Work Zone Traffic Control II

Course Number: CE-03-911

PDH: 3

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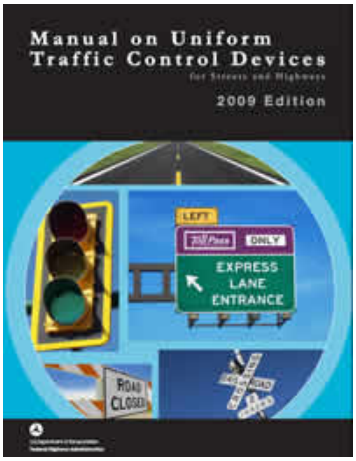
INTRODUCTION

This course is the second of two in this series that shows how to effectively plan and design temporary traffic controls for work zone locations. The contents of this course are intended to serve as guidance and not as an absolute standard or rule. Its purpose is to help you to use the **Manual on Uniform Traffic Control Devices (MUTCD) Part 6 – Temporary Traffic Control** more effectively and not replace it. Should there be any discrepancies between the contents of this course and the MUTCD - always follow the MUTCD.

Upon course completion, you should be familiar with the general design guidelines for work zone traffic control. The course objective is to give engineers and designers an in-depth look at the principles to be considered when selecting and designing temporary traffic control for work zones.

For this course, the *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) 2009 Edition* will serve as a reference for fundamental design principles. The MUTCD is recognized as the **national standard** for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel. Any traffic control device design or application contained within it is considered to be in the public domain and available for use.



http://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf **MUTCD 2009**

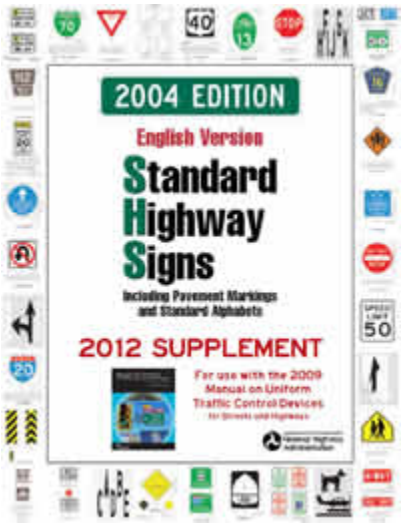
http://mutcd.fhwa.dot.gov/pdfs/2009/part6.pdf **Part 6**

Traffic signs and pavement markings are typically used for conveying laws and regulations, traffic and roadway conditions, and guidance and other information. These critical tools provide important information for safe travel on any U.S. roadway system.

Road users process different types of visual and non-visual information differently: speed, roadway conditions, traffic, legal enforcement, noise levels, etc. Signs and markings serve as reminders of important information, so road users do not have to memorize everything.

The goal is to provide drivers with relevant information when they need it - resulting in safer, more efficient roadways with reduced liability risks. However, poor sign management can greatly reduce safety, contribute to roadway incidents, and increase liability exposure.

The *Standard Highway Signs and Markings* book contains detailed specifications for all adopted standard signs and pavement markings. All traffic control devices have to be similar to or mirror images of those this manual. Any symbols or colors cannot be modified unless otherwise stated.



http://mutcd.fhwa.dot.gov/SHSe/shs_2004_2012_sup.pdf

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)

By law (23 CFR 655, Subpart F), the *Manual on Uniform Traffic Control Devices* (MUTCD) is recognized as "the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel". It is the definitive authority for traffic signs and pavement markings.

Nationwide consistency is the goal of the MUTCD by requiring uniform, understandable, and effective traffic control devices on all facilities open to public travel. It defines the nationwide standards for the installation and maintenance of the devices on all streets and highways. The MUTCD allows us to drive anywhere in the U.S. using the same basic signs with the same meanings. Drivers who see a particular sign should expect it to mean the same thing regardless of location.

The MUTCD has nine chapters ("Parts"):

General

Signs

Marking

Highway Traffic Signals

Low-Volume Roads

Temporary Traffic Control

School Areas

Highway-Rail Grade Crossings

Bicycle Facilities

Since this course concentrates primarily on the subject of temporary traffic control, we will focus mainly on **Part 6 - Temporary Traffic Control**.

PAVEMENT MARKINGS

Pavement marking is more than just roadway striping. It is a guidance system that relays regulatory and vehicle-path information to the user without requiring them to divert their attention from the road. These markings should encourage safe, efficient traffic flow while optimizing roadway capacity. In order to be effective, pavement markings need to be easily recognized and understood. A uniform system of marking color, shape, and application has been developed to convey the same message for a specific situation.

All pavement markings need to be properly maintained to assure good daytime and nighttime visibility. It is the municipality's responsibility to maintain the marking once the decision has been made to install it. If the municipality decides that the marking is no longer needed, documentation of the decision process should be recorded. Pavement markings deemed non-applicable or confusing should be removed as soon as possible.

Temporary markings within TTC zones provide a clearly defined path through the work zone. These markings are typically needed during roadway reconstruction while open to traffic (resurfacing, lane shifts, etc.).

MATERIALS

Pavement markings typically include paints and thermoplastics but they may also use other marking materials (colored paving, raised pavement markers, etc.). Highly visible delineators and channelizing devices can also be placed vertically above the roadway.

Paint is the easiest, cheapest, and most commonly used pavement marking material. However, it is also the least durable. To combat poor nighttime visibility, retroreflectivity can be improved by adding glass beads into the wet paint.

Thermoplastic pavement markings use a heated temperature-setting plastic material for use on asphalt pavements. Due to temperature-related expansion and contraction differentials between plastic and concrete (which may result in thermoplastic separation) thermoplastic is prohibited from use on concrete.

Marking color, pattern, and orientation provide crucial information to roadway users. Complying with these standards provide positive guidance and should be maintained throughout the product's life. Materials that minimize tripping or maintain traction for users

(pedestrians, bicyclists, motorcycles, etc.) should also be considered when choosing pavement markings.

RAISED PAVEMENT MARKERS (RPM)

Raised pavement markers may be substituted for other types of markings in TTC zones. These are normally used for detours, temporary roadways, and/or new travel lane alignments. The color of raised pavement markers under both daylight and nighttime conditions should match the color of the marking for which they serve, supplement or substitute.

Retroreflective or internally illuminated raised pavement markers can be used in the roadway bordering curbed approach ends or on top of raised medians and curbs of islands. These markers are available in mono-directional and bidirectional types (capable of displaying the applicable color for each direction of travel). Internally illuminated markers must be steadily illuminated and not flash when used.

Non-retroreflective raised pavement markers should not be used as a lone substitute for other types of pavement markings without supplemental retroreflective or internally illuminated markers.

Directional configurations should maximize correct information and minimize confusing information from other markers that do not apply to the road user.

The spacing of RPMs should correspond with the pattern of broken lines for which the markers serve, supplement or substitute. For additional emphasis, retroreflective raised pavement markers may be spaced closer than described in the MUTCD if determined appropriate by engineering judgment/study.

For further information, the *"Traffic Control Devices Handbook"* contains spacing details for raised pavement markers on longitudinal markings.

DELINEATORS

Delineators should supplement or act in combination with other temporary traffic control devices to indicate the roadway's alignment and to outline the vehicle path through the TTC zone. Delineators are useful for roadway locations with long continuous sections or short stretches where the alignment might be confusing or unexpected (lane-reduction transitions,

horizontal curves, etc.). These are effective *guidance* devices (rather than warning devices) at night and during adverse weather due to their visibility when the roadway may be wet or snow covered.

Delineator Design

Delineators consist of retroreflective devices (3-inch minimum) that normally retroreflect light from a distance of 1,000 feet when illuminated by standard automobile high beam headlights.

Single delineators: One retroreflective element for a given direction of travel at a specific location. May be installed on the left-hand side where needed

Double delineator: Two identical retroreflective elements mounted together for a direction. An appropriately sized vertically elongated delineator may be substituted for a double delineator.

Delineator Application

A series of single delineators should be located on the right side of freeways and expressways and on one side of interchange ramps, except when either of the following conditions is met:

- On tangent sections of freeways and expressways when both of the following conditions are met:
    1. Continuous raised pavement markers are used to supplement pavement markings on lane lines throughout all curves and on all tangents,
    2. Roadside delineators are used to direct traffic into all curves.

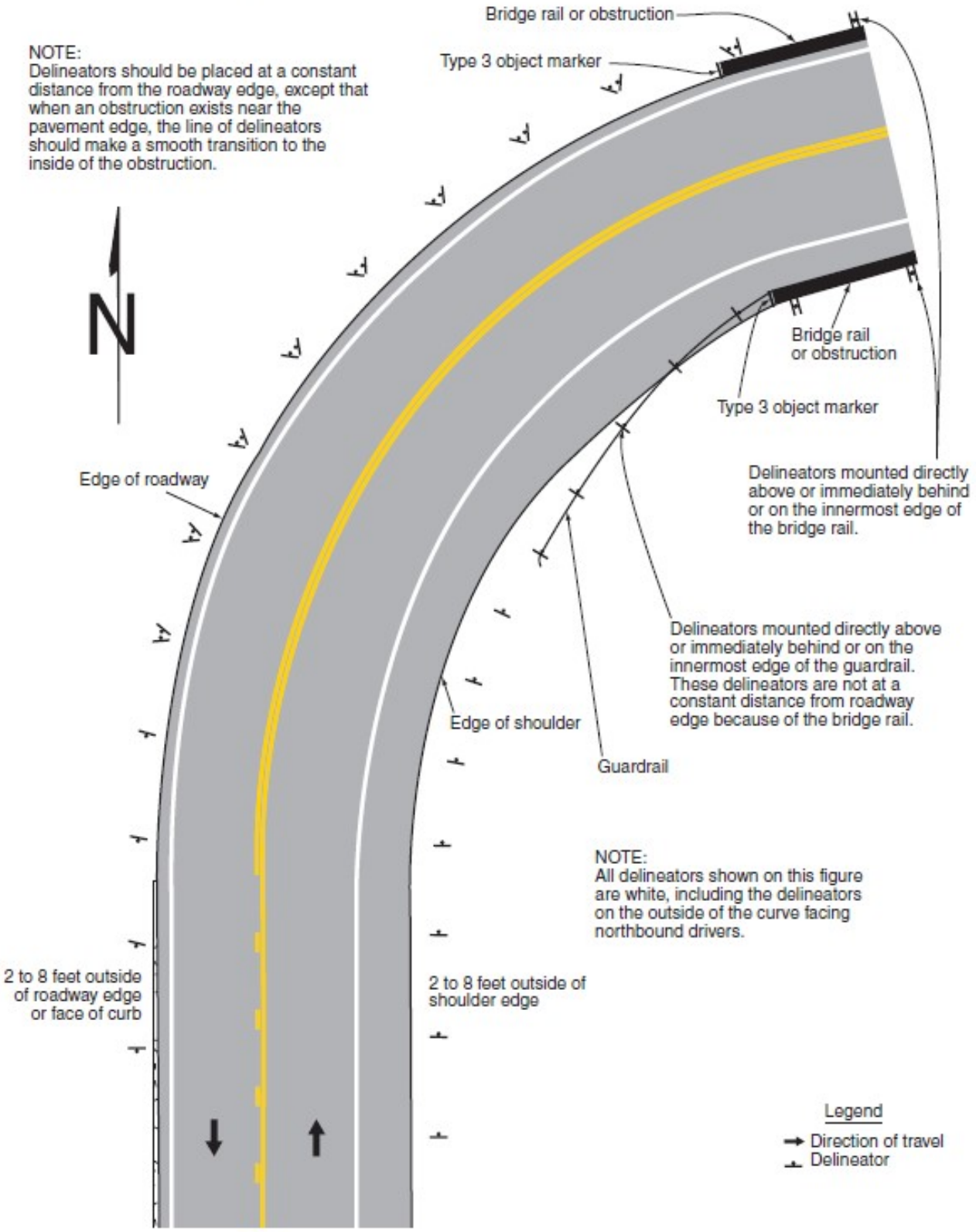
- On sections of roadways with continuous lighting between interchanges.

Delineators may also be used on other classes of roadways and their colors should comply with the edge line color.

TTC Delineator Colors

White	Both sides of a two-way roadway Right-hand side of a one-way roadway
Yellow	Left-hand side of a one-way roadway

Figure 3F-1. Examples of Delineator Placement



Appropriate colors can indicate where either an outside or inside traffic lane merges into an adjacent lane. Delineators should be installed adjacent to the lane reduced for the full transition length and show the reduction.

Red delineators may be used on the reverse side of any delineator where it would warn a road user traveling in the wrong direction on that particular ramp or roadway. These delineators should also be used on both sides of truck escape ramps (spaced at 50-foot intervals) to identify the ramp entrance. Spacing beyond the entrance should be adequate for the escape ramp's length and design.

Delineator Placement and Spacing

The mounting height of delineators should be approximately *4 feet* (measured vertically from the bottom of the device to the elevation of the edge of the pavement). They may be mounted at a lower elevation on the face or top of guardrails or other barriers.

Delineators should be installed at a constant distance from the edge of roadway *2 to 8 feet* outside the outer edge of the shoulder; or in line with roadside barriers (maximum distance of 8 feet outside the outer edge of the shoulder). For locations with obstructions between the pavement edge and the line of the delineators, the delineators should be transitioned to the innermost edge of the obstruction. For guardrail or other longitudinal barriers, the delineators should be transitioned just behind, directly above, or on the barrier's innermost edge.

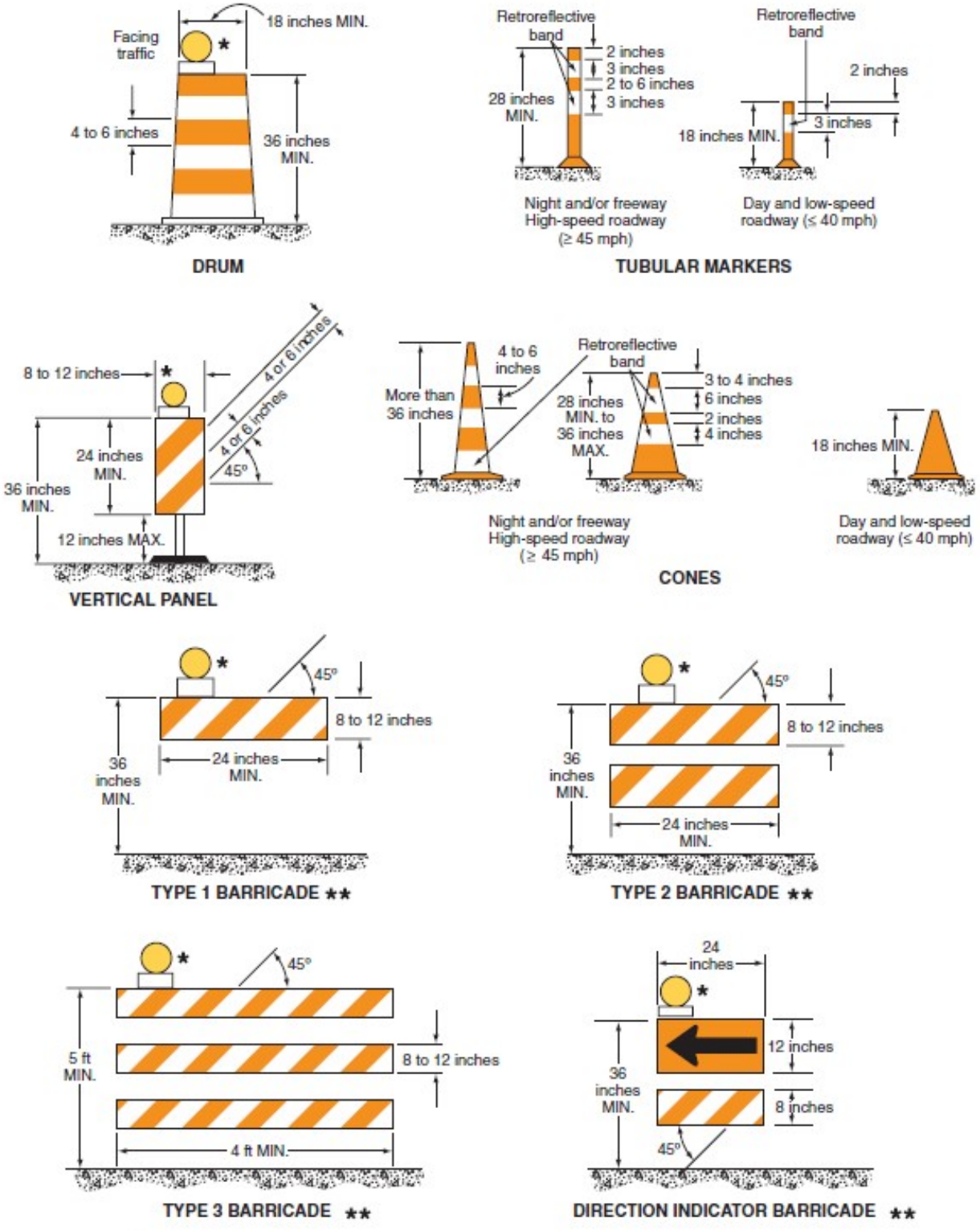
Delineators should be spaced so several delineators are always visible to the road user.

CHANNELIZING DEVICES

Channelization devices (cones, tubular markers, vertical panels, drums, lane separators, raised islands, etc.) are used to emphasize traffic control sites (road closures, islands, reversible lane delineation, and channelizing lines).

Colors for channelizing devices are typically orange or the same color as the pavement marking that they supplement/substitute. Channelizing devices must be retroreflective or internally illuminated for nighttime use. *White* retroreflective material should be used for devices that separate traffic in the same direction. If the channelization separates flows in the opposite direction or are located on the left side edge line of a one-way roadway, the sheeting or bands should be *yellow*. These devices should be kept clean and bright to maximize target value.

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.

Guidelines for Spacing Channelizing Devices

- The maximum spacing (feet) between devices in a taper should be equal to the speed limit (mph).
- All tapers should have a minimum of 6 channelizing devices.
- The maximum spacing (feet) between devices in a buffer or work area should be twice the speed limit (mph).
- For urban areas shorter spacing between devices in the buffer and work areas may be more appropriate (ex: spacing used in tapers).

TEMPORARY RAISED ISLANDS

A temporary raised island may be combined with pavement markings and other suitable channelizing devices to separate traffic for two-lane, two-way operations or freeways. These islands may also be used where the physical separation of traffic from the work zone is not required.

Temporary Raised Island Guidelines

Roadway	ADT
Two-Lane Two-Way	4000 to 15,000
Freeway	22,000 to 60,000

Temporary raised islands should not be designed that may cause a motorist to lose control if their vehicle inadvertently strikes the island. In the event that the island is struck, island fragments should not be able to penetrate the vehicle or involve other motorists.

Basic Temporary Raised Island Dimensions

Height	4 inches
Width	12 inches
Corners	Rounded or camfered

LIGHTING DEVICES

Lighting devices (warning lights, vehicle rotating or strobe lights, and arrow panels) for short-term work zones are designed to supplement signs and channelizing devices.

Warning lights (Type A, Type B, Type C, and Type D 360-degree) are portable, powered, yellow, lens-directed, enclosed lights with a maximum spacing equal to channelizing device spacing requirements. **Type A, Type C, and Type D** warning lights need to be capable of visibility on a clear night from a distance of *3,000 feet*. **Type B** warning lights should be visible on a sunny day without the sun directly on or behind the device from a distance of *1,000 feet*. The minimum mounting height for warning lights is *30 inches* to the bottom of the lens.

Principal Types of Warning Lights

Low-Intensity Flashing Lights (Type A)

- used at night to warn drivers of a potentially hazardous area
- may be mounted on channelizing devices

High-Intensity Flashing Lights (Type B)

- used during both daylight and nighttime hours to warn motorists of a hazard or to draw attention to advance warning signs
- operates 24 hours per day
- may be mounted on supports or warning signs

Low-Intensity Steady-Burn Lights (Type C & Type D 360 degree warning lights)

- used at night in a series to delineate the edge of the travel way
- may be placed on the outside of a curve to delineate the curve

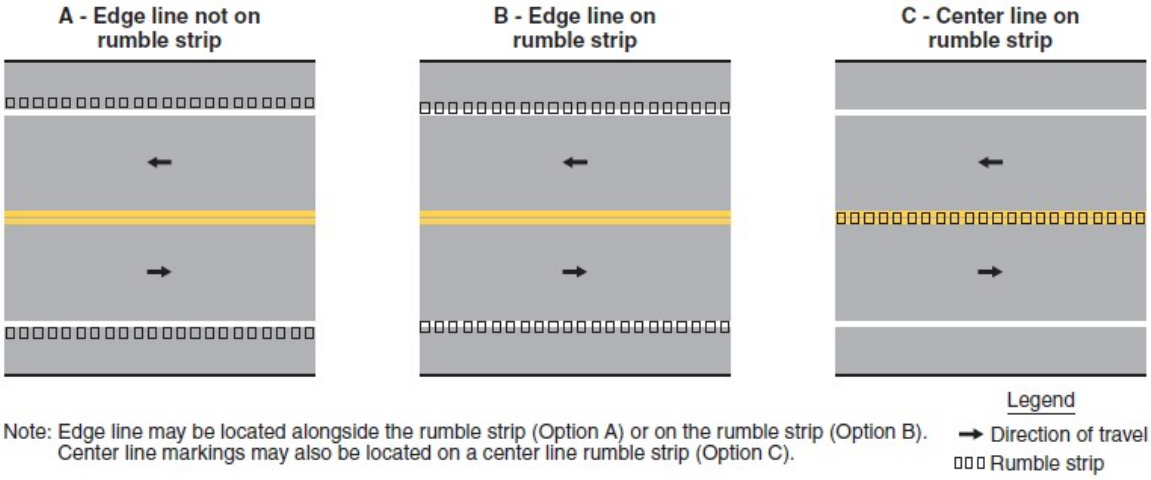
RUMBLE STRIP MARKINGS

Longitudinal rumble strips are either a series of rough-textured, slightly raised, or depressed road surfaces that warn drivers through vibration and sound of the edges of the travel lane.

Possible Longitudinal Rumble Strip Locations

Shoulder	Roadway shoulder near travel lane
Divided Highway	Median side (left) and/or outside shoulder (right)
Two-way Roadways	Along center line

Figure 3J-1. Examples of Longitudinal Rumble Strip Markings



Note: Edge line may be located alongside the rumble strip (Option A) or on the rumble strip (Option B). Center line markings may also be located on a center line rumble strip (Option C).

An edge line or center line may be installed over a longitudinal rumble strip to create a *rumble stripe.* However, edge lines should not be placed in addition to shoulder rumble stripes.

Transverse rumble strips consist of intermittent narrow, transverse areas of roughly textured, slightly raised, or depressed road surface that extend across the travel lanes. Through noise and vibration, these alert drivers to unusual vehicular traffic conditions, such as unexpected changes in road alignment or conditions that require stops or speed reductions.

For locations where a transverse rumble strip color within a travel lane does not match the color of the pavement, the color of the strip should be either *black or white*. White transverse rumble strips should not be installed where they may be confused with other transverse markings (stop lines, crosswalks, etc.).

Transverse rumble strips should not be placed on sharp horizontal/vertical curves, or on roadways used by bicyclists unless a minimum clear path of *4 feet* is provided at each roadway edge or each paved shoulder.

DURATION OF WORK

The work duration of a temporary traffic control zone determines the number and types of devices to be used. Typically, the number of traffic control devices is directly proportional to the operation's length.

Long-Term Stationary – More than 3 days.

Intermediate- Term Stationary - More than 1 daylight period to 3 days, or night work lasting more than 1 hour..

Short-Term Stationary – Daytime work for more than 1 hour within a single daylight period.

Short Duration – Up to 1 hour.

Mobile – Intermittently or continuously.

LOCATION OF WORK

A work zone's location determines the types of traffic control chosen. Usually, the closer the work is to traffic, the more traffic control devices will be required.

Advance warning should convey that work is taking place within the traveled way and should supply information about roadway conditions (exceptions include short-duration and mobile operations). These traffic control devices indicate how traffic can move through the work zone.

MOBILE OPERATIONS

Mobile operations are typically either *intermittent* or *continuously moving* work activities. Safety should never be compromised by using fewer devices than needed due to frequently changing locations. For successful mobile operations, the advance warning area must move with the work area or be moved periodically to warn motorists.

Portable devices should be used whenever possible. Vehicles with appropriate colors, markings, lights, signs, arrow panels, or changeable message signs may be substituted for channelizing

devices. Shadow vehicles with truck-mounted attenuators (TMS's) are typically used for these operations.

Intermittent Mobile Operations

These operations (litter cleanup, utility operations, roadway maintenance, etc.) involve frequent short stops but are similar to stationary operations. Slow moving operations (less than 3 mph) may require stationary signage to be periodically retrieved and repositioned in the advance warning area. If flaggers are used, caution must be used to prevent unnecessary exposure to hazards.

Continuously Mobile Operations

These are mobile work operations where workers and equipment move along at slow speeds without stopping (mowing, pavement striping, street sweeping, or herbicide spraying). For locations with low traffic volumes and good visibility, a well-marked well-signed vehicle may be sufficient. For high traffic volumes and/or speeds, a shadow vehicle must be used to ensure the advance area moves with the work area.

Figure 6H-4. Short-Duration or Mobile Operation on a Shoulder (TA-4)

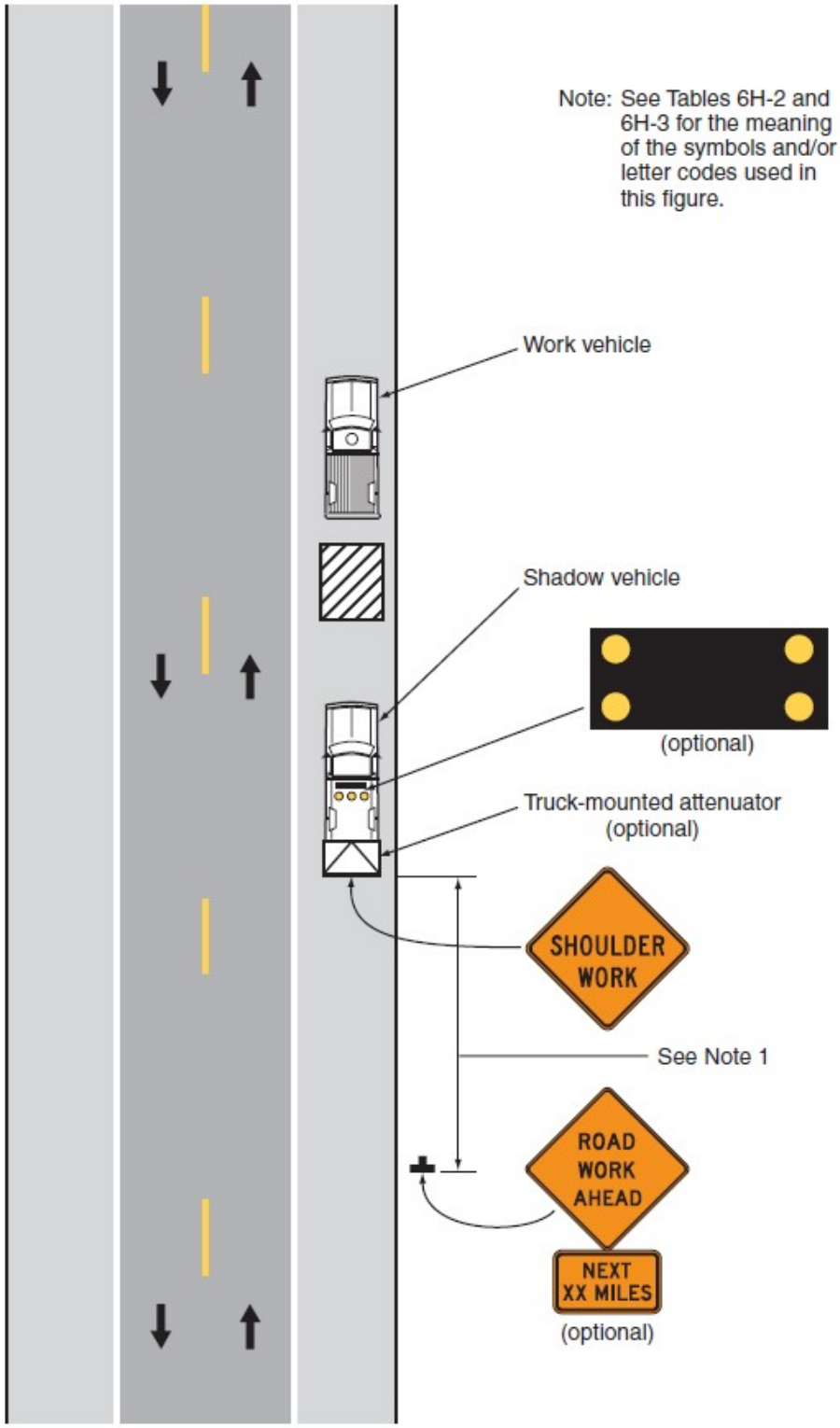


Figure 6H-17. Mobile Operations on a Two-Lane Road (TA-17)

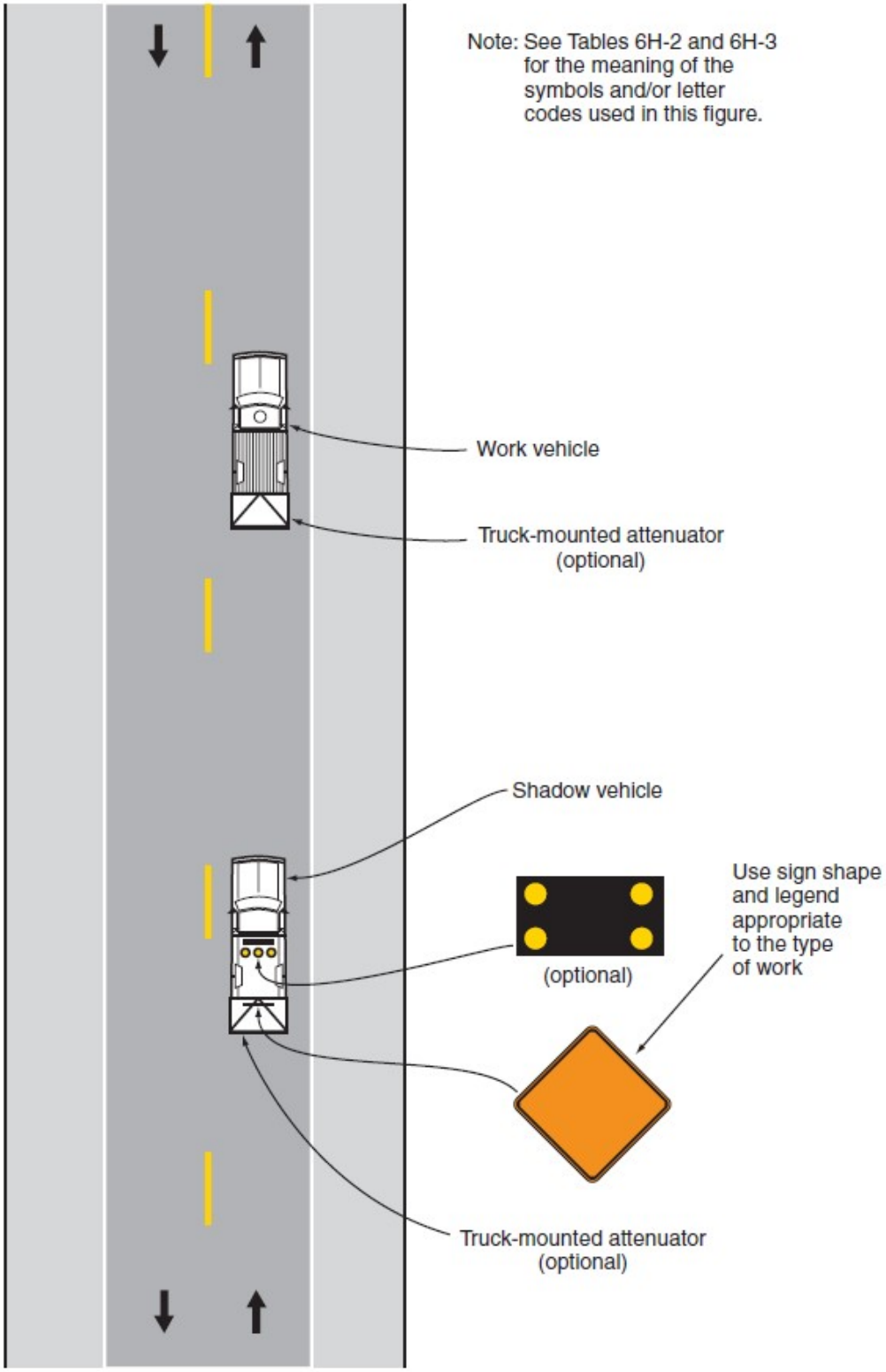
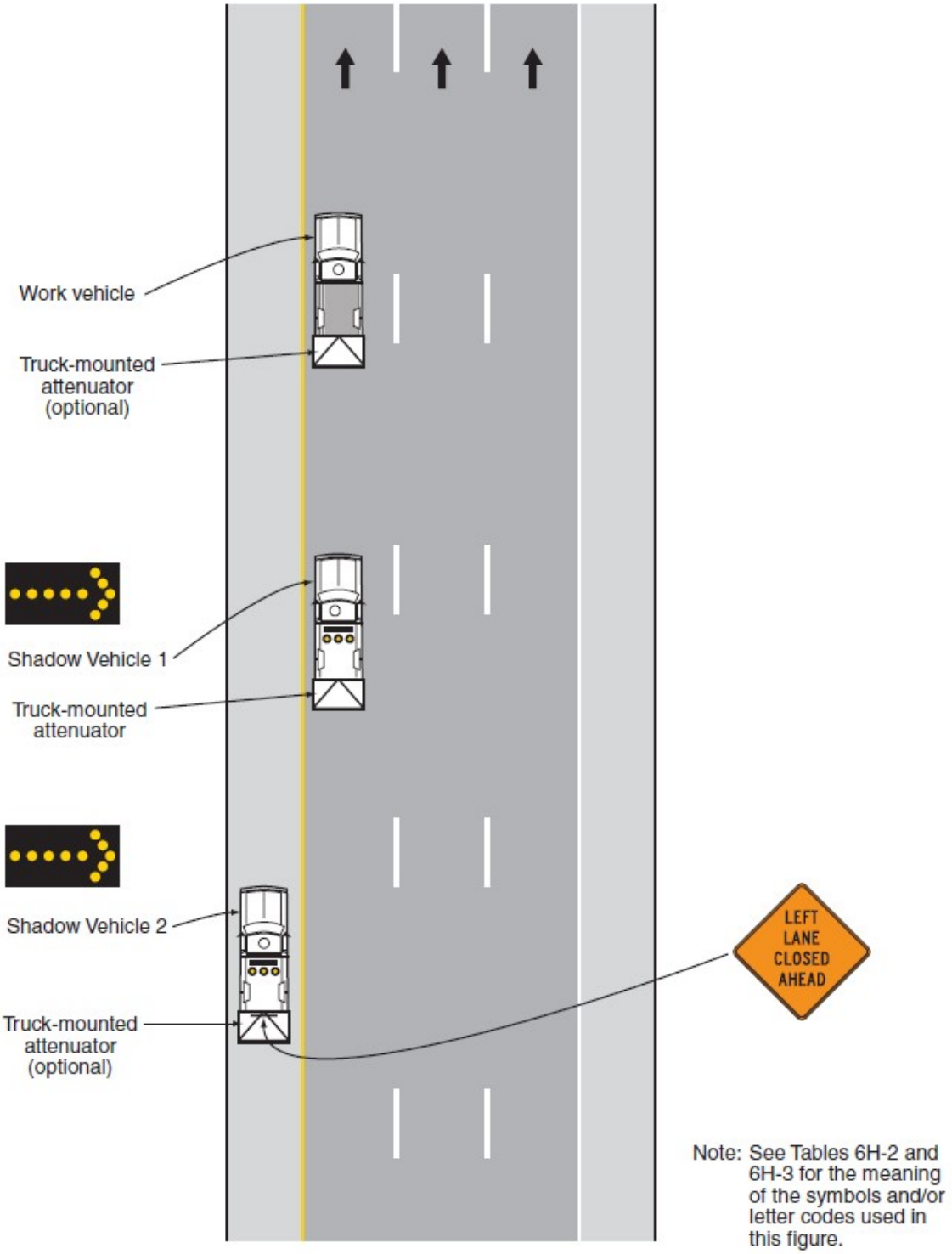


Figure 6H-35. Mobile Operation on a Multi-Lane Road (TA-35)



MAINTENANCE ISSUES

Traffic control devices require periodic inspection to ensure that they are serviceable for their intended purpose. Pavement markings that are no longer applicable need to be scarified or obliterated to be unidentifiable. These markings need to be retroreflective unless there is sufficient ambient light. Any interstate or highway device should also be retroreflective.

Pavement markings (thermoplastic, epoxy, or tape) should be replaced as required or recommended by the manufacturer. Painted markings have shorter life spans and should be repainted annually or when necessary.

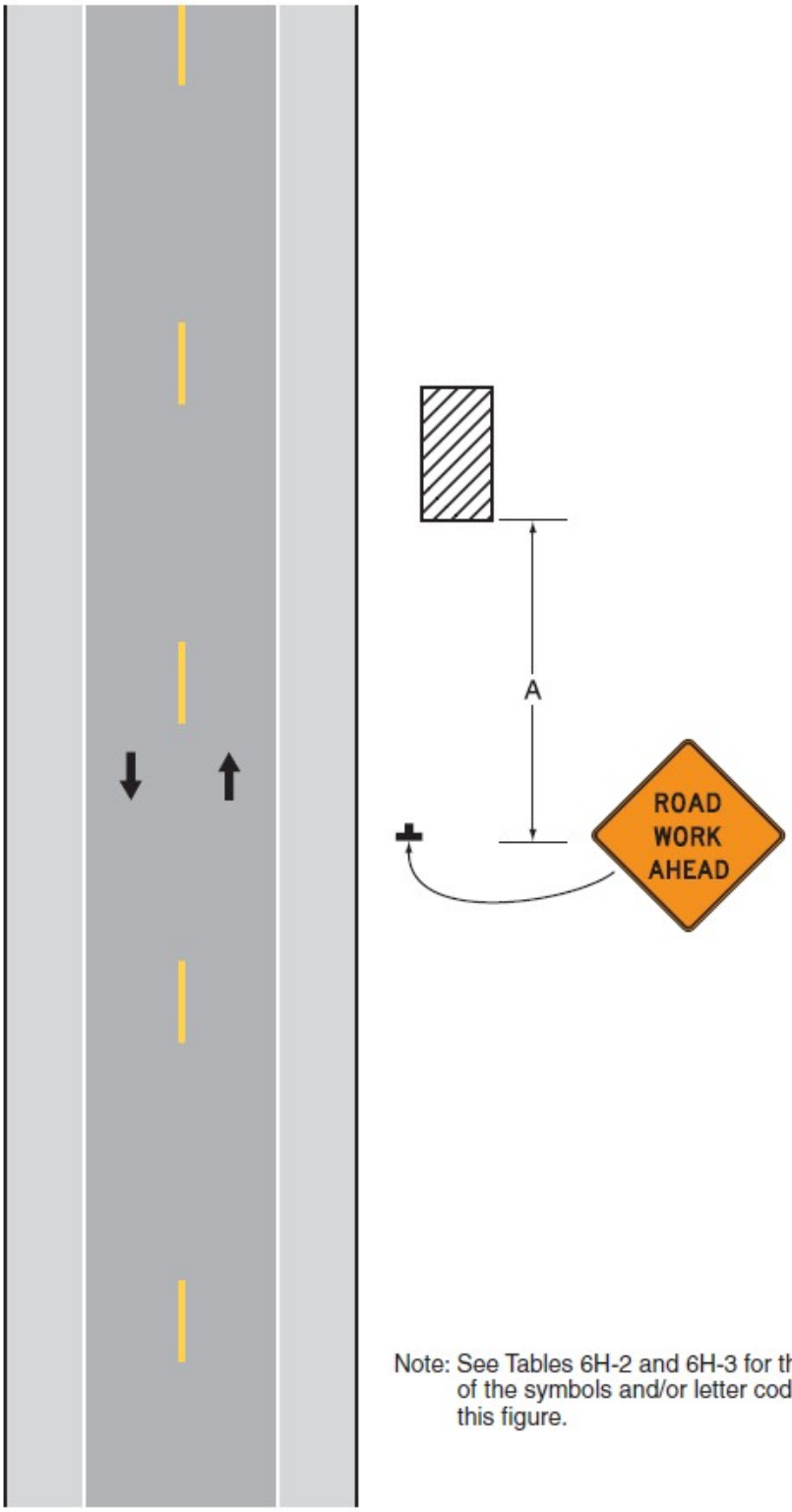
An up-to-date inventory is essential for proper maintenance by providing a record of existing devices, and estimating replacement quantities.

Inspections should be conducted during daylight and night hours (as well as under wet road conditions) to evaluate marking visibility and retroreflectivity. Any water can severely affect retroreflectivity with tarred joints and sealed cracks appearing more dominant than the striping. Bright sunlight at low angles (sunrise and sunset) can also produce this effect.

TYPICAL APPLICATIONS OF TEMPORARY TRAFFIC CONTROL

The following diagrams are typical examples of effective work zone traffic control. These layouts do not cover every situation requiring work area protection and may be tailored to fit the conditions of a particular location.

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.

Figure 6H-4. Short-Duration or Mobile Operation on a Shoulder (TA-4)

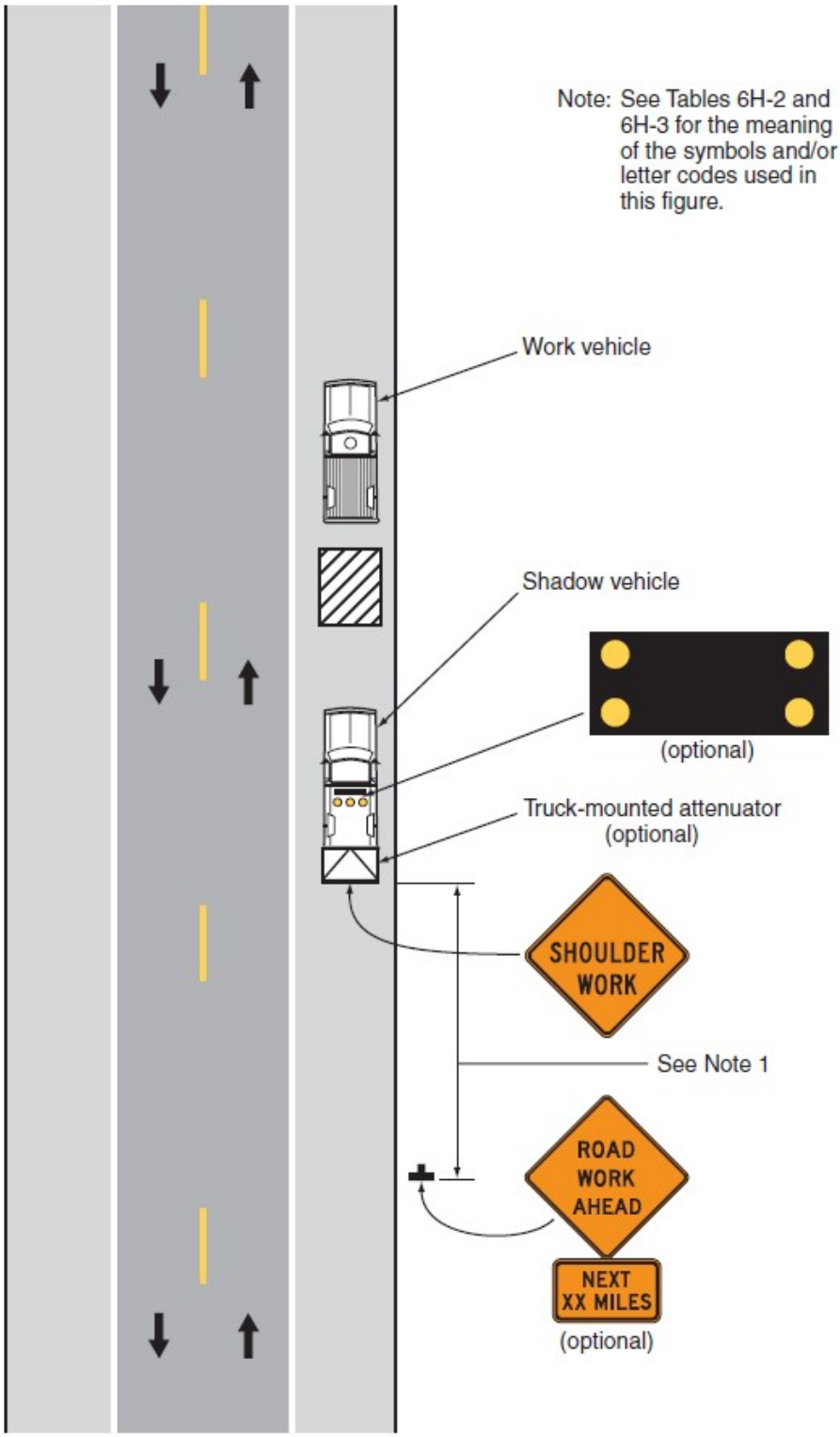
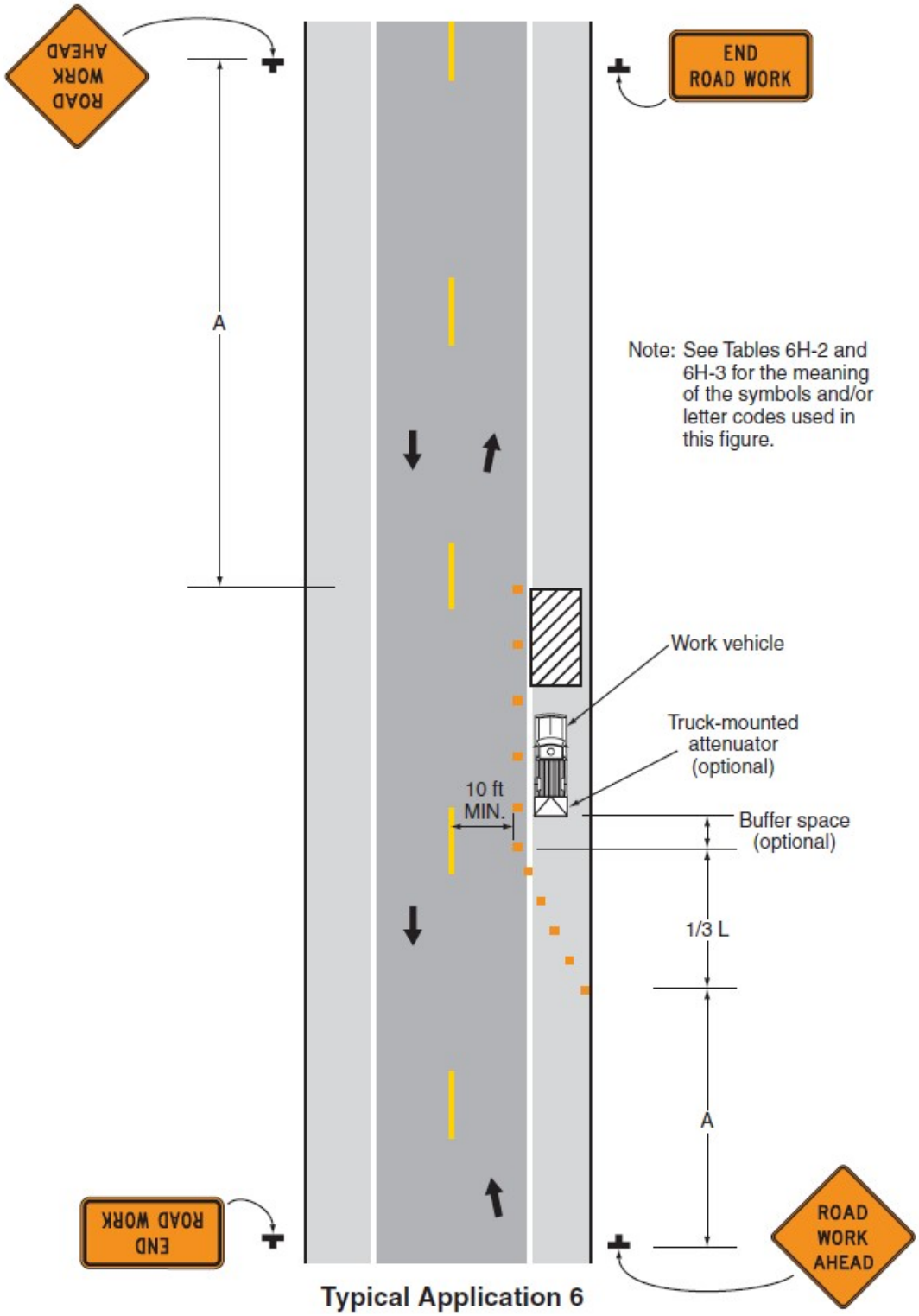


Figure 6H-6. Shoulder Work with Minor Encroachment (TA-6)



Typical Application 6

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

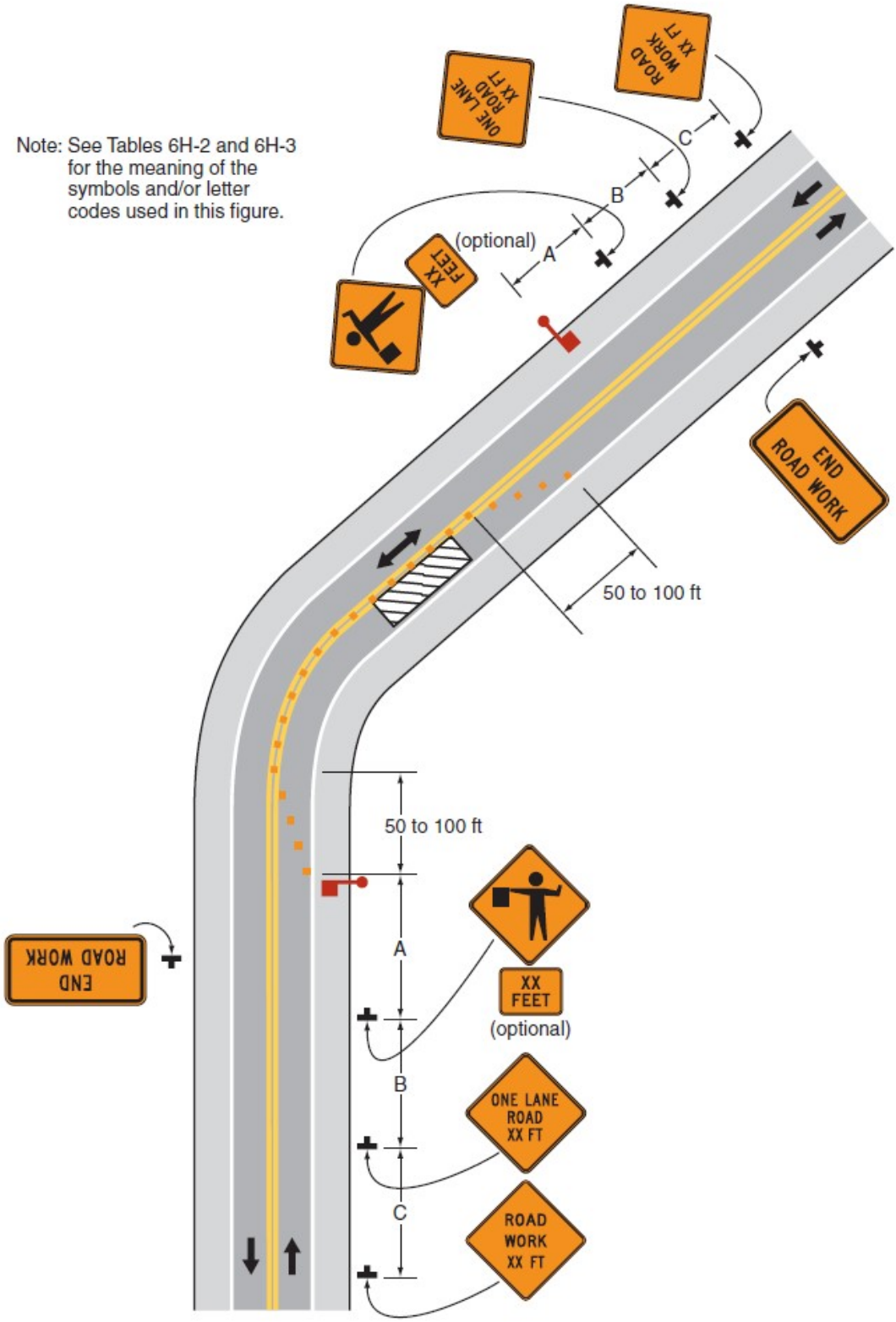


Figure 6H-11. Lane Closure on a Two-Lane Road with Low Traffic Volumes (TA-11)

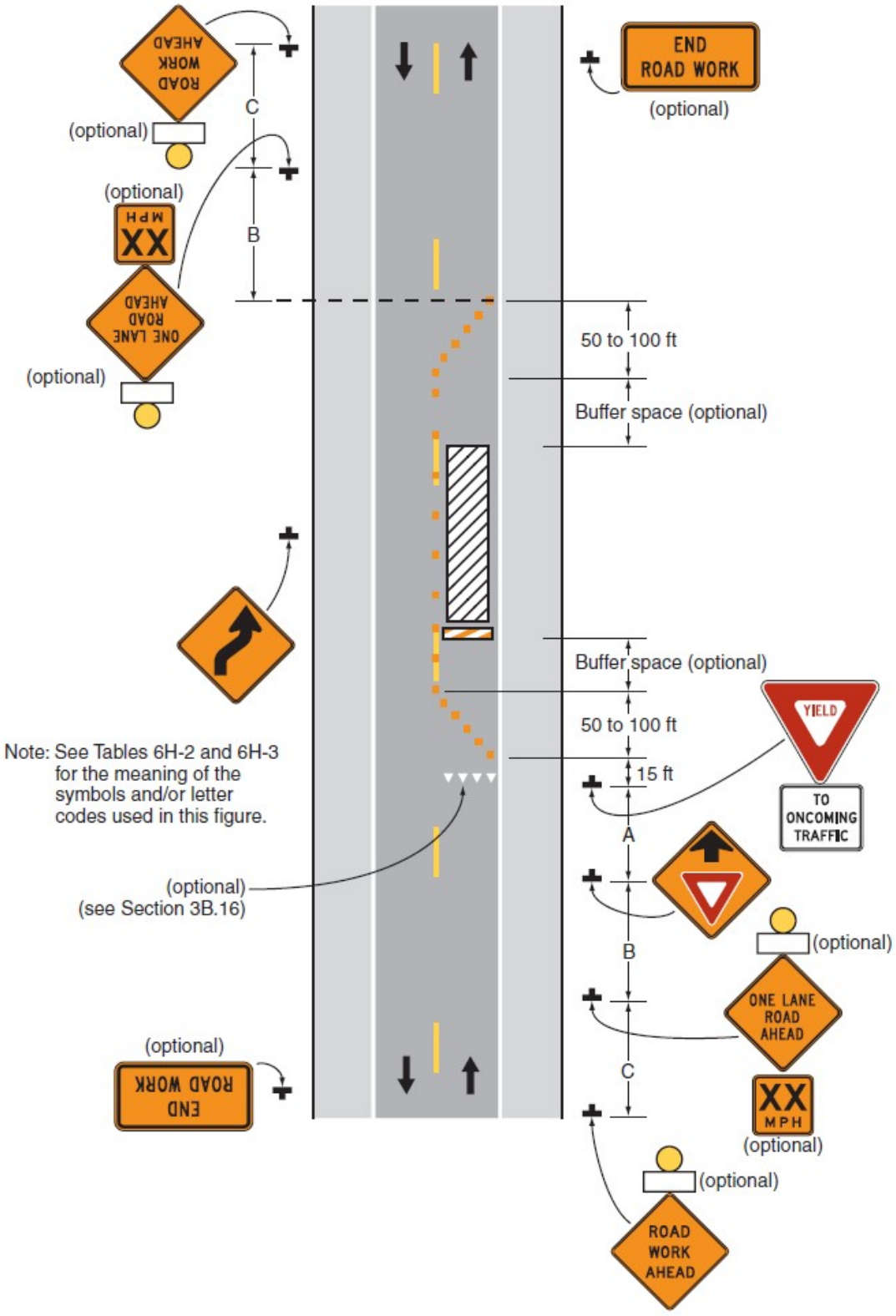
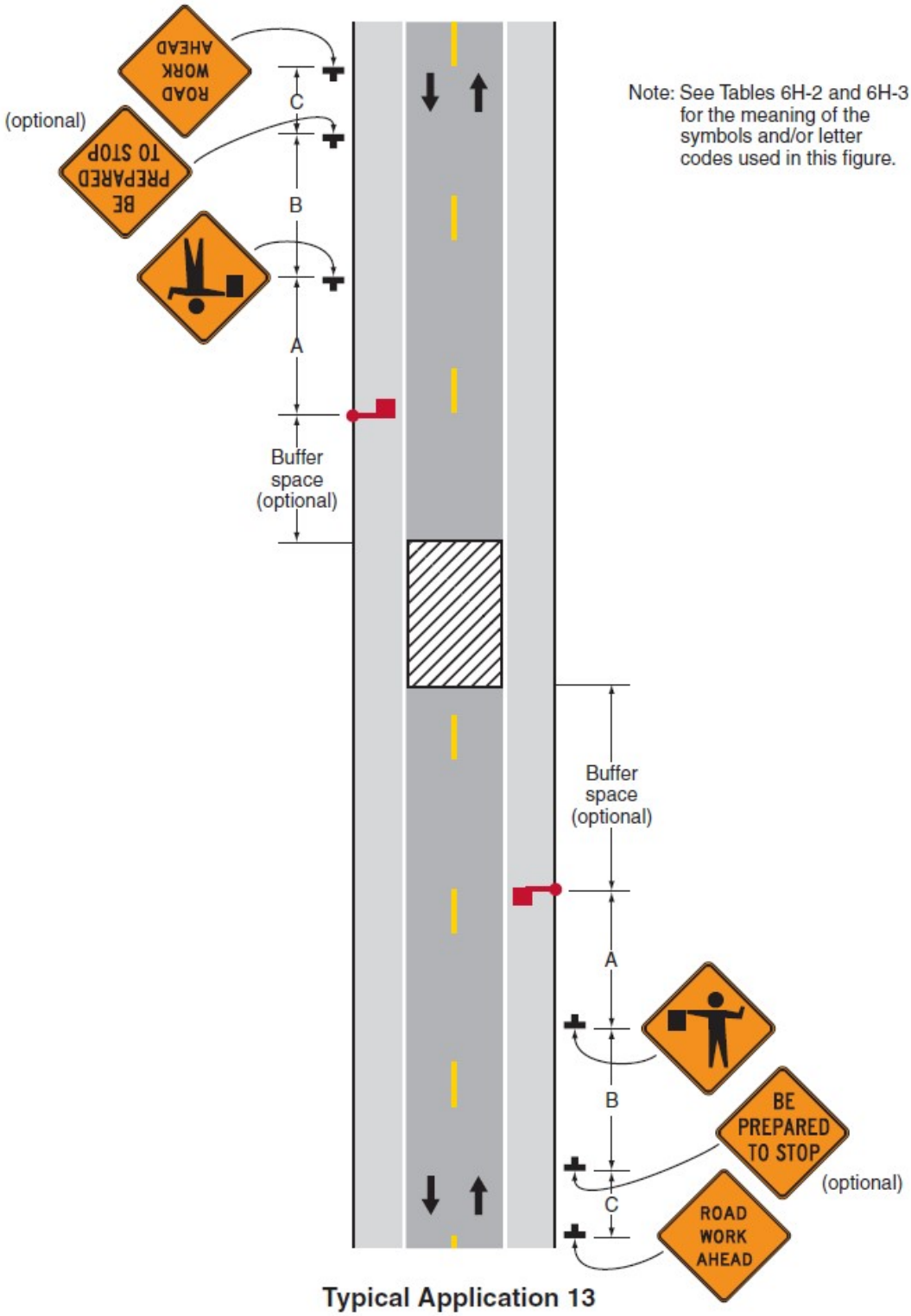


Figure 6H-13. Temporary Road Closure (TA-13)



Typical Application 13

Figure 6H-15. Work in the Center of a Road with Low Traffic Volumes (TA-15)

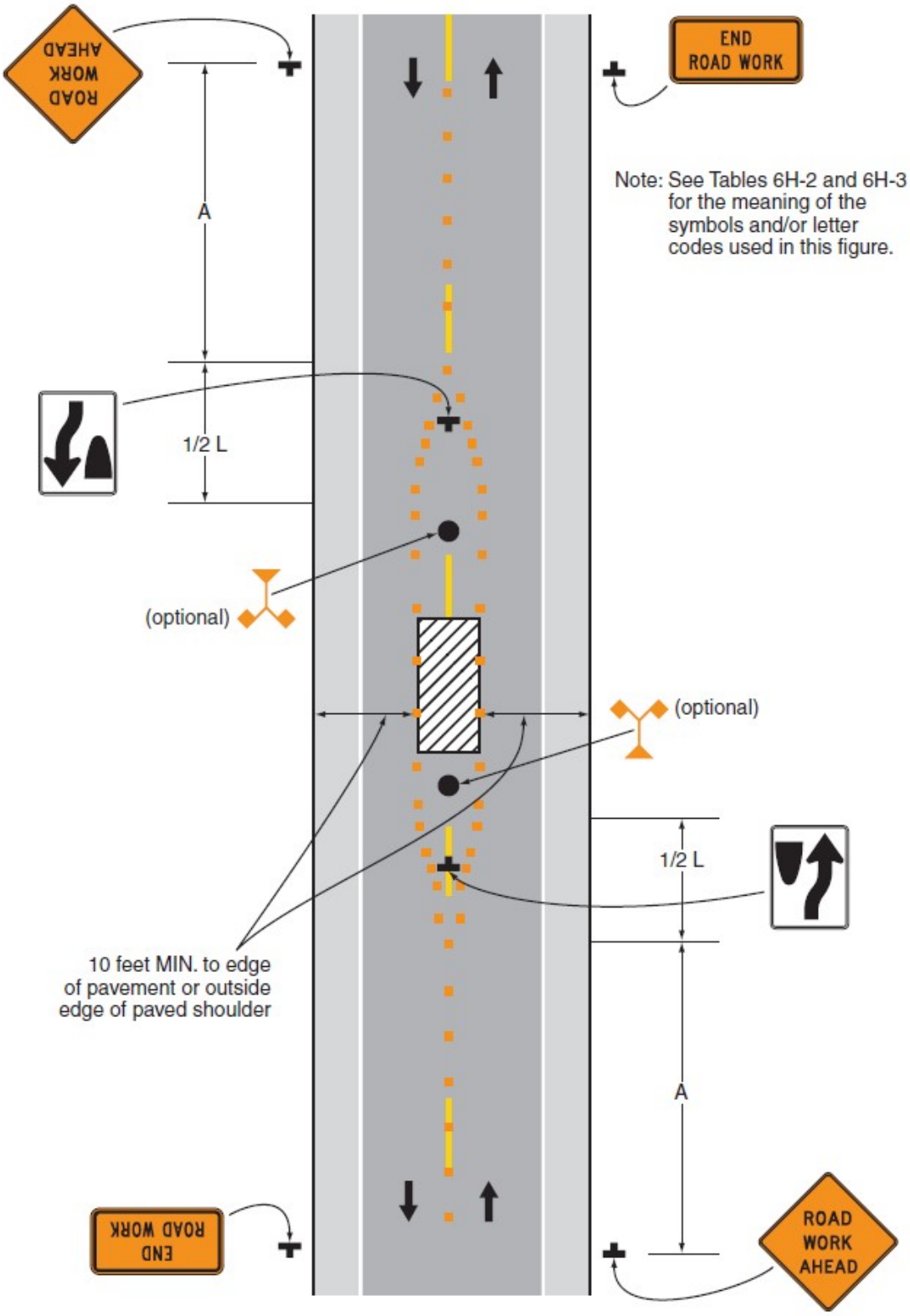
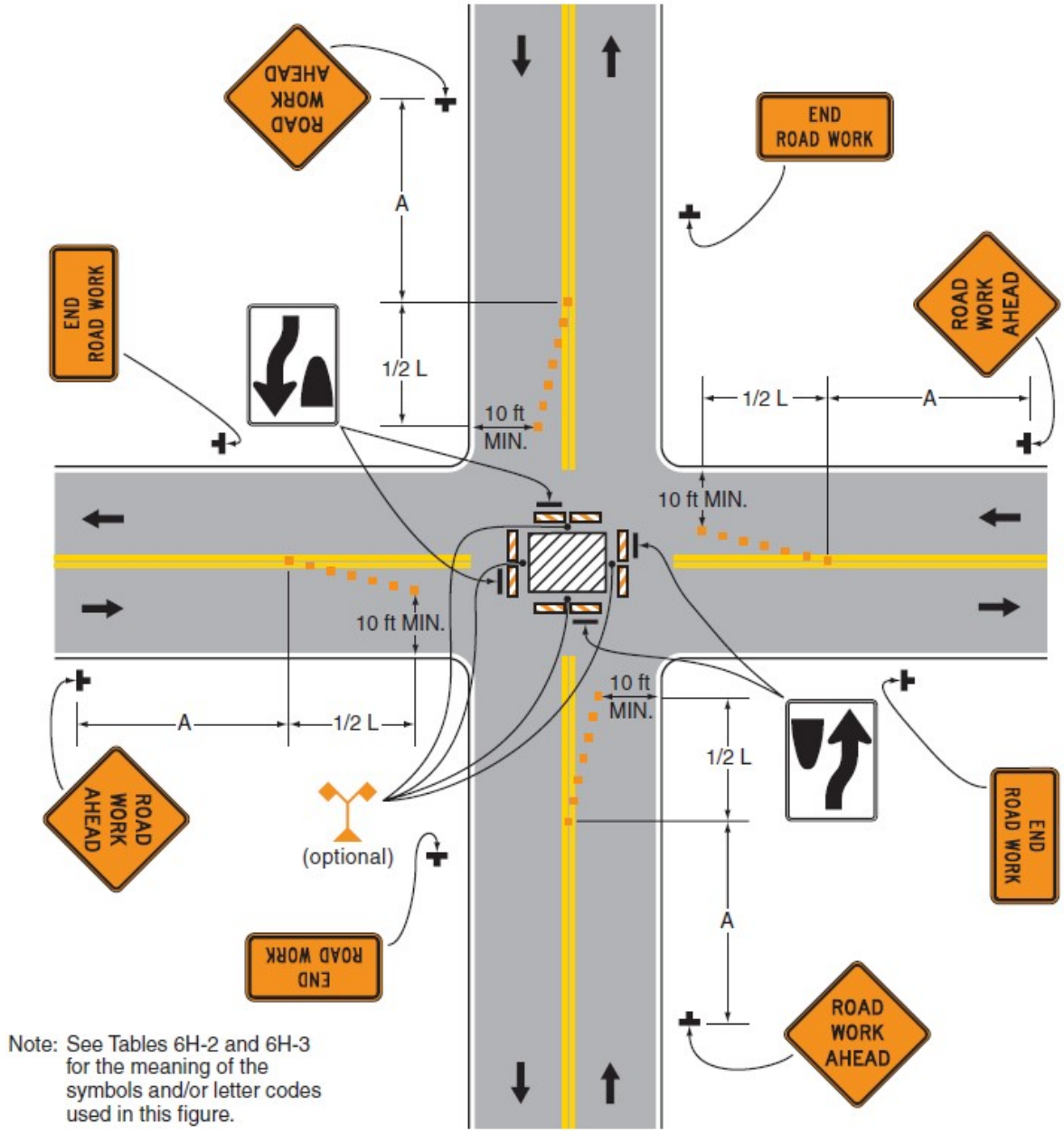
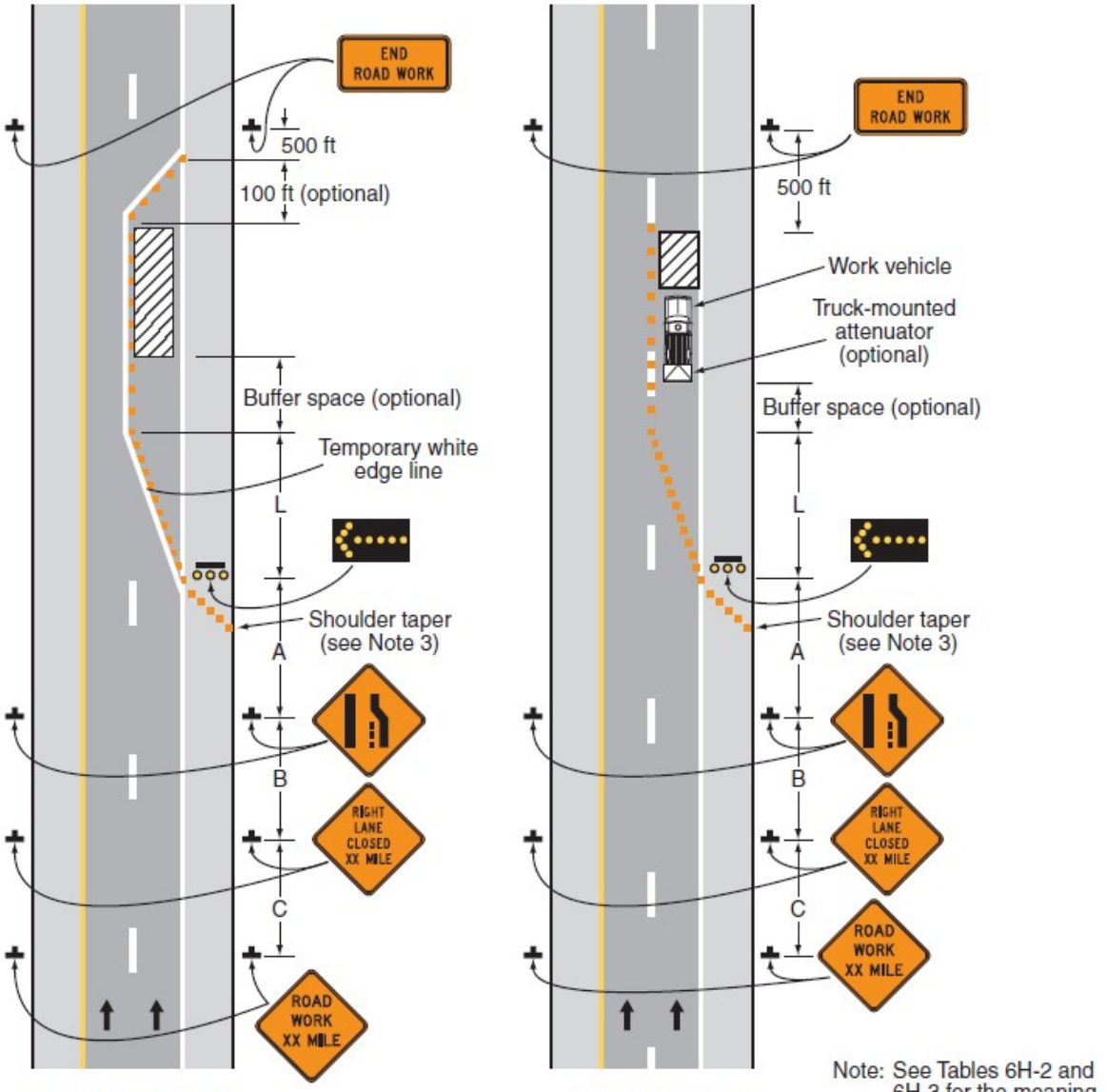


Figure 6H-26. Closure in the Center of an Intersection (TA-26)



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

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



SUMMARY

This course discussed how to effectively plan and design temporary traffic controls for work zone locations. The course objective was to give participants an in-depth look at the principles to be considered when selecting and designing for temporary traffic control in work zones.

The goal of traffic signs and pavement markings is to provide drivers with relevant information when they need it - resulting in safer, more efficient roadways with reduced liability risks. Signs and markings convey laws and regulations, traffic and roadway conditions, and guidance and other information. These tools provide important information for safe travel on any U.S. roadway system.

Road users process different types of visual and non-visual information differently - speed, roadway conditions, traffic, legal enforcement, noise levels, etc. Traffic signs and pavement markings serve as reminders of important information and keep road users from having to memorize everything.

By completing this course, you should now be familiar with the general design guidelines *(Manual on Uniform Traffic Control Devices – MUTCD, AASHTO "Green Book", Standard Highway Signs and Markings, etc.)* for work zone traffic control. For further information about temporary traffic control in work zones, please refer to **MUTCD Part 6 – Temporary Traffic Control.**

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(Note: All figures, tables, exhibits, etc. contained in this course are from the MUTCD, except where noted otherwise.)