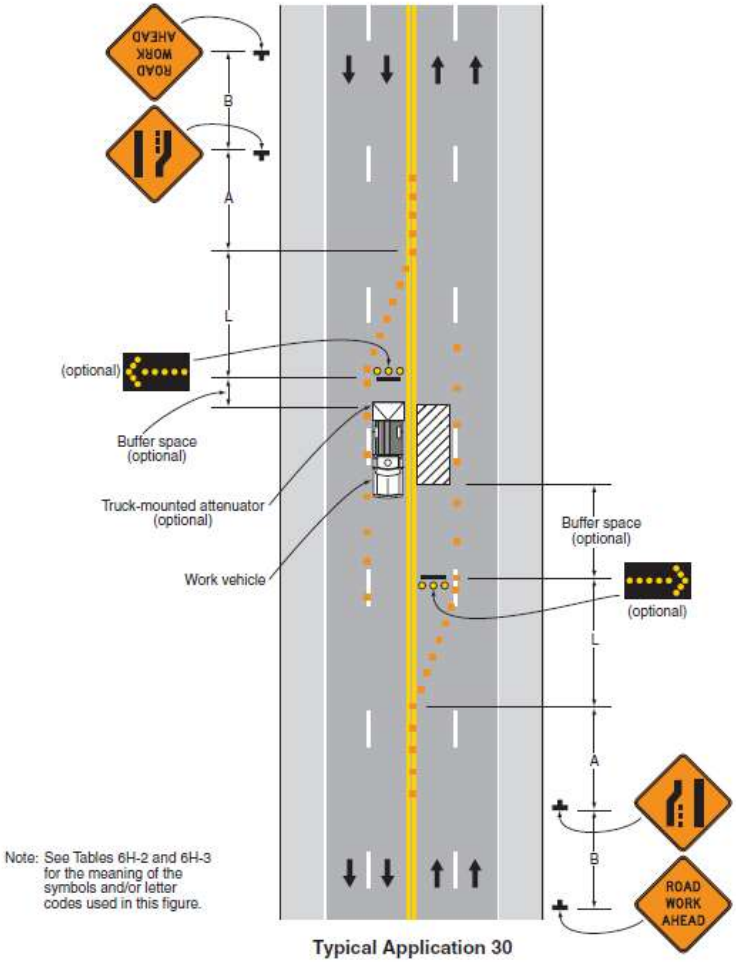
* Speed category to be determined by the highway agency
** The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The "first sign" is the sign in a three-sign series that is closest to the TTC zone. The "third sign" is the sign that is furthest upstream from the TTC zone.)

Typical distances for placement of advance warning signs on freeways and expressways should be longer because drivers are conditioned to uninterrupted flow.

Freeway – a divided highway with full control of access.
Expressway – a divided highway with partial control of access.

(see TA-30 on pages 77-78)

Figure 6H-30. Interior Lane Closure on a Multi-Lane Street (TA-30)

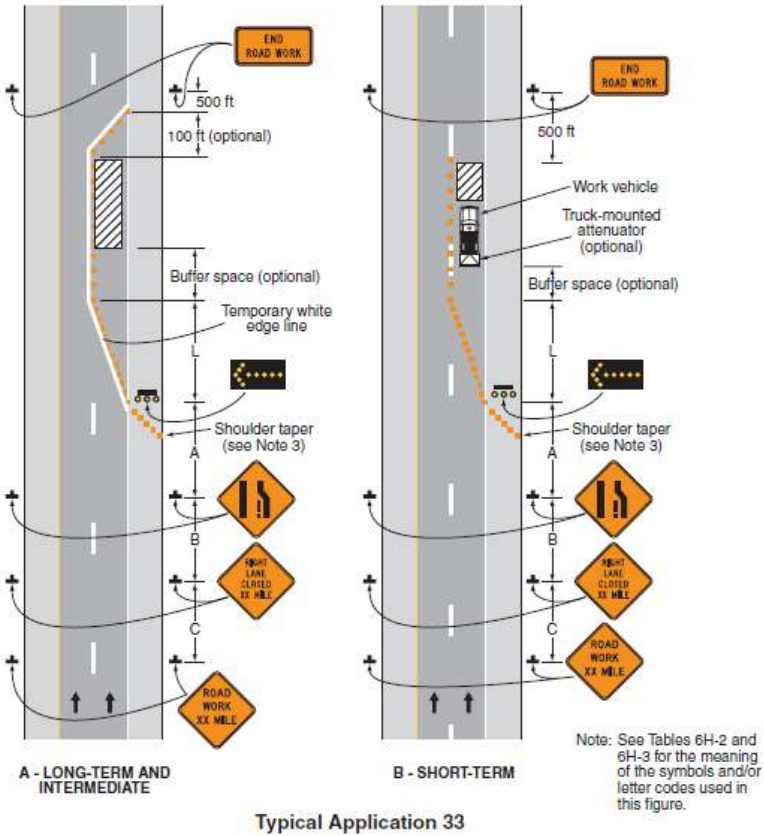


Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Typical Application 30

(See TA -33 on pages 81-82)

Figure 6H-33. Stationary Lane Closure on a Divided Highway (TA-33)



Typical Application 33

Summary - - Lane Closure on a Multi-lane Road

This is a step-by-step summary of procedures for planning a lane closure on a multi-lane road. It was developed for explanatory purposes to assist TEEX training efforts.

1) *Select the proper Typical Application, such as TA-30.*

2) *Sketch the road where the work is to be performed.*

3) *Sketch the work space, including room for the workers, materials, and equipment.*

4) *Decide whether or not to have the optional lateral or longitudinal buffer space. If the longitudinal buffer space is used, determine the length from Table 6C-2 and sketch it on the approaching traffic side of the work space. The width of the lateral buffer space should be determined by engineering judgment. While the buffer space is optional, it is recommended since it provides a recovery area for errant vehicles. The buffer space must be kept free of workers, vehicles, equipment and material.*

5) *Determine the length of the merging taper from Table 6C-4 and sketch this distance on the approaching traffic side of the buffer or work space.*

6) *Determine the signs and sign spacing from the Typical Application, and sketch these on the approaching side of the merging taper.*

7) *The merging taper should be visible for a long distance, and the location of the beginning of the taper should be checked in the field with respect to a hill or curve. If the beginning of the taper is just over a hill, or around a curve, the designer should make adjustments by lengthening the buffer space and/or taper length.*

8) *The designer should also inspect in the field the location where the initial advance warning sign is to be placed. The initial sign should be visible for a long distance, and should be located in front of vertical or horizontal curves. In urban areas, the far sides of intersections frequently have good visibility and should be considered for sign locations. If needed, additional signs should be placed to ensure good visibility.*

The traffic control is set up starting with the first sign motorists will see. The installation of devices then proceeds through the advance warning area, the transition area, the activity area and the termination area. Devices should be removed in the reverse sequence to that used for installation. The supervisor should review the installation and removal process with the crew before going to the field.

Law enforcement units heighten the awareness of passing traffic, and provide added protection for work crews during the installation and removal process.

Lane Closure on a Two-Lane, Two-Way Road Using Flaggers

When traffic in both directions must use a single lane for a limited distance, movements from each end shall be coordinated.

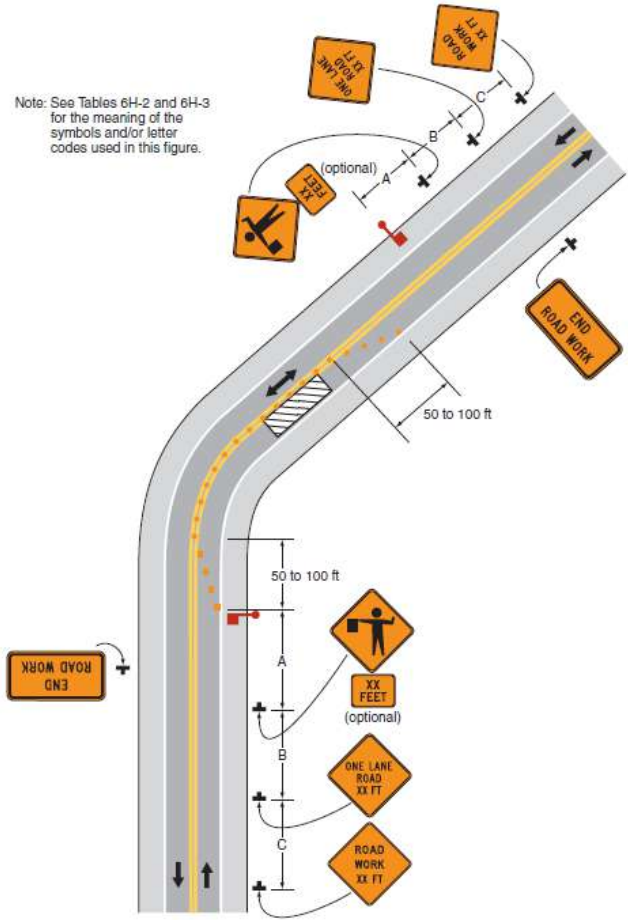
When a one-lane, two-way TTC zone is short enough to allow a flagger to see from one end of the zone to the other, traffic may be controlled by either a single flagger or by a flagger at each end of the section. When good visibility and traffic control cannot be maintained by one flagger station, traffic should be controlled by a flagger at each end of the section.

The flagger should stand either on the shoulder adjacent to the road user being controlled or in the closed lane prior to stopping road users. A flagger should only stand in the lane being used by moving road users after road users have stopped.

Except in emergency situations, flagger stations shall be preceded by an advance warning sign or signs. Except in emergency situations, flagger stations shall be illuminated at night. The Flagger symbol sign should be used in advance of any point where a flagger is stationed to control road users. The FLAGGER word message sign with distance legends may be substituted for the Flagger symbol sign.

(See TA-10 on Pages 53-54)

Figure 6H-10. Lane Closure on a Two-Lane Road Using Flaggers (TA-10)



Typical Application 10

Flagger stations should be located such that an errant vehicle has additional space to stop without entering the work space. Table 6C-2 may be used…to determine longitudinal buffer space.

Table 6C-2. Stopping Sight Distance as a Function of Speed

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed

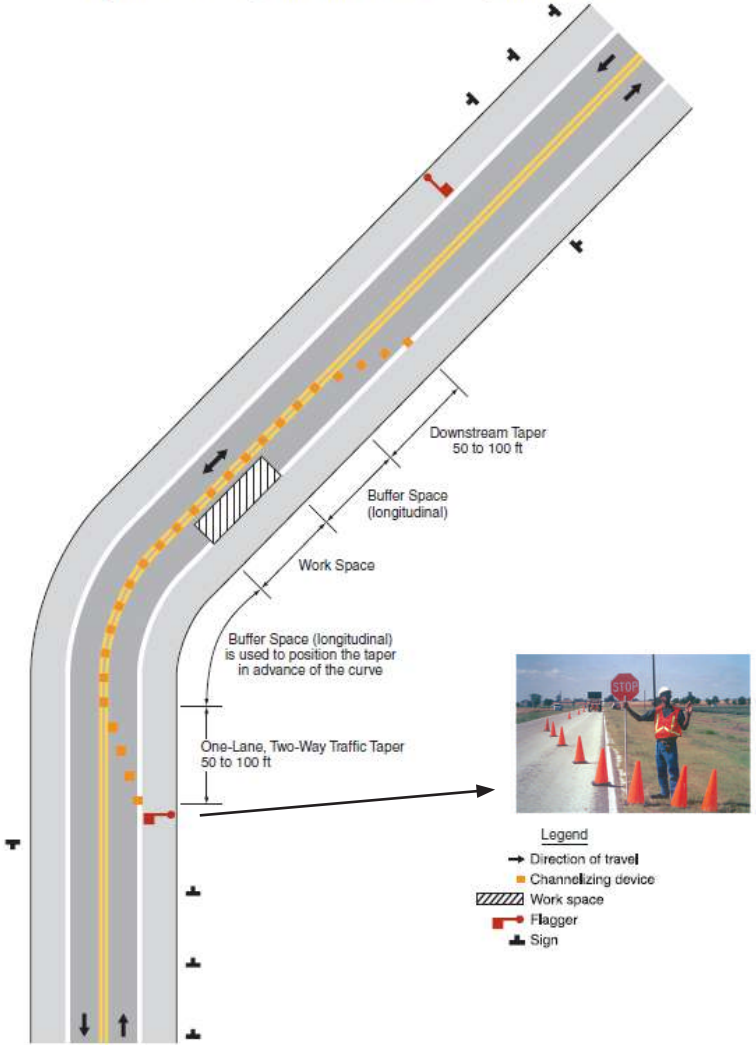
Flagger stations shall be located such that approaching road users will have sufficient distance to stop at the intended stopping point. The distances shown in Table 6E-1…may be used for the location of a flagger station.

Table 6E-1. Stopping Sight Distance as a Function of Speed

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed

Figure 6C-3. Example of a One-Lane, Two-Way Traffic Taper



Hand-Signaling Devices. The STOP/SLOW paddle should be the primary and preferred hand-signaling device because the STOP/SLOW paddle gives road users more positive guidance than red flags. Use of flags should be limited to emergency situations or at low-speed and/or low volume locations which can best be controlled by a single flagger. The use of paddles and flags by flaggers are illustrated in Figure 6E-1.

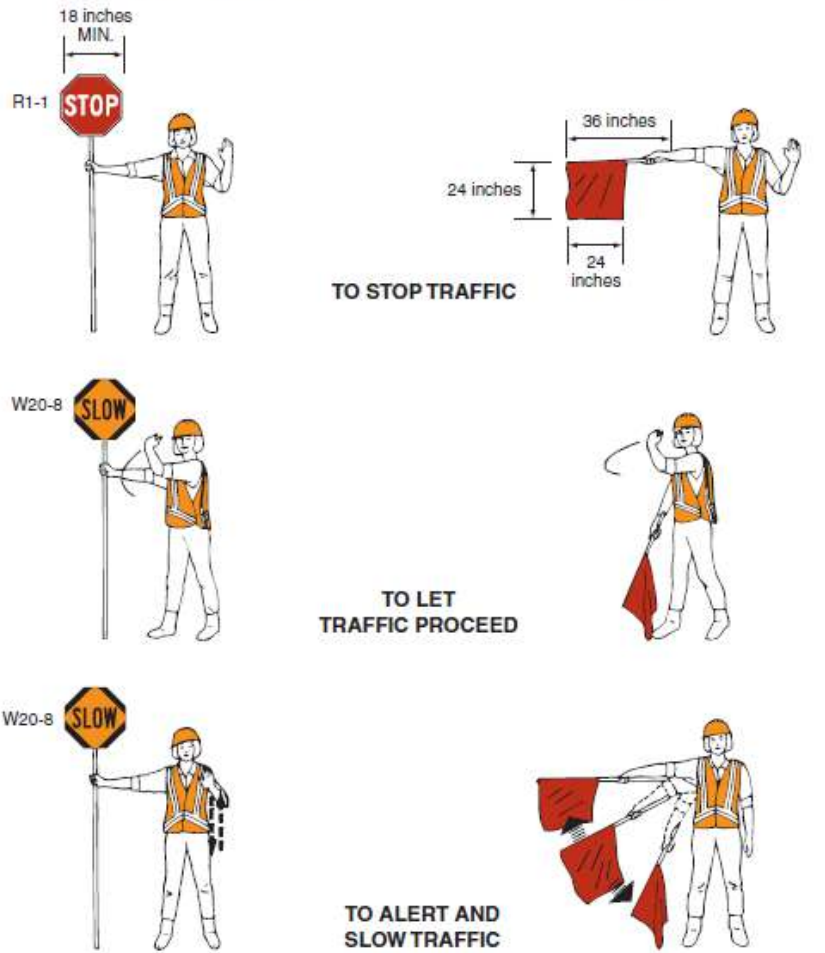
STOP/SLOW paddles shall be at least 18 inches wide with letters at least 6 inches high and should be fabricated from light semirigid material.

Flags, when used, shall be a minimum of 24 inches square, made of a good grade of red material, and securely fastened to a staff that is approximately 36 inches in length.

Pilot Car Method of One-Lane, Two-Way Traffic Control.
A pilot car may be used to guide a queue of vehicles through the TTC zone or detour. The operation of the pilot vehicle should be coordinated with flagging operations or other controls at each end of the one-lane section. The pilot car should have the name of the contractor or contracting authority prominently displayed.

The PILOT CAR FOLLOW ME sign shall be mounted at a conspicuous location on the rear of the vehicle.

Figure 6E-3. Use of Hand-Signaling Devices by Flaggers



High-Visibility Safety Apparel. For daytime and nighttime activity, flaggers shall wear safety apparel meeting the requirements of ISEA "American National Standard for High-Visibility Apparel" and labeled as meeting the ANSI 107-1999 standard performance for Class 2 or class 3 risk exposure.

The apparel background (outer) material shall be either fluorescent orange-red or fluorescent yellow-green or a combination of these colors.

For nighttime activity, safety apparel...labeled as meeting the ANSI 107-1999 standard performance for Class 3 risk exposure should be considered for flagger wear.

When uniformed law enforcement officers are used, high-visibility safety apparel as described in this Section should be worn by the law enforcement officer.

Qualifications for Flaggers. Because flaggers are responsible for public safety and make the greatest number of contacts with the public of all highway workers, they should be trained in safe traffic control practices and public contact techniques.

ANSI/ISEA 107-1999 class 2 vest.

Flaggers should be able to satisfactorily demonstrate the following abilities:

A. Ability to receive and communicate specific instructions clearly, firmly, and courteously;
B. Ability to move and maneuver quickly in order to avoid danger from errant vehicles;
C. Ability to control signaling devices (such as paddles and flags) in order to provide clear and positive guidance to drivers approaching a TTC zone in frequently changing situations.
D. Ability to understand and apply safe traffic control practices, sometimes in stressful or emergency situations; and
E. Ability to recognize dangerous traffic situations and warn workers in sufficient time to avoid injury.

Summary – Lane Closure on a Two-Lane, Two-Way Road

This is a step-by-step summary of procedures for planning a lane closure, using flaggers, on a two-lane, two-way road. It was developed for explanatory purposes to assist TEEX training efforts.

1) *Select the appropriate Typical Application, such as TA-10.*

2) *Sketch the section of the road where the work is to be performed.*

3) *Sketch the work space, including room for the workers, materials, and equipment.*

4) *Sketch in the buffer space distance down the centerline of the road away from the work space. Table 6C-2 (which provides the braking distance portion of stopping sight distance) may be used as a guide to determine the longitudinal buffer space distance.*

5) *Sketch in a 50 ft. to 100 ft. one-lane, two-way traffic taper from the centerline of the road (away from the work space) toward the shoulder, and sketch in the closed lane flagger position. Devices on this taper will be spaced at approximately 20 ft. spacings.*

6) *Sketch in the position of the open lane flagger 200 ft. beyond the end of the downstream taper.*

7) *Drivers must be able to see the flaggers from an adequate distance so they can stop at the intended stopping point, and the planned flagger locations must be checked in the field with respect to driver visibility. If a flagger would be located over a hill or around a curve, the flagger station must be moved further away from the work space to a location with adequate driver visibility. The distances shown in Table 6E-1, which provides information regarding the stopping sight distance, may be used for the location of a flagger station.*

8) *Determine the signs and sign spacing from the Typical Application, and sketch in these signs and distances.*

9) *The locations where the initial signs are to be placed should also be checked in the field with respect to a hill or curve. If needed, additional signs should be placed to ensure good visibility.*

Traffic control is typically set up in the "open lane" first, beginning with the Road Work Ahead sign. After all "open lane" signs are in place, the "open lane" flagger is positioned, and can stop traffic as necessary while the "closed lane" signs and flagger are positioned. Both flaggers can then stop traffic while the channelizing devices are placed.

After the work is completed, remove the traffic control in the reverse order from which it was installed. The supervisor should review the installation and removal process with the crew before going to the field.

Pedestrian and Worker Safety

<u>Pedestrian Considerations.</u> The various TTC provisions for pedestrian and worker safety set forth in Part 6 shall be applied by knowledgeable (for example, trained and/or certified) persons after appropriate evaluation and engineering judgment.

Advance notification of sidewalk closures shall be provided… It must be recognized that pedestrians are reluctant to retrace their steps to a prior intersection for a crossing…The following three items should be considered when planning for pedestrians in TTC zones:

A. Pedestrians should not be led into conflicts with work site vehicles, equipment, and operations.

B. Pedestrians should not be led into conflicts with vehicles moving through or around the work site.

C. Pedestrians should be provided with a reasonably safe, convenient, and accessible path that replicates as nearly as practical the most desirable characteristics of the existing sidewalk(s) or footpath(s).

<u>Worker Safety Considerations.</u> Equally as important as the safety of road users traveling through the TTC zone is the safety of workers. Maintaining TTC zones with road user flow inhibited as little as possible, and using TTC devices that get the road user's attention and provide positive direction are of particular importance. Likewise, equipment and vehicles moving within the activity area create a risk to workers on foot. When possible, the

separation of moving equipment and construction vehicles from workers on foot provides the operator of these vehicles with a greater separation clearance and improved sight lines to minimize exposure to the hazards of moving vehicles and equipment. The following are the key elements of worker safety and TTC management that should be considered to improve worker safety:

A. Training—all workers should be trained on how to work next to motor vehicle traffic in a way that minimizes their vulnerability.

B. Temporary Traffic Barriers—temporary traffic barriers should be placed along the work space…

C. Speed Reduction—reducing the speed of vehicular traffic…should be considered.

D. Activity Area—planning the internal work activity area to minimize backing-up maneuvers of construction vehicles should be considered to minimize the exposure to risk.

E. Worker Safety Planning—a competent person designated by the employer should conduct a basic hazard assessment for the work site and job classifications required in the activity area.

Worker Safety Apparel

Visibility of workers is critical in public. When motorists or operators of heavy machinery can see workers on foot, the workers are more secure. The high visibility clothing that meets ANSI/ISEA standards is the worker's first line of defense against accidents.

All workers must wear hight visibility safety apparel that meets ANSI standards for Class 1, 2, and 3 exposure. The person designated by the employeras responsible for the safety of workers must select the most appropriate type of clothing

According to 2008 regulations on worker visibility, all workers on federally funded road projects should use high visibility protective clothing that complies with ANSI/ISEA 107-2004 for expoure of Class 2 or Class 3.

Signs

TTC zone signs convey both general and specific messages by means of words or symbols and have the same three categories as all road user signs: regulatory, warning, and guide.

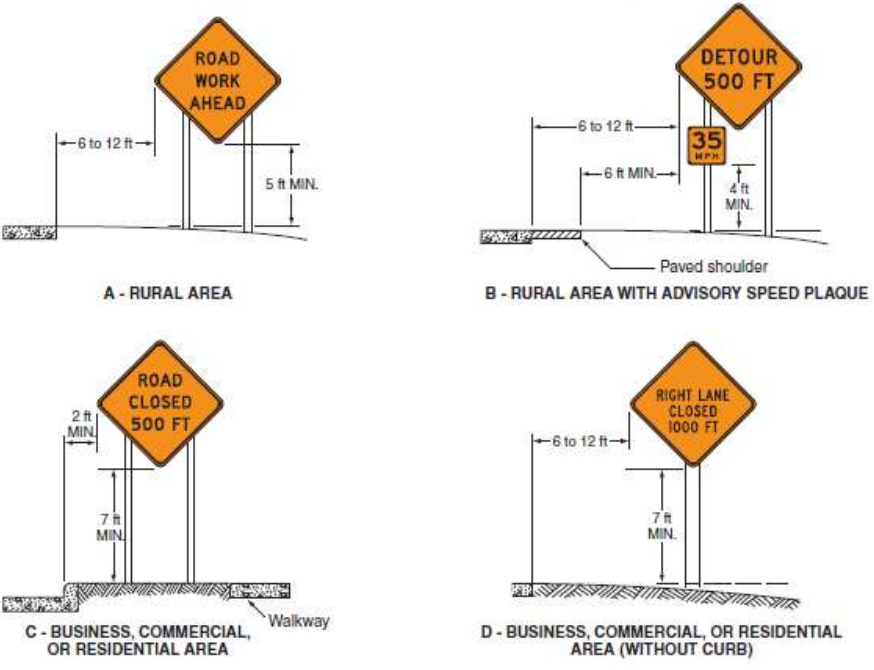
Brackets and signs must comply with NCHRP350 standards (until Dec. 31, 2010), and if it is a new product, comply with MASH (after Jan. 1, 2011).

All signs used at night shall be either retroreflective…or illuminated to show the same shape and similar color both day and night. Signs that have lost significant legibility shall be promptly replaced.

Signs shall be covered or removed when work is not in progress.

Neither portable nor permanent sign supports should be located on sidewalks, bicycle facilities, or areas designated for pedestrian or bicycle traffic.

Figure 6F-1. Height and Lateral Location of Signs—Typical Installations



Ground-mounted signs installed at the side of the road in rural areas shall be mounted at a height at least 7 ft, measured from the bottom of the sign to the near edge of the pavement.

The height to the bottom of a secondary sign mounted below another sign may be 1 ft less than the appropriate height specified above.

Work Duration

The five categories of work duration and their time at a location shall be:

A. Long-term stationary is work that occupies a location more than 3 days.

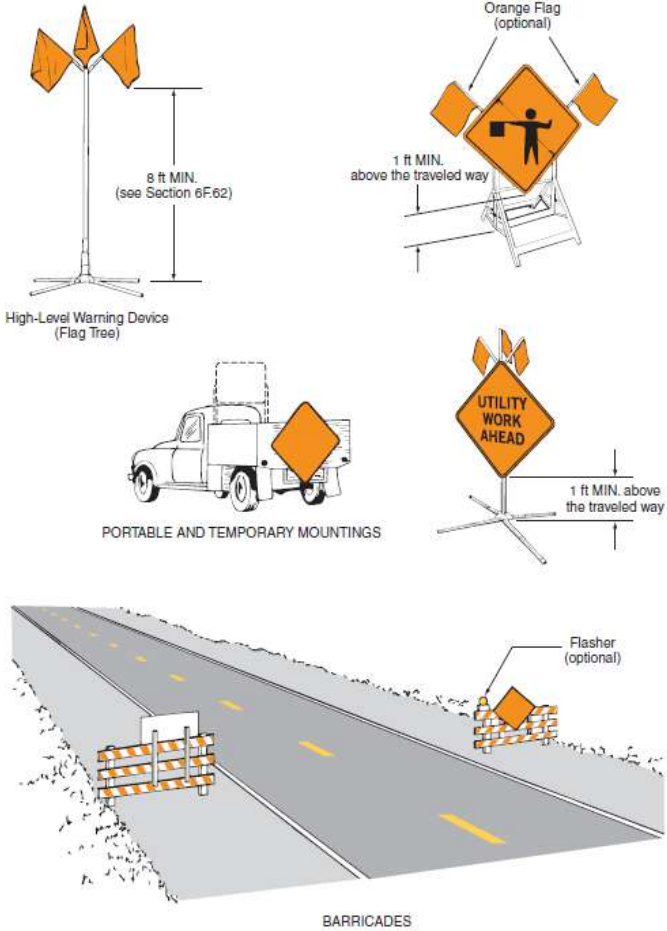
B. Intermediate-term stationary is work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more than 1 hour.

C. Short-term stationary is daytime work that occupies a location for more than 1 hour within a single daylight period.

D. Short duration is work that occupies a location up to 1 hour.

E. Mobile is work that moves continuously or intermittently (stopping up to approximately 15 minutes).

Figure 6F-2. Methods of Mounting Signs Other Than on Posts



Signs mounted…on portable supports…shall be no less than 1 ft above the traveled way.

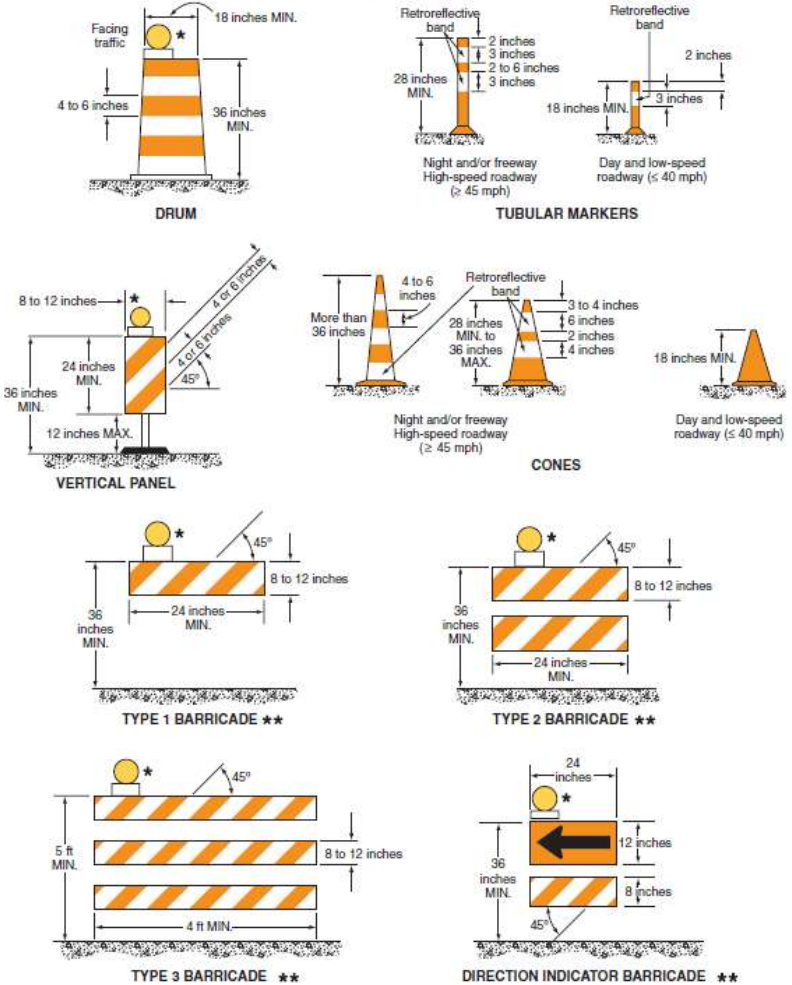
Channelizing Devices

Channelizing devices include cones, tubular markers, vertical panels, drums, barricades, longitudinal channelizers and temporary raised islands.

Channelizing devices must comply with national standards NCHRP 350 (until December 31, 2010) and, if a new product, with MASH (after January 1, 2011). NOTE: Although this is a requirement of the 2009 MUTCD, the 2003 MUTCD (which is still used in some states) says that "channelizing devices must meet NCHRP 350 national standards." This means that channeling devices must meet NCHRP 350 or MASH as appropriate in each case.

Particular attention should be given to maintaining the channelizing devices to keep them clean, visible, and properly positioned at all times.

Figure 6F-7. Channelizing Devices



* Warning lights (optional)
** Rail stripe widths shall be 6 inches, except that 4-inch wide stripes may be used if rail lengths are less than 36 inches. The sides of barricades facing traffic shall have retroreflective rail faces.

Barricades

A barricade is a portable or fixed device having from one to three rails with appropriate markings and is used to control road users by closing, restricting, or delineating all or a portion of the right-of-way.

Type I Barricades may be used on conventional roads or urban streets. Type II or Type III Barricades should be used on freeways and expressways or other high-speed roadways.

Type I or Type II Barricades are intended for use in situations where road user flow is maintained through the TTC zone. Type III Barricades should be used to close or partially close a road.

Stripes on barricade rails shall be alternating orange and white retroreflective stripes sloping downward at an angle of 45 degrees in the direction road users are to pass.

Pavement Markings

Road users should be provided pavement markings within a TTC zone comparable to the pavement markings normally maintained along such roadways, particularly at either end of the TTC zone.

Pavement markings shall be maintained along paved streets and highways in all long- and intermediate-term stationary TTC zones. Markings should be provided in intermediate-term, stationary work zones. **Pavement marking alignment shall match the alignment in place at both ends of the TTC zone.**

For long-term stationary operations, pavement markings in the temporary traveled way that are no longer applicable shall be removed or obliterated as soon as practical.

All pavement markings and devices used to delineate road user paths shall be carefully reviewed during daytime and nighttime periods.

Temporary Pavement Markings. Temporary pavement markings are those that are allowed to remain in place until the earliest date when it is practical and possible to install pavement markings that meet the Part 3 standards for pavement markings. Temporary pavement markings should not be in place for more than 2 weeks unless justified using engineering judgment.

Raised Pavement Markers. Raised pavement markers should be considered for use along surfaced detours or temporary roadways, and other changed or new travel-lane alignments.

Arrow Panels

An arrow panel should be placed on the shoulder of the roadway or, if practical, further from the traveled lane. It should be delineated with retroreflective TTC devices. When an arrow panel is not being used, it should be removed; if not removed, it should be shielded; or if the previous two options are not feasible, it should be delineated with retroreflective TTC devices.

Arrow panel elements shall be capable of at least a 50 percent dimming from full brilliance. The dimmed mode shall be used for nighttime operation of arrow panels. Full brilliance should be used for daytime operation of arrow panels.

An arrow panel in the arrow or chevron mode shall be used only for stationary or moving lane closures on multi-lane roadways.

Arrow panel(s) shall not be used to laterally shift traffic. When arrow panels are used to close multiple lanes, a separate arrow panel shall be used for each closed lane.

For shoulder work, blocking the shoulder, for roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway, an arrow panel shall be used only in the caution mode.

A vehicle displaying an arrow panel shall be equipped with high-intensity rotating, flashing, oscillating, or strobe lights.

Portable Changeable Message Signs

The primary purpose of Portable Changeable Message signs in TTC zones is to advise the road user of unexpected situations. Portable Changeable Message signs have a wide variety of applications in TTC zones including: roadway, lane, or ramp closures, crash or emergency incident management, width restriction information, speed control or reductions, advisories on work scheduling,...warning of adverse conditions, or special events, and other operational control.

Typical Applications

The goal of TTC in work zones is safety with minimum disruption to road users. The key factor in promoting TTC zone safety is proper judgment.

Chapter 6H presents typical applications for a variety of situations commonly encountered. In general, the procedures illustrated represent minimum solutions for the situations depicted. While not every situation is addressed, the information illustrated can generally be adapted to a broad range of conditions. Applying these guidelines to actual situations and adjusting to field conditions requires engineering judgment.

The typical applications provided are from the 2009 MUTCD.

Table 6H-2. Meaning of Symbols on Typical Application Diagrams

Arrow board

Arrow board support or trailer (shown facing down)

Changeable message sign or support trailer

Channelizing device

Crash cushion

Direction of temporary traffic detour

Direction of traffic

Flagger

High-level warning device (Flag tree)

Longitudinal channelizing device

Luminaire

Pavement markings that should be removed for a long-term project

Shadow vehicle

Sign (shown facing left)

Surveyor

Temporary barrier

Temporary barrier with warning light

Traffic or pedestrian signal

Truck-mounted attenuator

Type 3 barricade

Warning light

Work space

Work vehicle

Notes for Figure 6H-1—Typical Application 1

Work Beyond the Shoulder

Guidance:

1. If the work space is in the median of a divided highway, an advance warning sign should also be placed on the left side of the directional roadway.

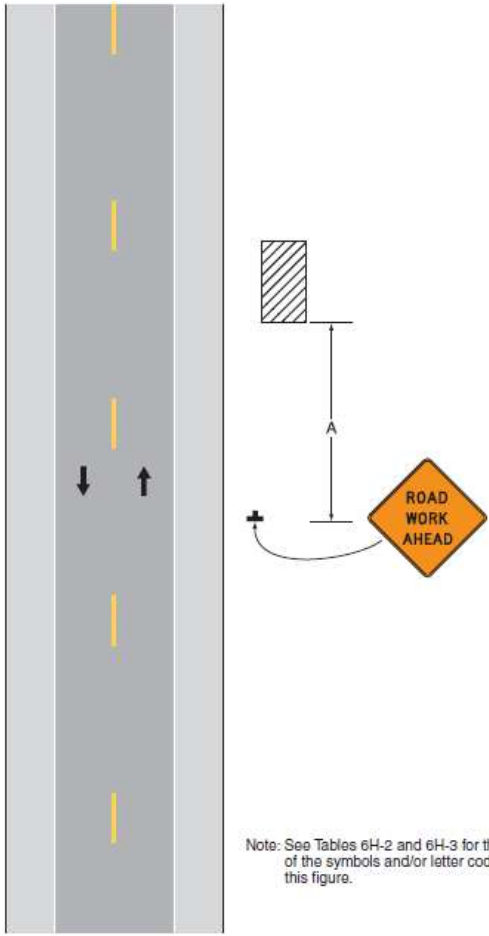
Option:

2. The ROAD WORK AHEAD sign may be replaced with other appropriate signs such as the SHOULDER WORK sign. The SHOULDER WORK sign may be used for work adjacent to the shoulder.
3. The ROAD WORK AHEAD sign may be omitted where the work space is behind a barrier, more than 24 in behind the curb, or 15 ft or more from the edge of any roadway.
4. For short-term, short-duration or mobile operation, all signs and channelizing devices may be eliminated if a vehicle with activated high-intensity rotating, flashing, oscillating, or strobe lights is used.
5. Vehicle hazard warning signals may be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights

Standard:

6. **Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**

Figure 6H-1. Work Beyond the Shoulder (TA-1)



Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Typical Application 1

Notes for Figure 6H-3—Typical Application 3

Work on Shoulders

Guidance:

1. A SHOULDER WORK sign should be placed on the left side of the roadway for a divided or one-way street only if the left shoulder is affected.

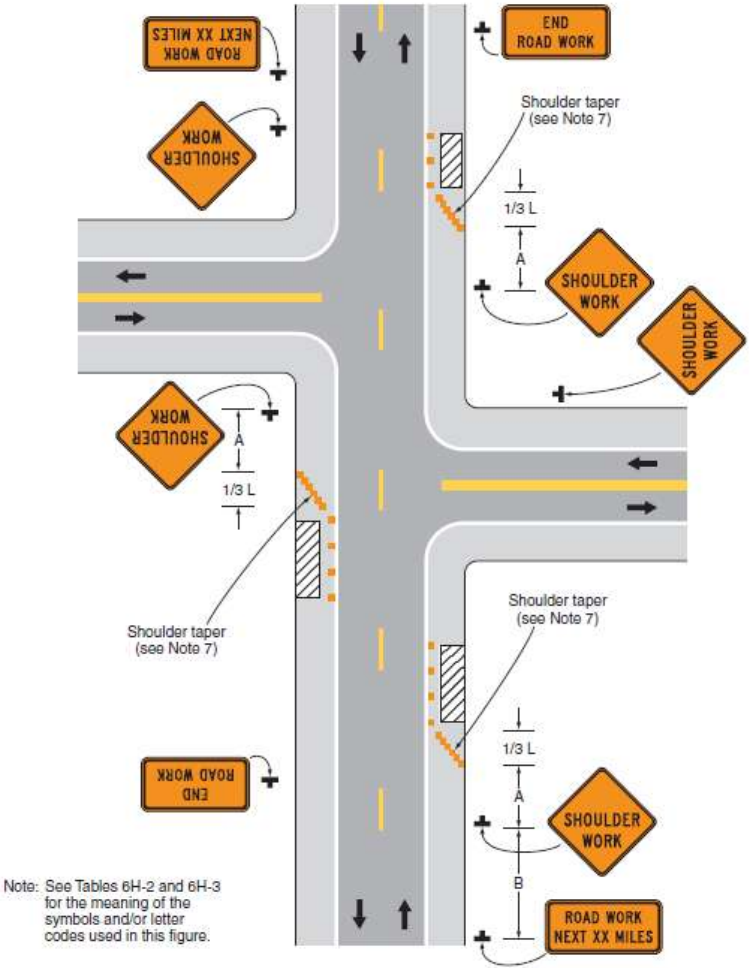
Option:

2. The Workers symbol signs may be used instead of SHOULDER WORK signs.
3. The SHOULDER WORK AHEAD sign on an intersecting roadway may be omitted where drivers emerging from that roadway will encounter another advance warning sign prior to this activity area.
4. For short-duration operations of 60 minutes or less, all signs and channelizing devices may be eliminated if a vehicle with activated high-intensity rotating, flashing, oscillating, or strobe lights is used.
5. Vehicle hazard warning signals may be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights.

Standard:

6. **Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**
7. **When paved shoulders having a width of 8 ft or more are closed, at least one advance warning sign shall be used. In addition, channelizing devices shall be used to close the shoulder in advance to delineate the beginning of the work space and direct vehicular traffic to remain within the traveled way.**

Figure 6H-3. Work on the Shoulders (TA-3)



Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Typical Application 3

Notes for Figure 6H-10—Typical Application 10

Lane Closure for One Lane-Two Way Traffic Control

Option:

1. For low-volume situations with short work zones on straight roadways where the flagger is visible to road users approaching from both directions, a single flagger, positioned to be visible to road users approaching from both directions, may be used (see Chapter 6E).
2. The ROAD WORK AHEAD and the END ROAD WORK signs may be omitted for short-duration operations.
3. Flashing warning lights and/or flags may be used to call attention to the advance warning signs. A BE PREPARED TO STOP sign may be added to the sign series.

Guidance:

4. The buffer space should be extended so that the two-way traffic taper is placed before a horizontal (or crest vertical) curve to provide adequate sight distance for the flagger and a queue of stopped vehicles.

Standard:

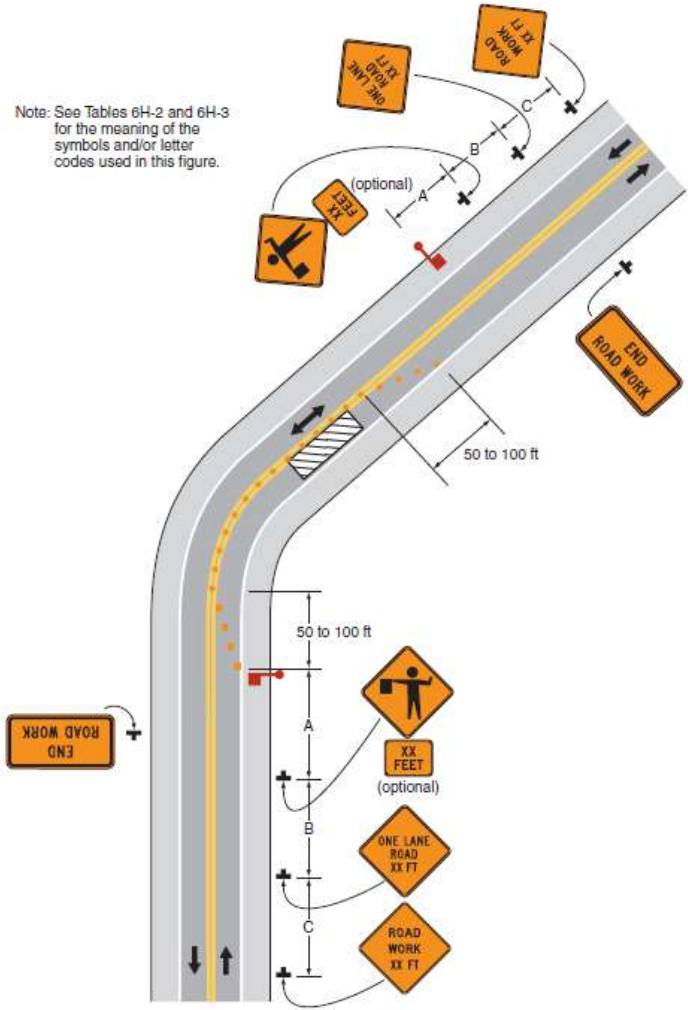
5. **At night, flagger stations shall be illuminated, except in emergencies.**

Guidance:

6. When used, the BE PREPARED TO STOP sign should be located between the Flagger sign and the ONE LANE ROAD sign.
7. When a highway-rail grade crossing exists within or upstream of the transition area and it is anticipated that queues resulting from the lane closure might extend through the highway-rail grade crossing, the TTC zone should be extended so that the transition area precedes the highway-rail grade crossing.
8. When a highway-rail grade crossing equipped with active warning devices exists within the activity area, provisions should be made for keeping flaggers informed as to the activation status of these warning devices.
9. When a highway-rail grade crossing exists within the activity area, drivers operating on the left side of the normal centerline should be provided with comparable warning devices as for drivers operating on the right side of the normal centerline.
10. Early coordination with the railroad company should occur before work starts.

Option:

11. A flagger or a uniformed law enforcement officer may be used at the highway-rail grade crossing to minimize the probability that vehicles are stopped within 15 ft of the highway-rail grade crossing, measured from both sides of the outside rails.



Typical Application 10

Notes for Figure 6H-17—Typical Application 17

Mobile Operations on Two-Lane Road

Standard:

1. **Vehicle-mounted signs shall be mounted in a manner such that they are not obscured by equipment or supplies. Sign legends on vehicle-mounted signs shall be covered or turned from view when work is not in progress.**
2. **Shadow and work vehicles shall display high-intensity rotating, flashing, oscillating, or strobe lights.**
3. **If an arrow panel is used, it shall be used in the caution mode.**

Guidance:

4. Where practical and when needed, the work and shadow vehicles should pull over periodically to allow vehicular traffic to pass.
5. Whenever adequate stopping sight distance exists to the rear, the shadow vehicle should maintain the minimum distance from the work vehicle and proceed at the same speed. The shadow vehicle should slow down in advance of vertical or horizontal curves that restrict sight distance.
6. The shadow vehicles also be equipped with two high-intensity flashing lights mounted on the rear, adjacent to the sign.

Option:

7. The distance between the work and shadow vehicles may vary according to terrain, work activity, and other factors.
8. Additional shadow vehicles to warn and reduce the speed of oncoming or opposing vehicular traffic may be used. Law enforcement vehicles may be used for this purpose.
9. A truck-mounted attenuator may be used on the shadow vehicle or on the work vehicle.
10. If the work and shadow vehicles cannot pull over to allow vehicular traffic to pass frequently, a DO NOT PASS sign may be placed on the rear of the vehicle blocking the lane.

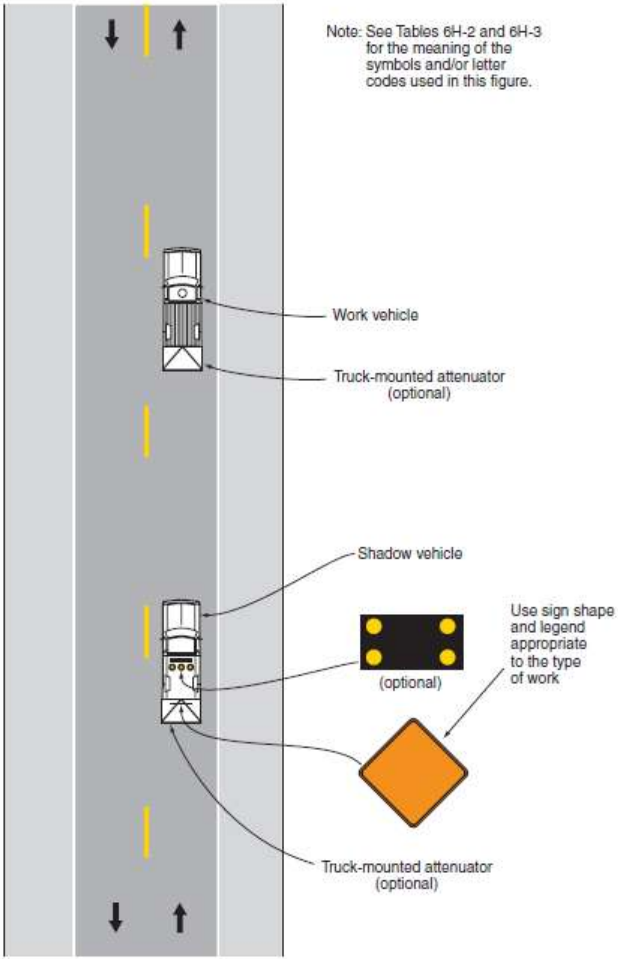
Support:

11. Shadow vehicles are used to warn motor vehicle traffic of the operation ahead.

Standard:

12. **Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**

Figure 6H-17. Mobile Operations on a Two-Lane Road (TA-17)



Typical Application 17

Notes for Figure 6H-22—Typical Application 22

Right Lane Closure on Far Side of Intersection

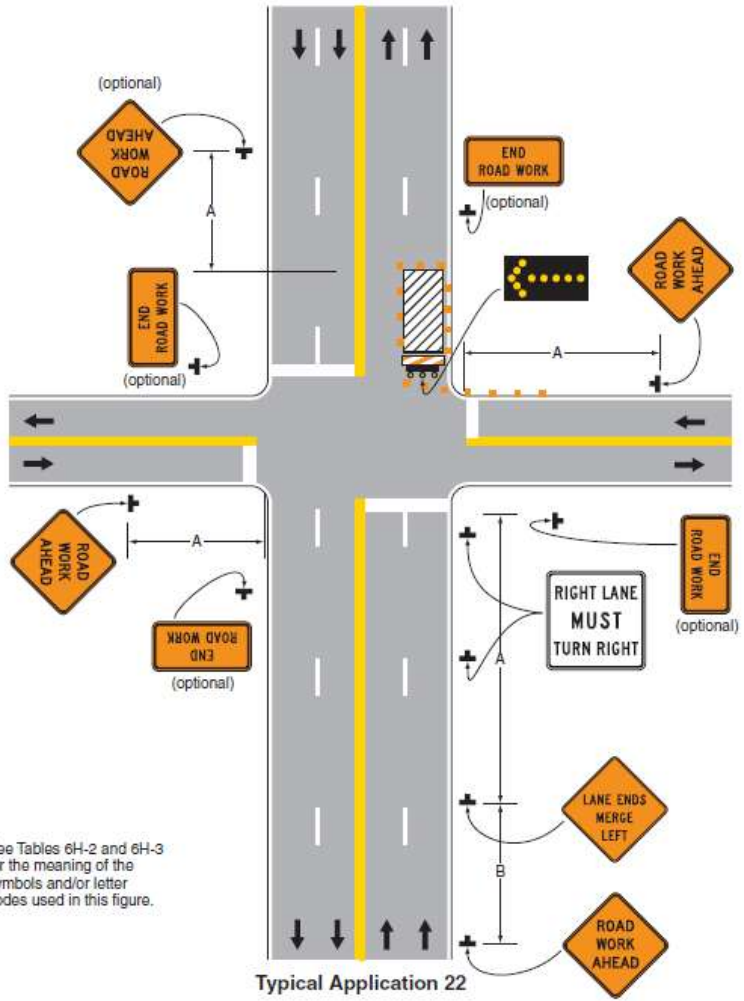
Guidance:

1. If the work space extends across a crosswalk, the crosswalk should be closed using the information and devices shown in Figure 6H-29.

Option:

2. The normal procedure is to close on the near side of the intersection any lane that is not carried through the intersection. However, when this results in the closure of a right lane having significant right turning movements, then the right lane may be restricted to right turns only, as shown. This procedure increases the through capacity by eliminating right turns from the open through lane.
3. For intersection approaches reduced to a single lane, left-turning movements may be prohibited to maintain capacity for through vehicular traffic.
4. Flashing warning lights and/or flags may be used to call attention to the advance warning signs.
5. Where the turning radius is large, it may be possible to create a right-turn island using channelizing devices or pavement markings.

Figure 6H-22. Right-Hand Lane Closure on the Far Side of an Intersection (TA-22)



Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Typical Application 22

Notes for Figure 6H-28—Typical Application 28
Sidewalk Detour or Diversion

Standard:

1. **When crosswalks or other pedestrian facilities are closed or relocated, temporary facilities shall be detectable and shall include accessibility features consistent with the features present in the existing pedestrian facility.**

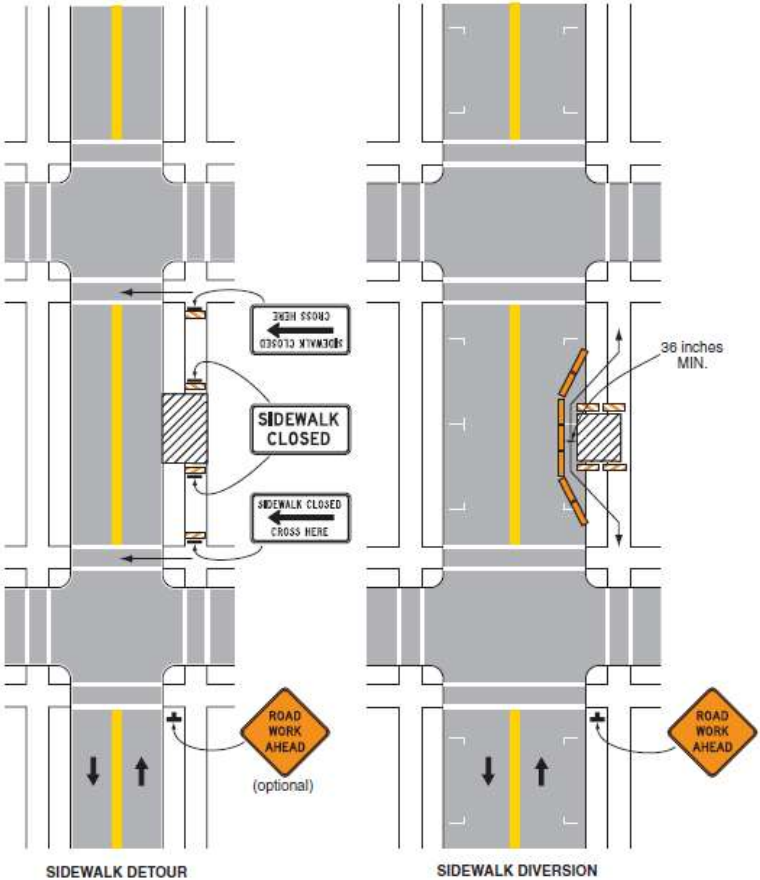
Guidance:

2. *Where high speeds are anticipated, a temporary traffic barrier and, if necessary, a crash cushion should be used to separate the temporary sidewalks from vehicular traffic.*
3. *Audible information devices should be considered where midblock closings and changed crosswalk areas cause inadequate communication to be provided to pedestrians who have visual disabilities.*

Option:

4. Street lighting may be considered.
5. Only the TTC devices related to pedestrians are shown. Other devices, such as lane closure signing or ROAD NARROWS signs, may be used to control vehicular traffic.
6. For nighttime closures, Type A Flashing warning lights may be used on barricades that support signs and close sidewalks.
7. Type C Steady-Burn or Type D 360-degree Steady-Burn warning lights may be used on channelizing devices separating the temporary sidewalks from vehicular traffic flow.
8. Signs, such as KEEP RIGHT (LEFT), may be placed along a temporary sidewalk to guide or direct pedestrians.

Figure 6H-28. Sidewalk Detour or Diversion (TA-28)



Typical Application 28

Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Notes for Figure 6H-30—Typical Application 30
Interior Lane Closure on a Multi-Lane Street

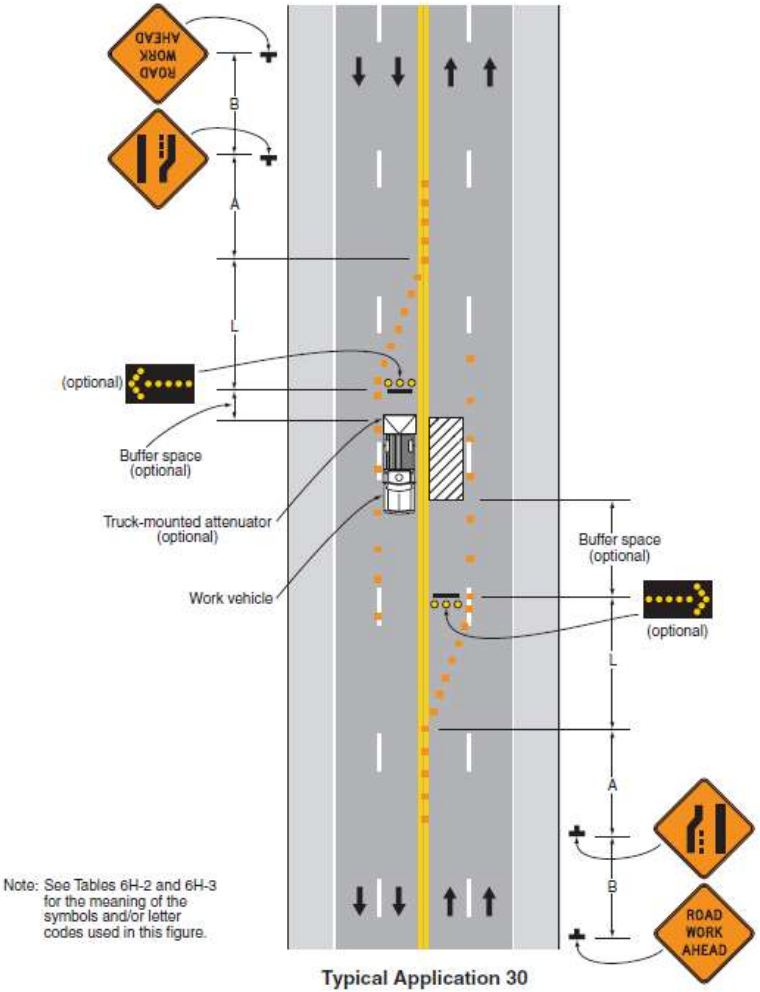
Guidance:

1. *This information applies to low-speed, low-volume urban streets. Where speed or volume is higher, additional signing such as LEFT LANE CLOSED XX FT should be used between the signs shown.*

Option:

2. The closure of the adjacent interior lane in the opposing direction may not be necessary, depending upon the activity being performed and the work space needed for the operation.
3. Shadow vehicles with a truck-mounted attenuator may be used.

Figure 6H-30. Interior Lane Closure on a Multi-Lane Street (TA-30)



Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

Typical Application 30

Notes for Figure 6H-33—Typical Application 33
Stationary Lane Closure on a Divided Highway

Standard:

1. **This information also shall be used when work is being performed in the lane adjacent to the median on a divided highway. In this case, the LEFT LANE CLOSED signs and the corresponding Lane Ends signs shall be substituted.**
2. **When a side road intersects the highway within the TTC zone, additional TTC devices shall be placed as needed.**

Guidance:

3. *When paved shoulders having a width of 8 feet or more are closed, channelizing devices should be used to close the shoulder in advance of the merging taper to direct vehicular traffic to remain within the traveled way.*

Option:

4. A truck-mounted attenuator may be used on the work vehicle and/or shadow vehicle.

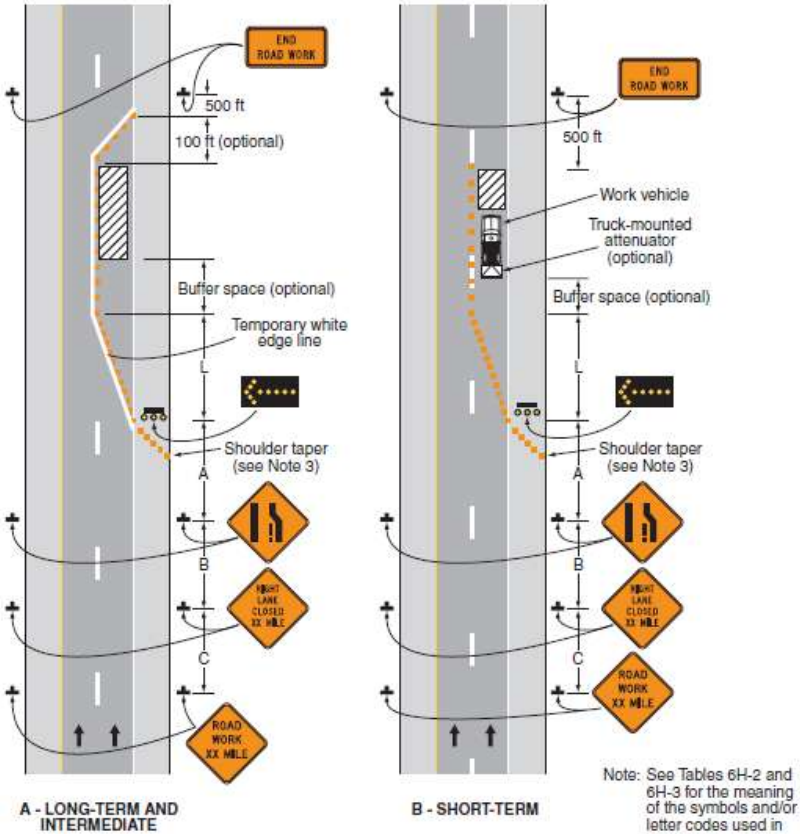
Support:

5. Where conditions permit, restricting all vehicles, equipment, workers, and their activities to one side of the roadway might be advantageous.

Standard:

6. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

Figure 6H-33. Stationary Lane Closure on a Divided Highway (TA-33)



Typical Application 33

Notes for Figure 6H-35—Typical Application 35
Mobile Operation on a Multi-Lane Road

Standard:

1. **Arrow boards shall, as a minimum, be Type B, with a size of 60 x 30 inches.**
2. **Vehicle-mounted signs shall be mounted in a manner such that they are not obscured by equipment or supplies. Sign legends on vehicle-mounted signs shall be covered or turned from view when work is not in progress.**
3. **Shadow and work vehicles shall display high-intensity rotating, flashing, oscillating, or strobe lights.**
4. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

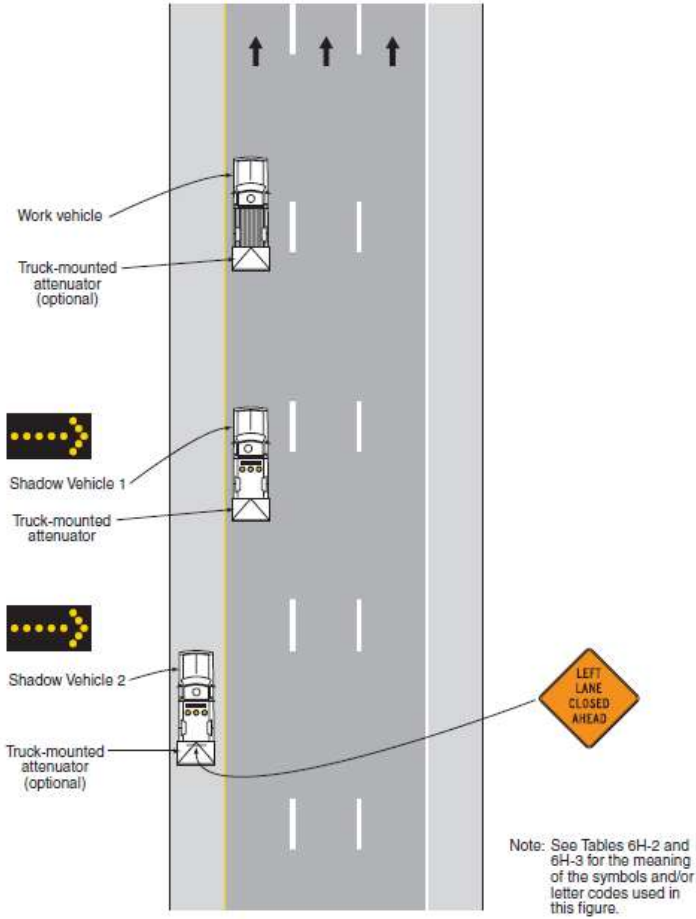
Guidance:

5. *Vehicles used for these operations should be made highly visible with appropriate equipment, such as flags, signs, or arrow boards.*
6. *Shadow Vehicle 1 should be equipped with an arrow board and truck-mounted attenuator.*
7. *Shadow Vehicle 2 should be equipped with an arrow board. An appropriate lane closure sign should be placed on Shadow Vehicle 2 so as not to obscure the arrow board.*
8. *Shadow Vehicle 2 should travel at a varying distance from the work operation so as to provide adequate sight distance for vehicular traffic approaching from the rear.*
9. *The spacing between the work vehicles and the shadow vehicles, and between each shadow vehicle should be minimized to deter road users from driving in between.*
10. *Work should normally be accomplished during off-peak hours.*
11. *When the work vehicle occupies an interior lane (a lane other than the far right or far left) of a directional roadway having a right-hand shoulder 10 feet or more in width, Shadow Vehicle 2 should drive the right-hand shoulder with a sign indicating that work is taking place in the interior lane.*

Option:

12. A truck-mounted attenuator may be used on Shadow Vehicle 2.
13. On high-speed roadways, a third shadow vehicle (not shown) may be used with Shadow Vehicle 1 in the closed lane, Shadow Vehicle 2 straddling the edge line, and Shadow Vehicle 3 on the shoulder.
14. Where adequate shoulder width is not available, Shadow Vehicle 3 may also straddle the edge line.

Figure 6H-35. Mobile Operation on a Multi-Lane Road (TA-35)



Typical Application 35

Notes for Figure 6H-37—Typical Application 37
Double Lane Closure on a Freeway

Standard:

1. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

Guidance:

2. *Ordinarily, the preferred position for the second arrow board is in the closed exterior lane at the upstream end of the second merging taper. However, the second arrow board should be placed in the closed interior lane at the downstream end of the second merging taper in the following situations:*
   a. *When a shadow vehicle is used in the interior closed lane, and the second arrow board is mounted on the shadow vehicle;*
   b. *If alignment or other conditions create any confusion as to which lane is closed by the second arrow board; and*
   c. *When the first arrow board is placed in the closed exterior lane at the downstream end of the first merging taper (the alternative position when the shoulder is narrow).*

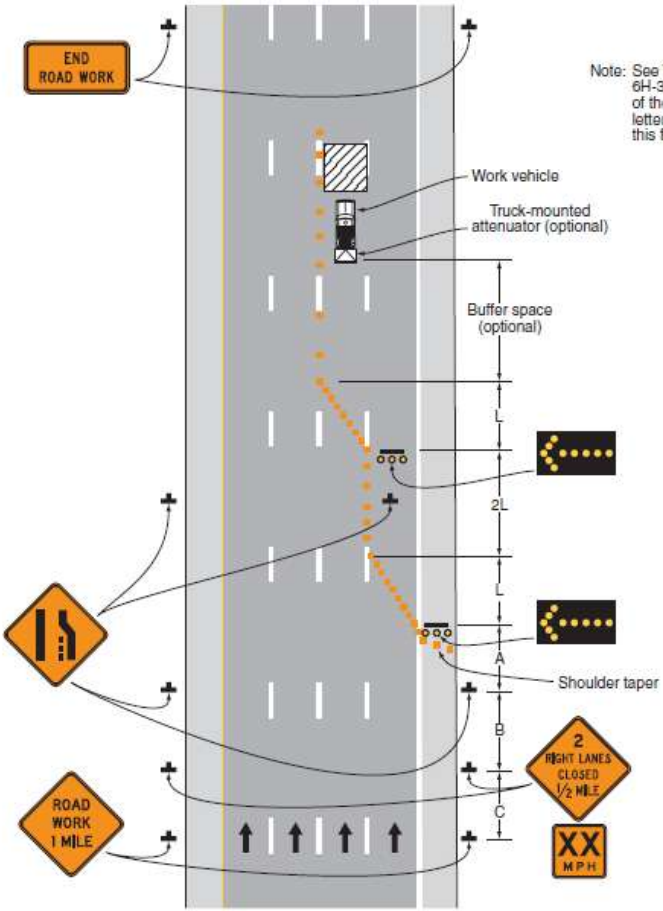
Option:

3. Flashing warning lights and/or flags may be used to call attention to the initial warning signs.
4. A truck-mounted attenuator may be used on the shadow vehicle.
5. If a paved shoulder having a minimum width of 10 feet and sufficient strength is available, the left and adjacent interior lanes may be closed and vehicular traffic carried around the work space on the right-hand lane and a right-hand shoulder.

Guidance:

6. *When a shoulder lane is used that cannot adequately accommodate trucks, trucks should be directed to use the normal travel lanes.*

Figure 6H-37. Double Lane Closure on a Freeway (TA-37)



Typical Application 37

Traffic Incident Management Areas

A traffic incident management area is an area of a highway where temporary traffic controls are imposed…in response to a road user incident, natural disaster, hazardous material spill, or other unplanned incident. It is a type of TTC zone and extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where vehicles return to the original lane alignment and are clear of the incident.

The primary functions of TTC at a traffic incident management area are to move road users reasonable safely and expeditiously past or around the traffic incident, to reduce the likelihood of secondary traffic crashes…

In order to reduce response time for traffic incidents, highway agencies, appropriate public safety agencies, and private sector responders should mutually plan for occurrences of traffic incidents…

On-scene responders should be trained in safe practices for accomplishing their tasks in and near traffic. Responders should always be aware of their visibility to oncoming traffic and take measures to move the traffic incident as far off the traveled roadway as possible or to provide for appropriate warning.

Responders arriving at a traffic incident should estimate the magnitude of the traffic incident, the expected time duration of the traffic incident, and the expected vehicle queue length, and then should initiate procedures to have the appropriate temporary traffic controls set up for these estimates.

Major Traffic Incidents. These traffic incidents typically involve closing all or part of a roadway facility for a period exceeding 4 hours.

Intermediate Traffic Incidents. Intermediate traffic incidents typically affect travel lanes for a time period of 60 minutes to 4 hours, and usually require traffic control on the scene to divert road users past the blockage.

For both Major and Intermediate Traffic Incidents, all traffic control devices needed to set up the TTC at a traffic incident should be available so that they can be readily deployed…The TTC should include the proper traffic diversions, tapered lane closures, and upstream warning devices to alert approaching traffic of the end of a queue.

Minor Traffic Incidents. Minor traffic incidents are typically disabled vehicles and minor crashes that result in lane closures of less than 60 minutes. On-scene responders are typically law enforcement and towing companies, and occasionally highway agency service patrol vehicles. Diversion of traffic into other lanes is often not needed or is needed only briefly. It is not generally possible or practical to set up a lane closure with traffic control devices for a minor traffic incident.

Use of Emergency-Vehicle Lighting. The use of emergency-vehicle lighting (such as high-intensity rotating, flashing, oscillating, or strobe lights) is essential, especially in the initial stages of a traffic incident, for the safety of emergency responders and persons involved in the traffic incident, as well as

road users approaching the traffic incident. Emergency-vehicle lighting, however, provides warning only and provides no effective traffic control. It is often confusing to road users, especially at night.

The use of emergency-vehicle lighting can be reduced if good traffic control has been established at a traffic incident scene. This is especially true for major traffic incidents that might involve a number of emergency vehicles. If good traffic control is established through placement of advanced warning signs and traffic control devices to divert or detour traffic, then public safety agencies can perform their tasks on scene with minimal emergency-vehicle lighting.

Warning and guide signs used for TTC traffic incident management situations may have a black legend and border on a fluorescent pink background.

TRAIN ▪ SERVE ▪ RESPOND

Texas Engineering Extension Service
Infrastructure Trainging and Safety Institute

301 Tarrow
College Station, TX 77840-7896

Teléfono: (800) SAFE-811 (800) 723-3811
Oficina: (979) 458-2001
Fax: (979) 458-1426

http://www.teex.org/hws

itsi@teexmail.tamu.edu

REGION VI
OSHA TRAINING INSTITUTE
SOUTHWEST EDUCATION CENTER
TEEX - A member of The Texas A&M University System

Revised in 2011