Implementing Safe Work Zone Operations Strategies

Every Block

You can start your registration page at the back of the handout.

Also, please put your name at the top of the evaluation form for later

<u>No ID Number or Type Necessary</u>

Date: 10/15/19

Sponsor: IL T2 (LTAP) & IPWMAN

Location: Bloomington, IL

Title: ISWZOS

Instructor: Neal Carboneau

Brought to you by …

U.S. Department of Transportation

Federal Highway Administration

COLLEGE OF ENGINEERING, ARCHITECTURE AND TECHNOLOGY

Engineering Extension

Oklahoma and Michigan Local Technical Assistance Programs

Transportation Training Institute, LLC

Disclaimer

The course materials for this training are based upon work supported by the Federal Highway Administration (FHWA) under Grant Agreement DTFH6116RA00018, "2016 Work Zone and Guardrail Safety Training Grants."

Any opinions, findings, conclusions or recommendations expressed in this course are those of the trainer and the grantee and do not necessarily reflect the view of the Federal Highway Administration. This course does not constitute a national standard, specification or regulation.

Disclaimer

This course provides training to assist the participants in meeting the objectives identified. Basic principles and discussions of industry practice are intended to assist practitioners in the planning and implementation of their temporary traffic control operations; planned using the appropriate Manual on Uniform Traffic Control Devices (MUTCD), engineering judgment and jurisdictional requirements for the location the work is being performed. Due to the multitude of situations in which these principles can be applied, the coursework only provides the basic foundation on which decisions should be made.

The employee and their employer are responsible and assume the liability for their comprehension of the principles, review and implementation of the information provided in this training as well as the application laws and regulations associated with the location of the work.

Main Points:
(Getting the Motorists' Attention)

- Reduce the Probability and Severity of an Incident
  - Shadow Vehicles
  - Buffer Space
  - Air Horns
  - First Aid

- Proper Implementation
  - Standard Operating Procedures
  - Engineering Judgment & Decision Making
  - Choosing the Right TTC for the Job
    - Mobile
    - Flagged
    - Self Regulating
- Addressing Site Conditions
  - On Site Modification

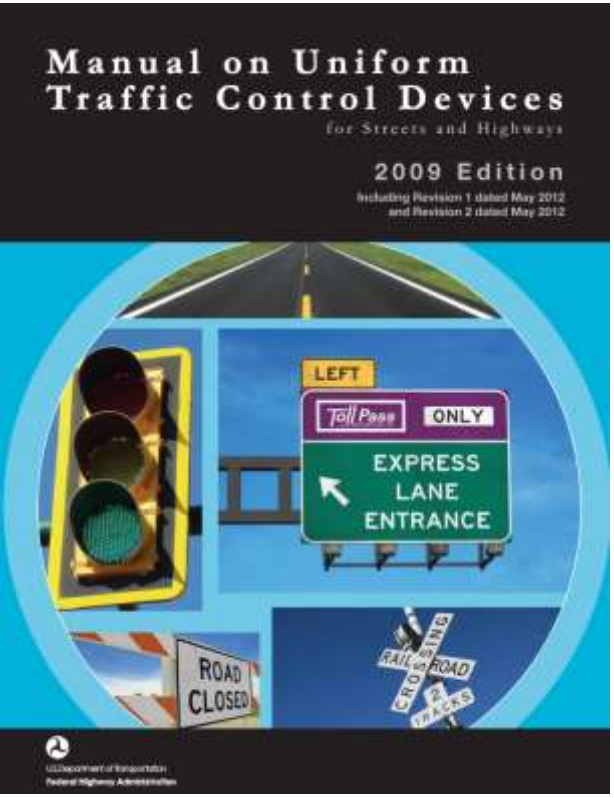
SEE the Difference - Safe, Effective & Efficient

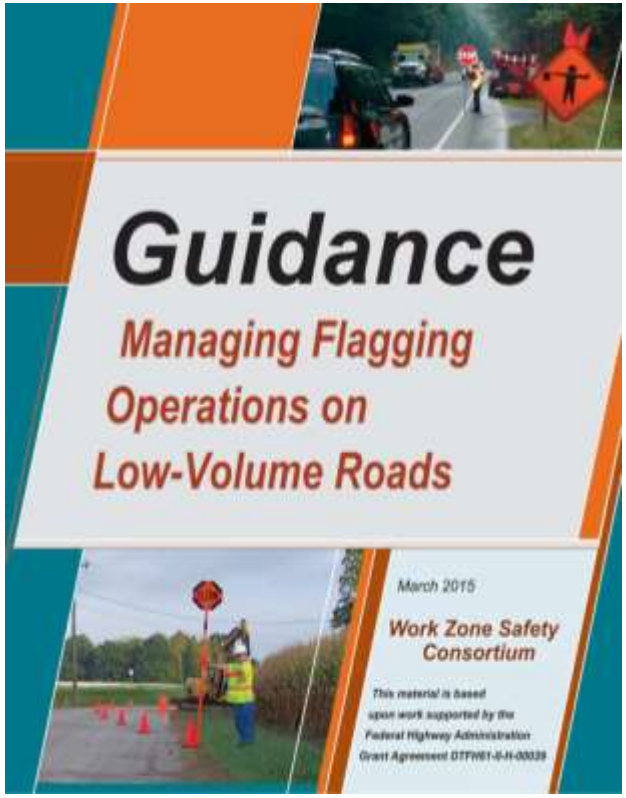
Helpful Resources

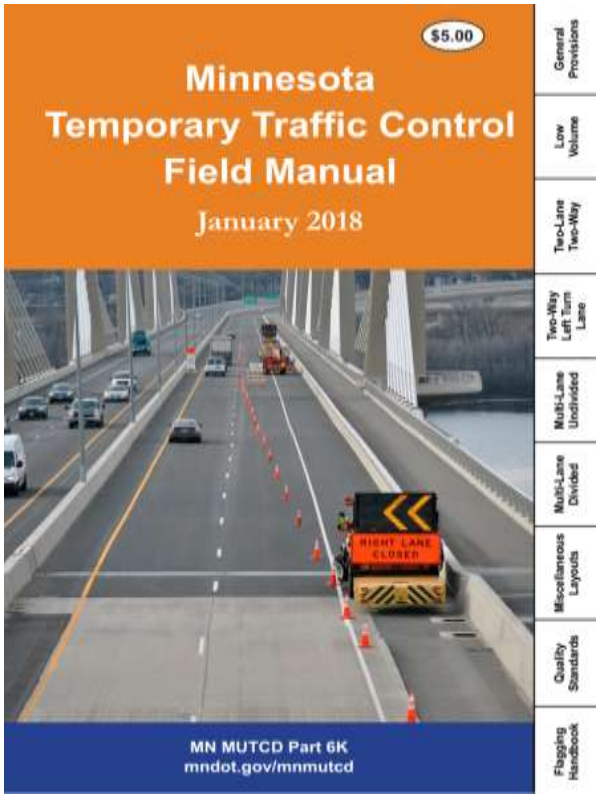
- A Dropbox Folder with Resources and Course Materials

https://goo.gl/Mi3Y9p

- The link is case sensitive capitalize the M and Y

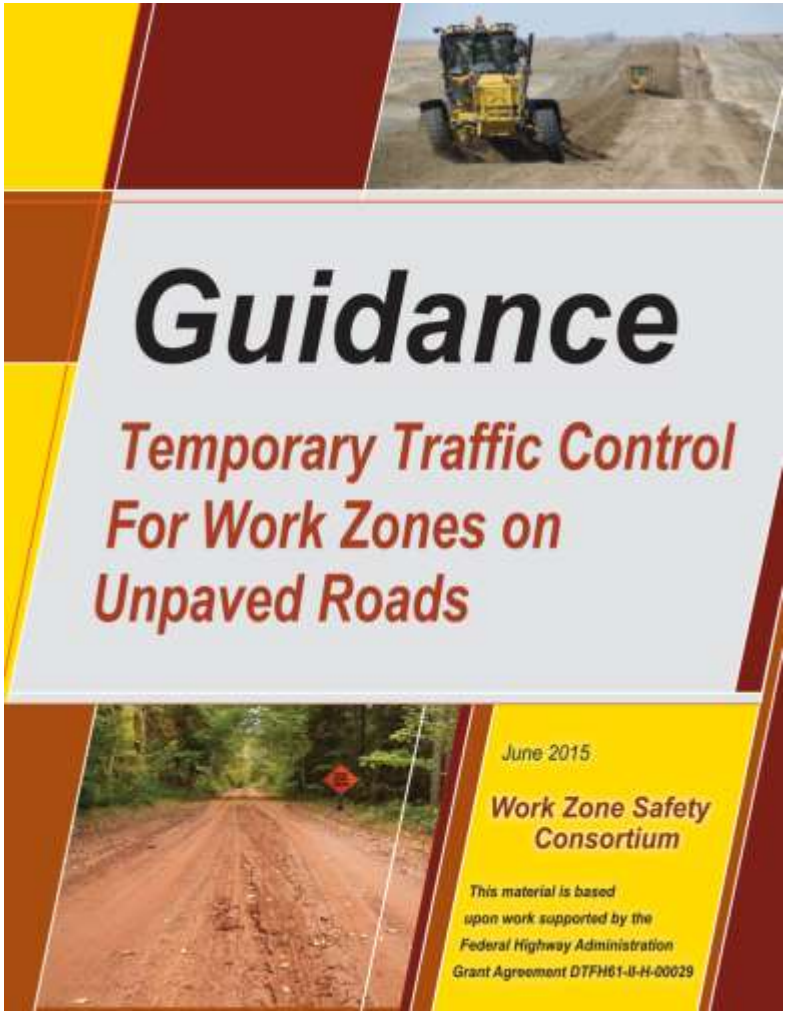


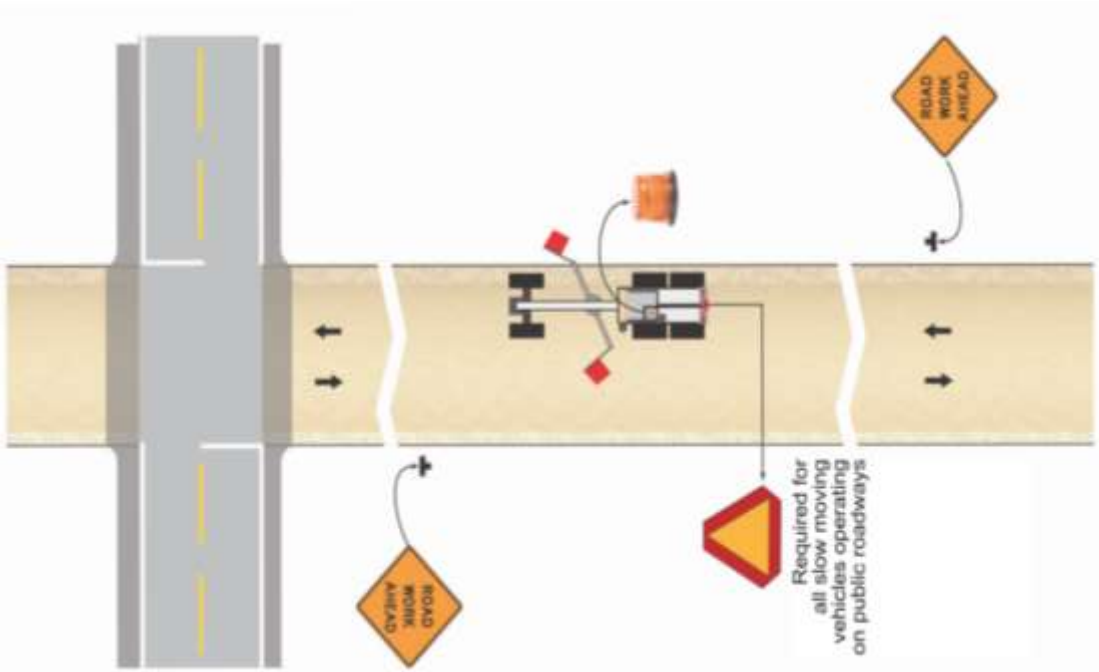




Other Helpful Resources Not Covered Today

Available on the Dropbox Link





Getting to Know the Handout

- On the 3x5 card:
  - Write down a question about traffic control that you have
- Look at every page (bold print, tables, details …) From:
- As you go:
  - Don’t spend too much time on each page
    - A second or two
    - If something catches your interest, put a yellow tab on that page and keep moving
  - Write down what caught your interest on the 3x5 card

Implementing Safe Work Zone Operations Strategies

Source: Texas A&M

Source: TTI-LLC

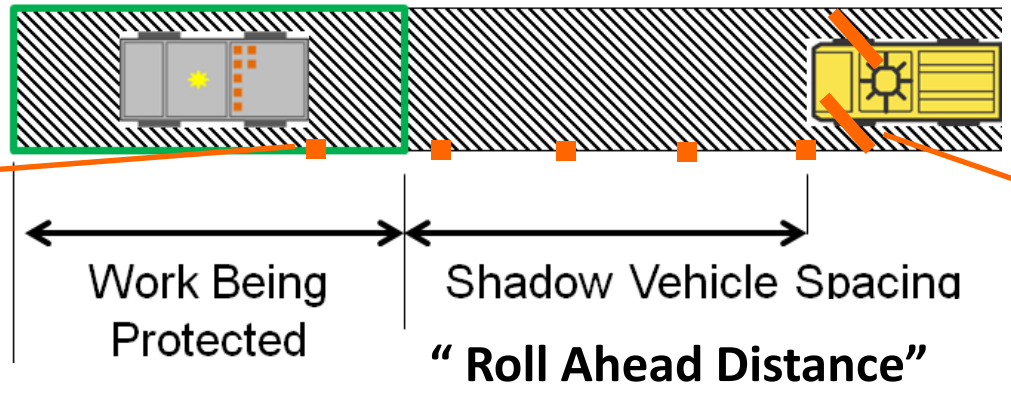
Every Block

Intro Video

Available on the Dropbox Link

AASHTO Roadside Design Guide Shadow Vehicle Positioning

Could Add Cones Along the Centerline for Visibility



Can Turn Wheels to The Curb or Shoulder

Shadow Vehicles Weighing 22,000 lbs or More		
Operating Speed Limit	Stationary	Moving < 15.5 MPH
≥ 55 MPH	150 Feet	172 Feet
45 - 50 MPH	100 Feet	150 Feet
< 45 MPH	74 Feet	100 Feet
Shadow Vehicles Weighing 9,900 lbs to 22,000 lbs		
Operating Speed Limit	Stationary	Moving < 15.5 MPH
≥ 55 MPH	172 Feet	222 Feet
45 - 50 MPH	123 Feet	172 Feet
< 45 MPH	100 Feet	100 Feet

Graphics Source: ARTBA & TTI-LLC

Crash Test Videos

Van travelling at 45 MPH

50,000 LB Truck Striking 25,000 LB Truck at 50 MPH

Available on the Dropbox Link

Where are you in relation to your shadow vehicle?

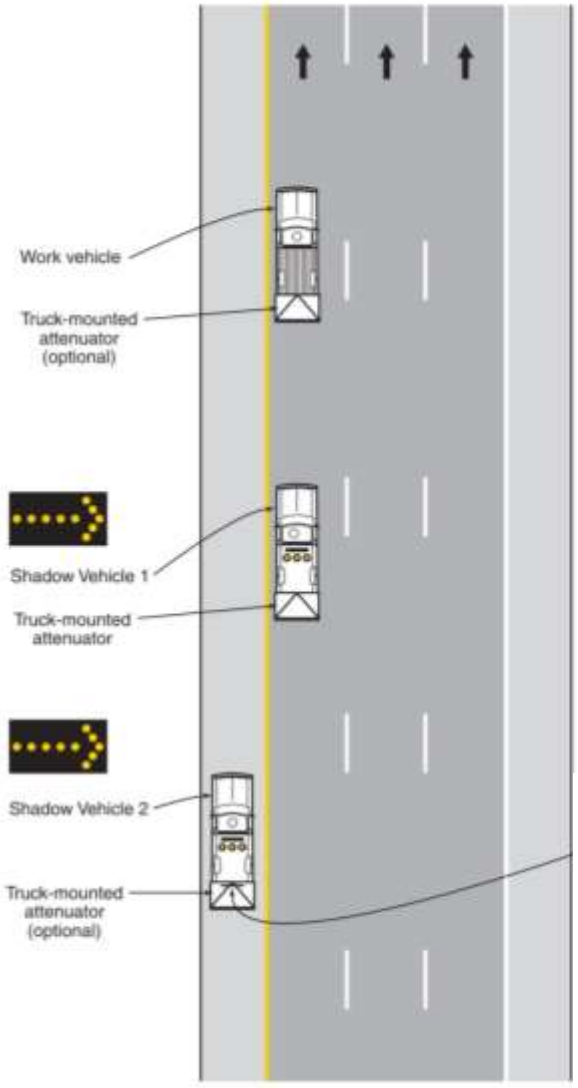
Source: TTI-LLC

This pickup with the message board in arrow mode might also be a sacrificial vehicle for the fire truck.

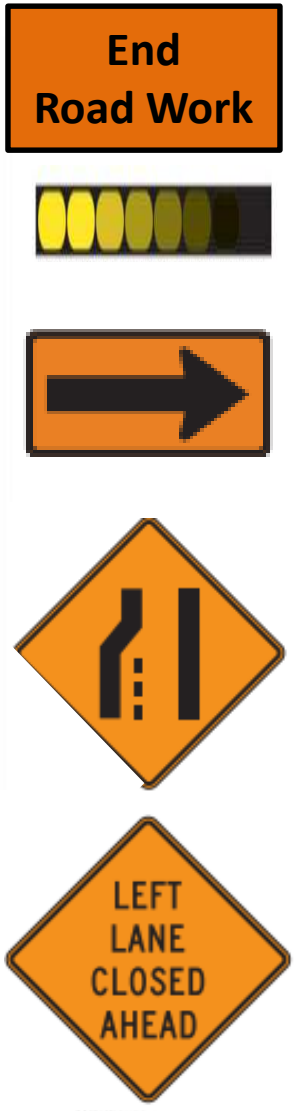
Source: TTI-LLC

Let's Look at the Multi Lane Typical Application … and Read the Notes

TA-35



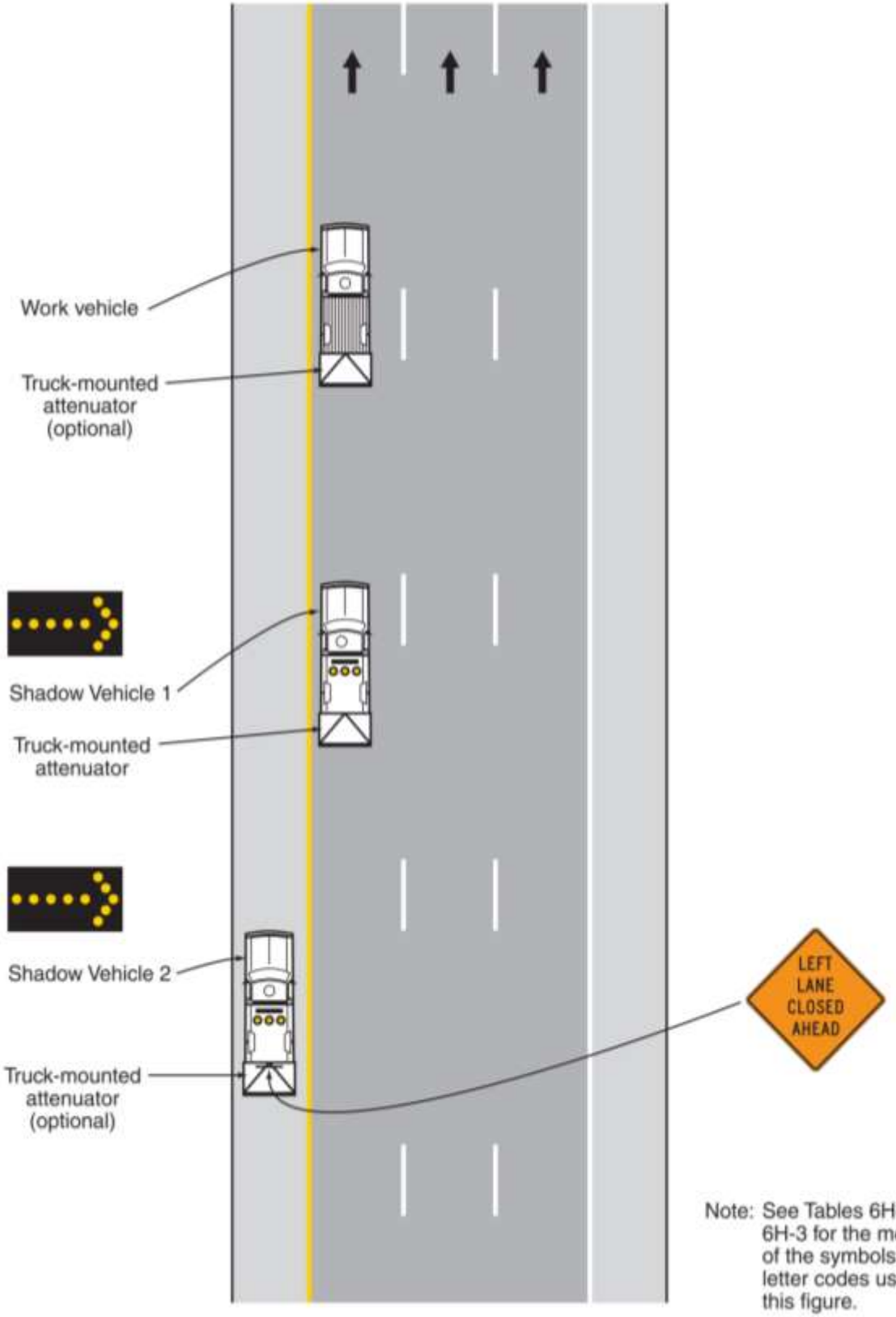
Typical Application 35



Every Block

Source: TTI-LLC

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



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

Typical Application 35

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.**

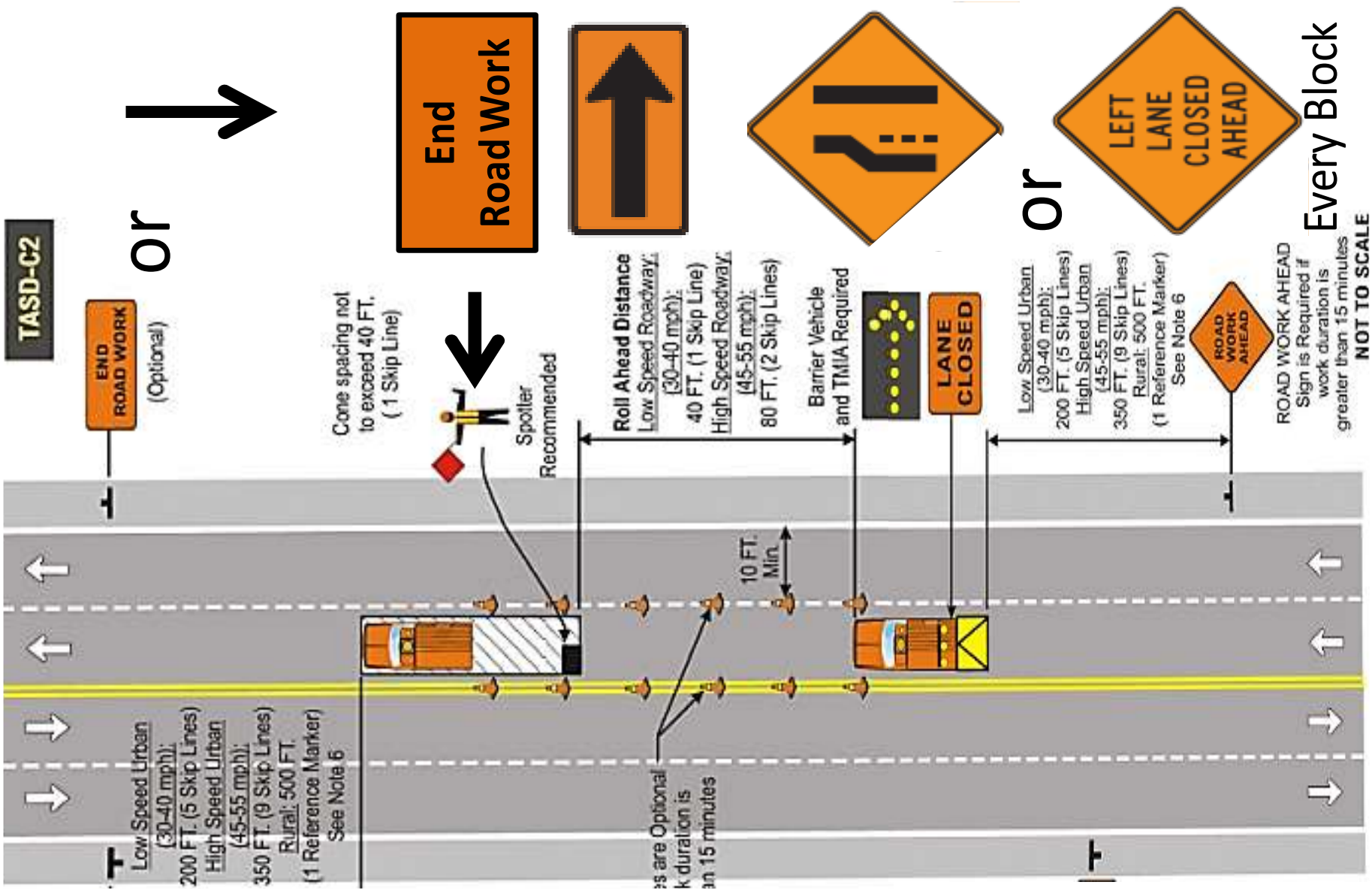
Guidance:

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:

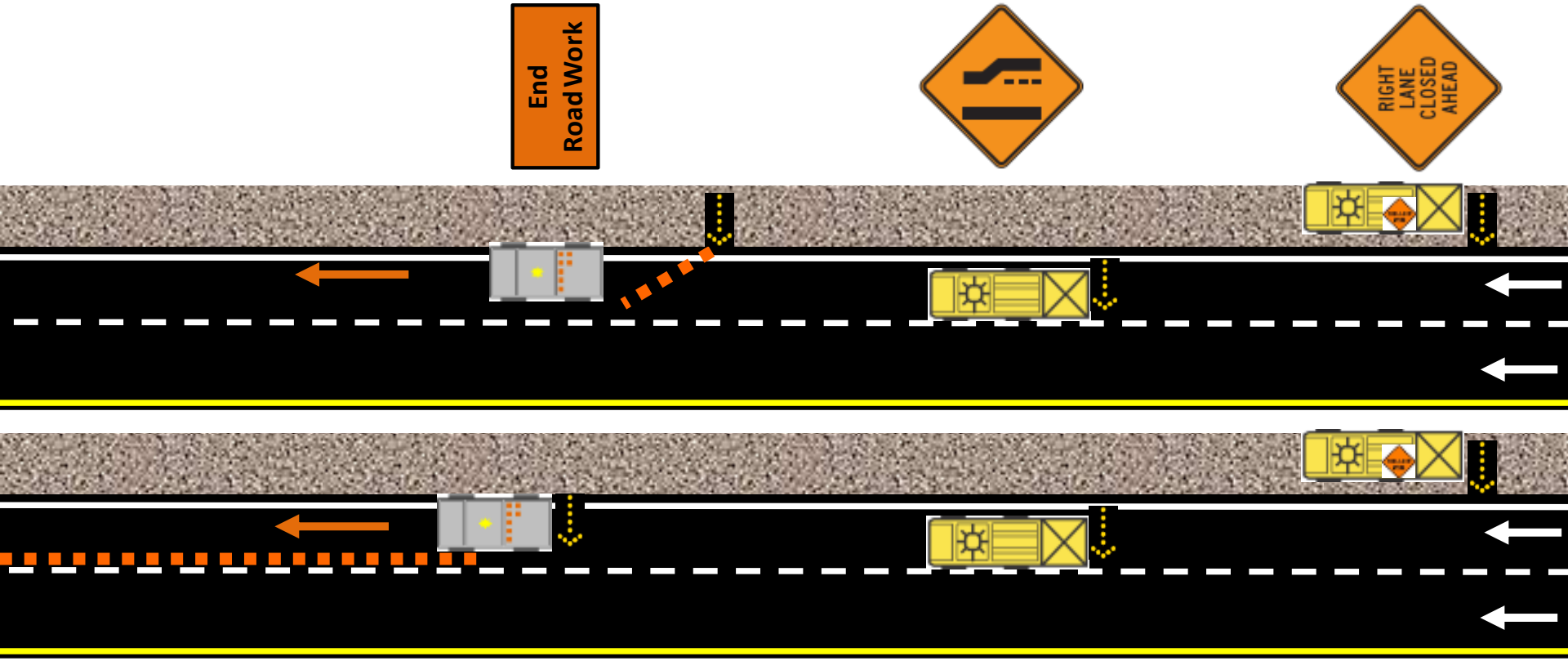
12. A truck-mounted attenuator may be used on Shadow Vehicle 2.
13. On high-speed roadways, a third shadow vehicle (not shown) may be used with Shadow Vehicle 1 in the closed lane, Shadow Vehicle 2 straddling the edge line, and Shadow Vehicle 3 on the shoulder.
14. Where adequate shoulder width is not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

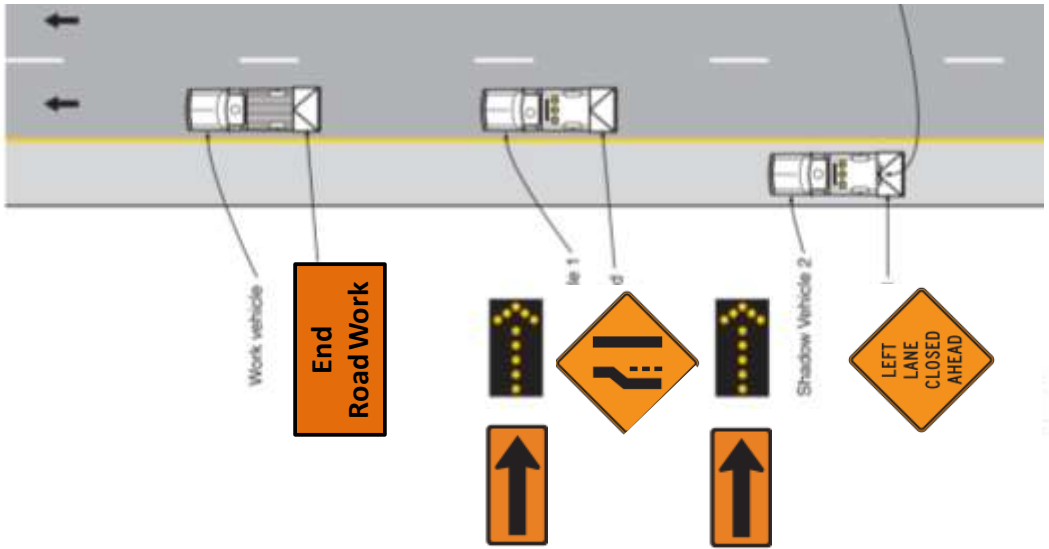
How about this? Pre-Set Signs?



Source: NYSDOT

Mobile Operations for Safer Installation





TA-35

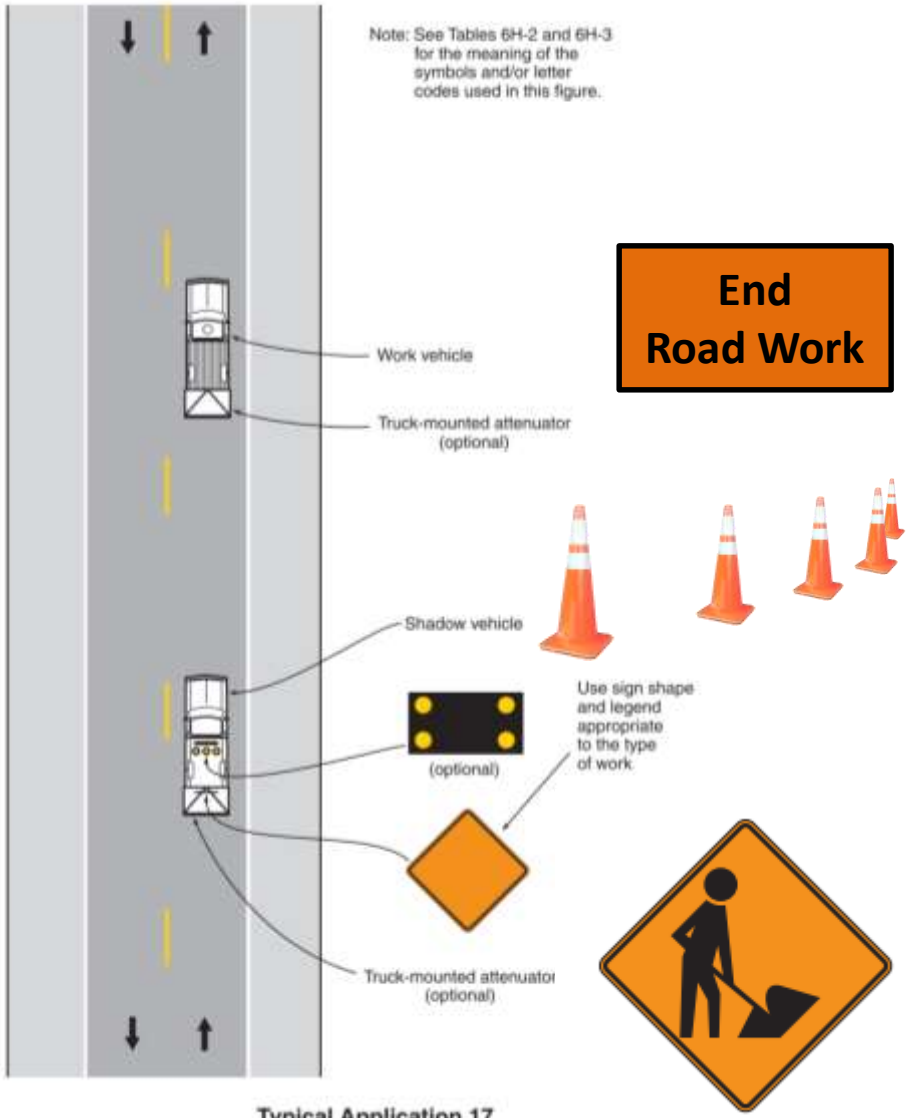
Modified

MNDOT - Light Stick
Directional Light Bar

Arrow Sticks may supplement other TTC devices, but shall not be used in place of arrow boards.

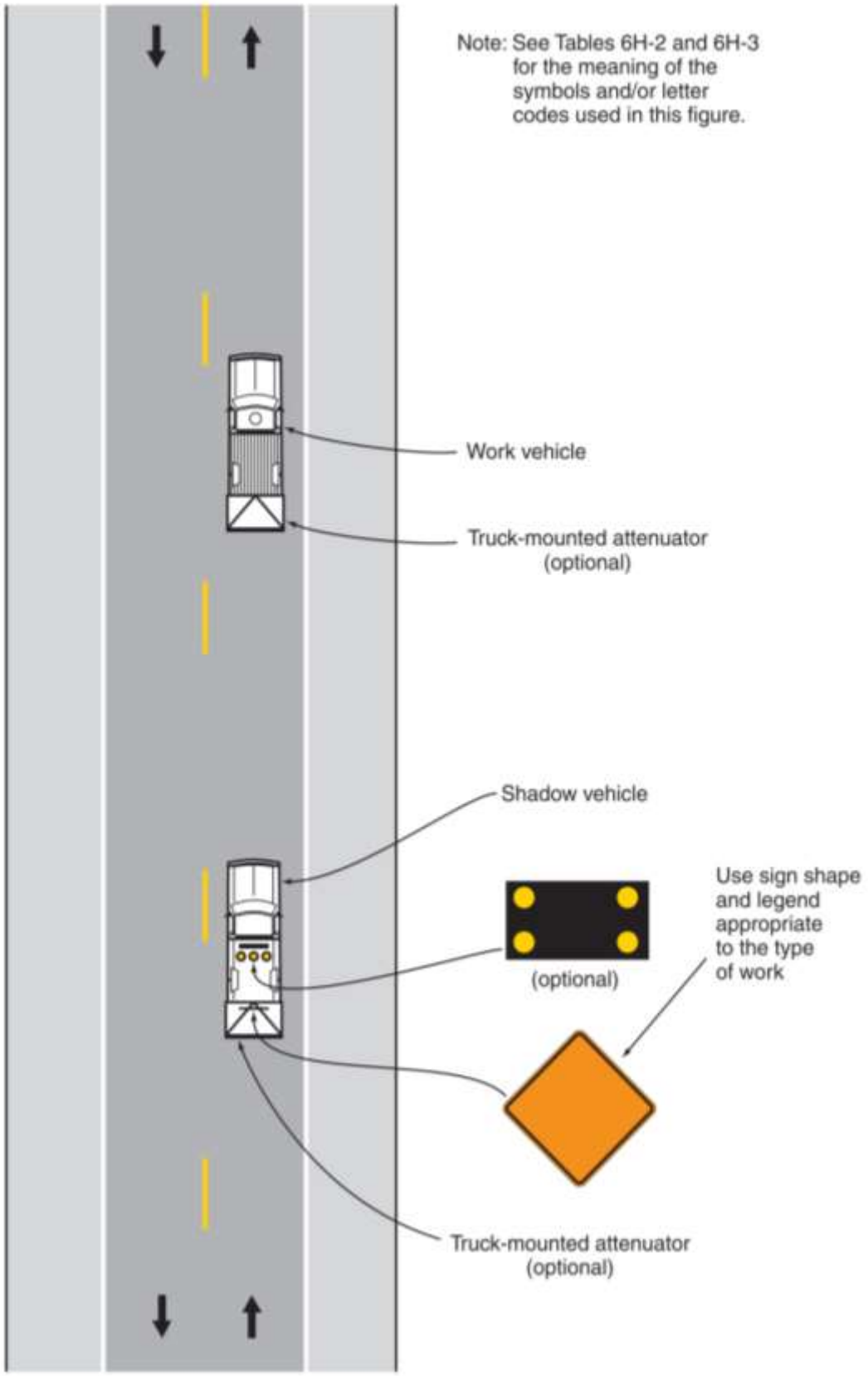
Let's Look at the Two Lane Typical Application … and Read the Notes

TA-17



Typical Application 17

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



Typical Application 17

Notes for Figure 6H-17—Typical Application 17
Mobile Operations on a 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 board 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 should 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, paint drying time, 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:

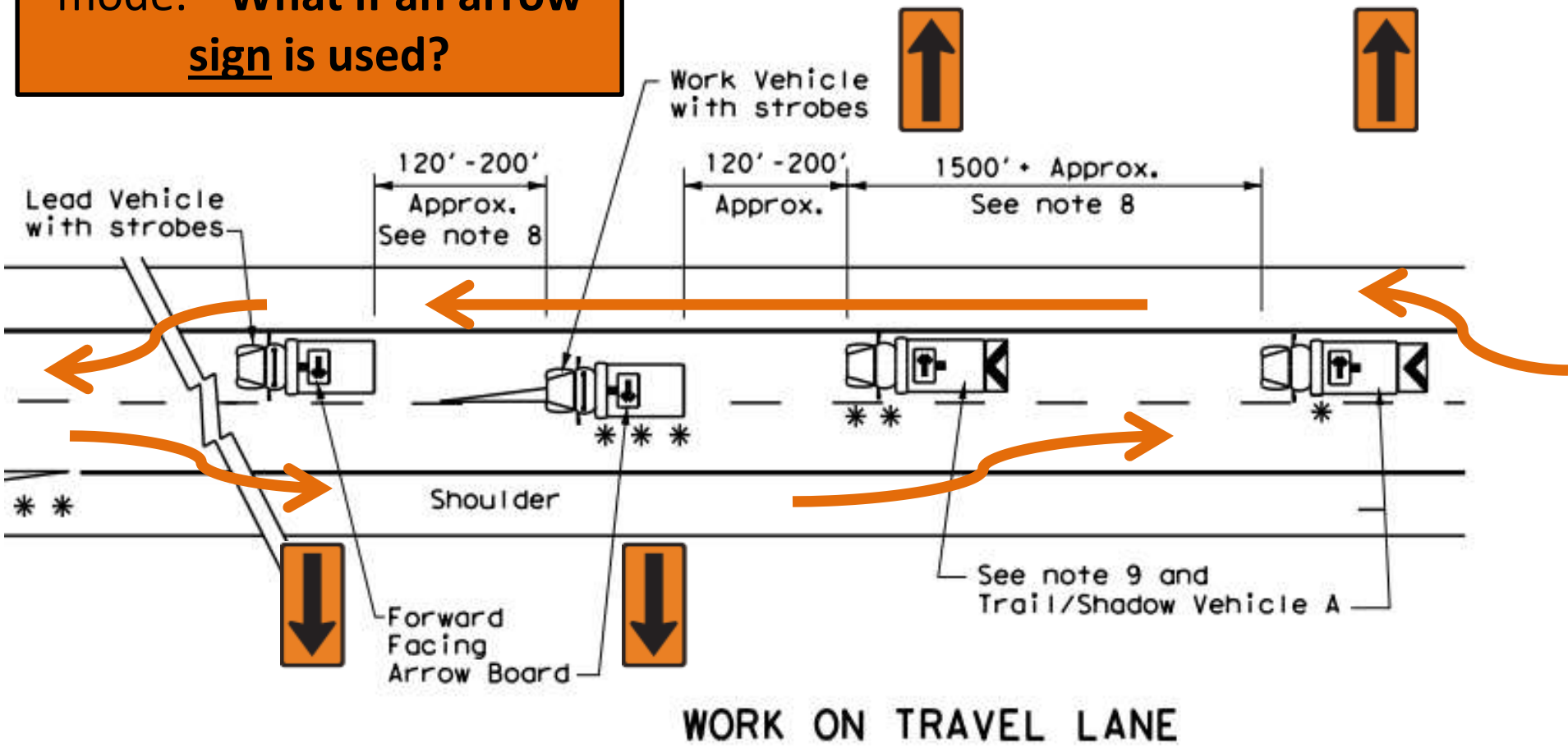
11. Shadow vehicles are used to warn motor vehicle traffic of the operation ahead.

Standard:

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

3: "If an arrow board is used, it shall be in caution mode." **What if an arrow <u>sign</u> is used?**

Addressing Opposing Traffic (Handling Larger Volumes of Traffic)



Source: TXDOT

Note: TXDOT Modified the MUTCD Language to Allow an Arrow Board in Arrow Mode on a Two Lane Road

What about these situations?

How about this?

From Managing Flagging Operations on Low Volume Roads

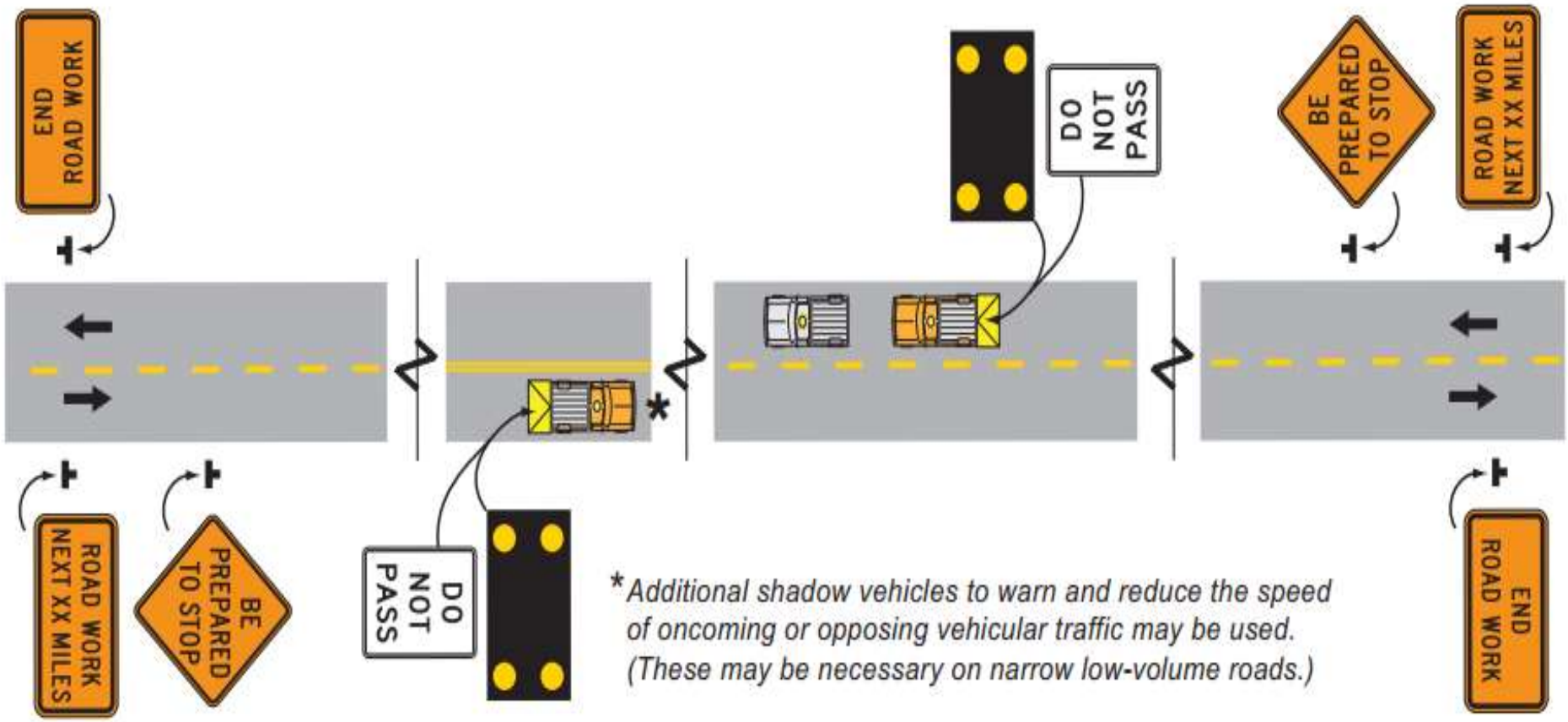


Figure 8. Example of a mobile operation where flagger and sign placement are constrained near the site of work. (Adapted from MUTCD TA-17).

Any thoughts on this operation?

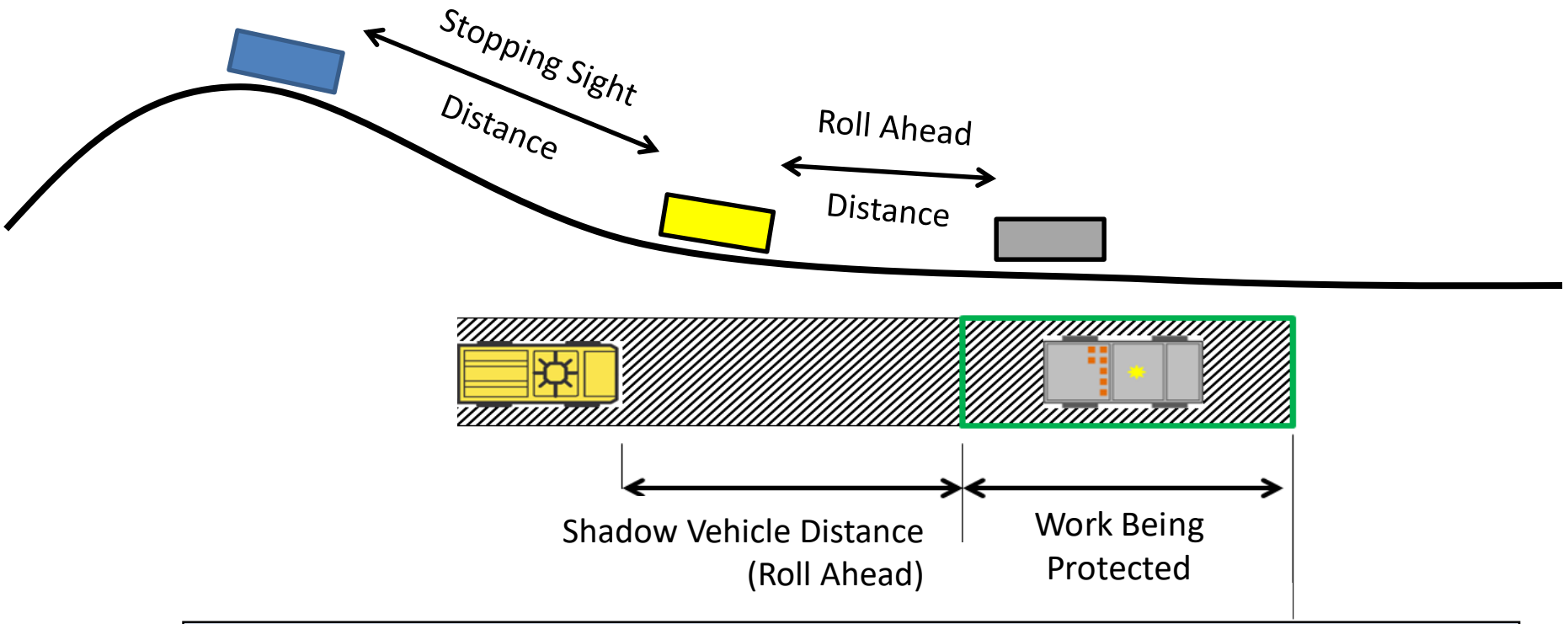
What if we used this?

When does the shadow vehicle come over the hill?

When a vehicle can stop before hitting it.

Speed in Miles Per Hour	Distance Between Signs**			Buffer Space Stopping Sight Distance in Feet
	4 x Speed Limit Urban Min	8 x Speed Limit Urban Max Rural Min	12 x Speed Limit Rural Max	
20	100	160	240	115
25	100	200	300	155
30	120	240	360	200
35	140	280	420	250
40	160	320	480	305
45	180	360	540	360
50	200	400	600	425
55	220	440	660	495
60	240	480	720	570
65		520	780	645
70		560	840	730
75		600	900	820

Source: TTI-LLC, Calculated from the MUTCD



Shadow Vehicles Weighing 22,000 lbs or More		
Operating Speed Limit	Stationary	Moving < 15.5 MPH
≥ 55 MPH	150 Feet	172 Feet
45 - 50 MPH	100 Feet	150 Feet
< 45 MPH	74 Feet	100 Feet
Shadow Vehicles Weighing 9,900 lbs to 22,000 lbs		
Operating Speed Limit	Stationary	Moving < 15.5 MPH
≥ 55 MPH	172 Feet	222 Feet
45 - 50 MPH	123 Feet	172 Feet
< 45 MPH	100 Feet	100 Feet

What if there is too much traffic?

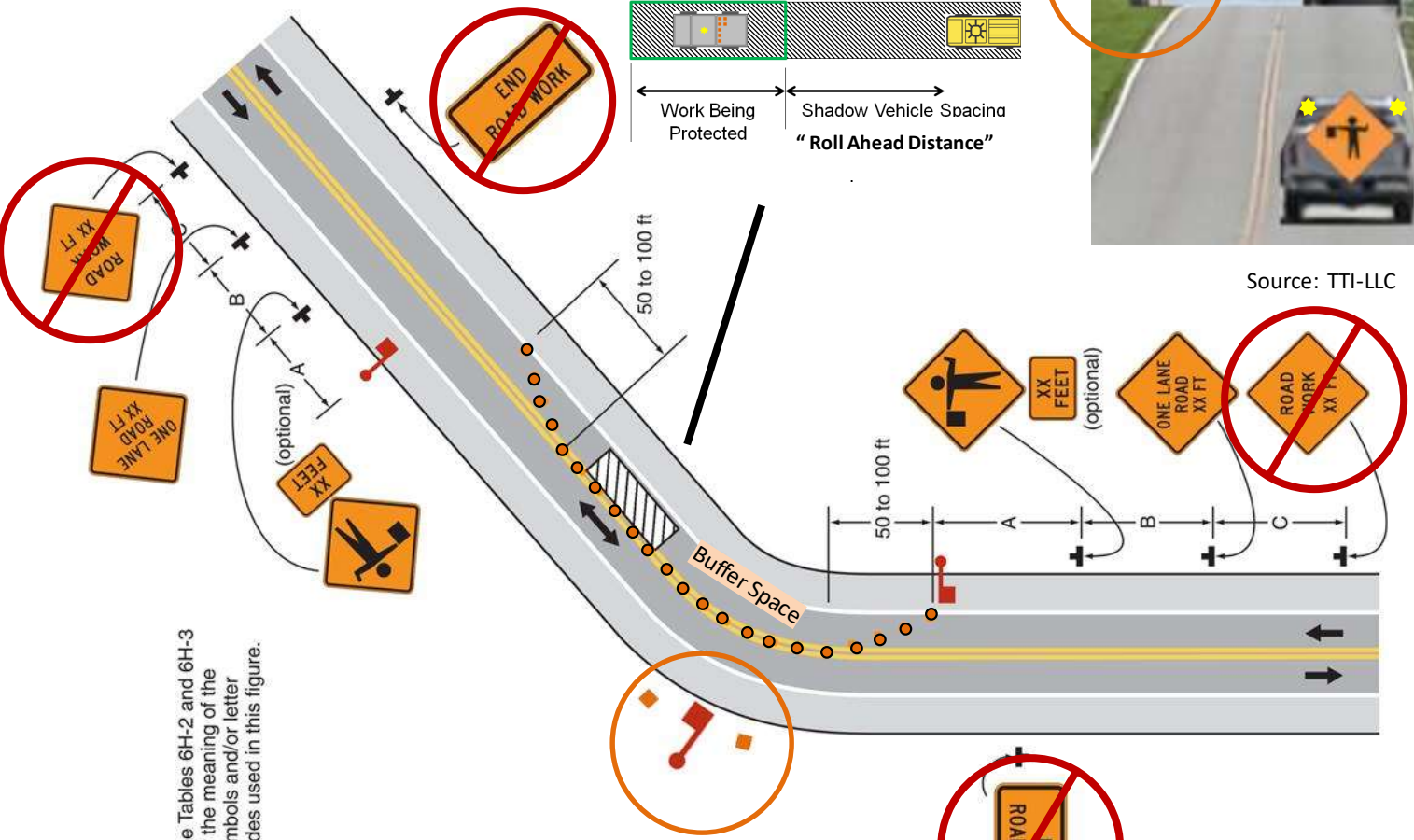
At the cross roads coming into this section?

TA 10 Allows Single Flaggers

Notice the Short Duration Language (< 1 Hour “per location”)

MUTCD TA-10 ***modified***
to show single flagger

Source: TTI-LLC



Section 6E.07 ¶ **08**

Notes for Figure 6H-10—Typical Application 10
Lane Closure on a Two-Lane Road Using Flaggers

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 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 grade crossing, the TTC zone should be extended so that the transition area precedes the grade crossing.*
8. *When a 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 grade crossing exists within the activity area, drivers operating on the left-hand side of the normal center line should be provided with comparable warning devices as for drivers operating on the right-hand side of the normal center line.*
10. *Early coordination with the railroad company or light rail transit agency should occur before work starts.*

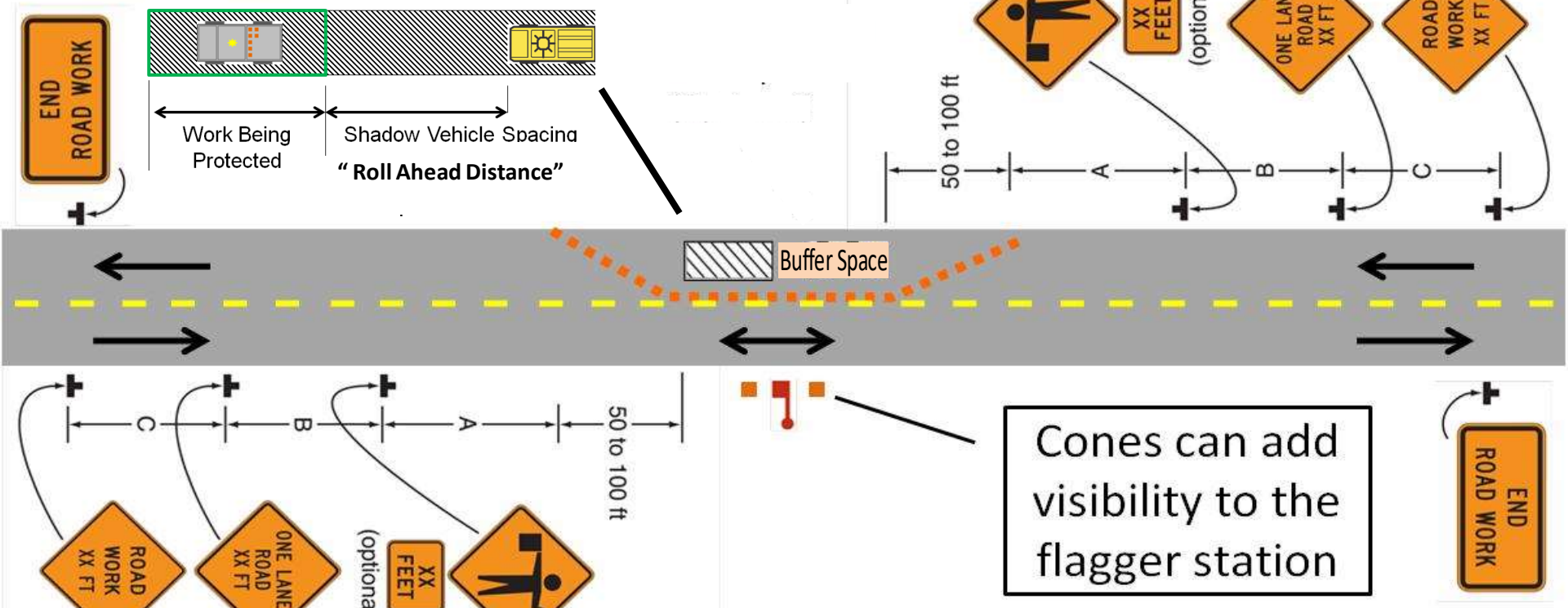
Option:

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

Single Flaggers Clarified in Managing Flagging Operations on Low Volume Roads

Source: Carboneau, Trans. Training Inst., Cropped

TA10 in the MUTCD Modified to Represent Single Flagger Control



Section 6E.07 ¶ **08**

Single Flagger Considerations from Managing Flagging Operations on Low Volume Roads

If you have larger manageable volumes you may need to keep one direction stopped while stopping the other.

Other Flagger Considerations

<u>What happens between stop and proceed</u>?

- Have body angled towards the stop slow paddle.
- Watch both directions for traffic, driveways, pedestrians .

To stop traffic:

Turn face and body towards traffic for stop or proceed signals. “Face Traffic”

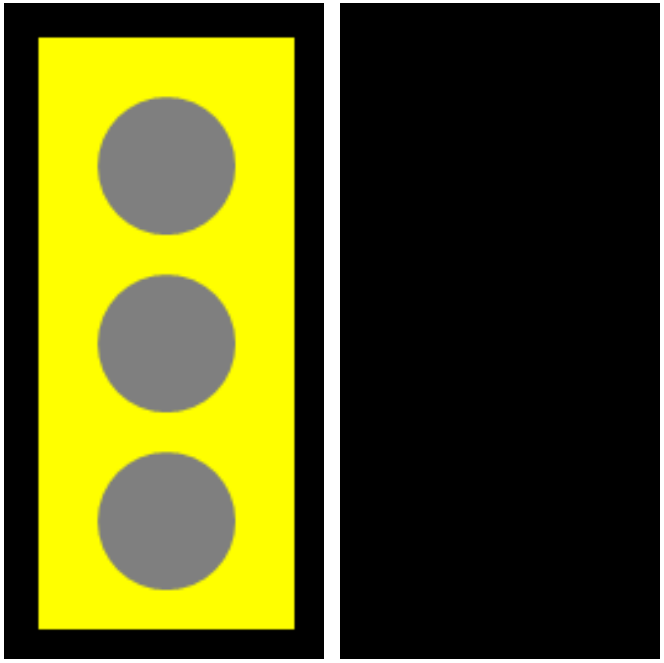
Section 6E.07 **¶ 06**

How do we get them to stop where we want?

Could Add …

or

Other Flagger Considerations …
Avoid Conflicting Messages
May Need Additional Flaggers (2+)

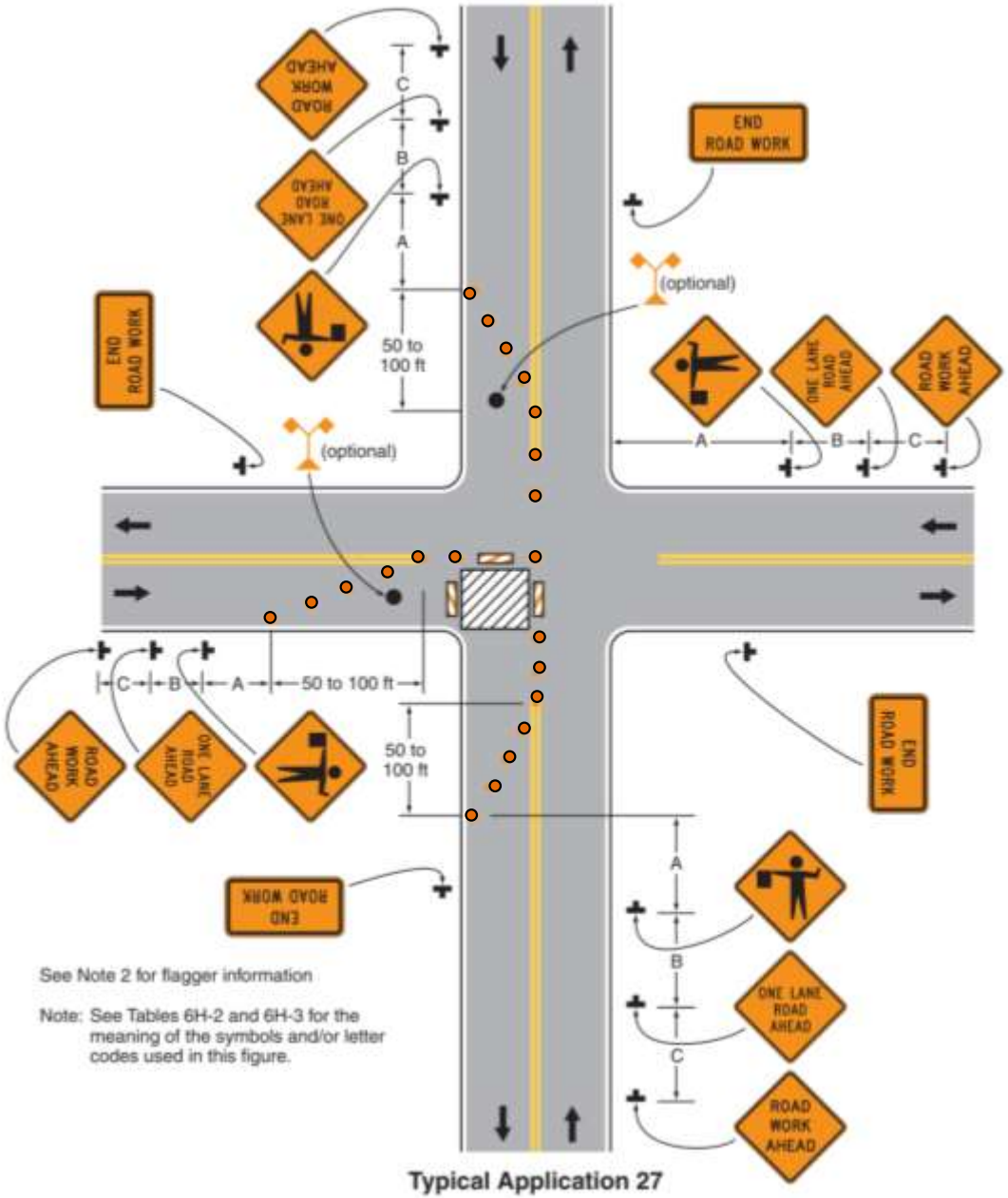


Source: TTI-LLC

Source: MIDOT & MRBA

Intersection Flagging

TA-27

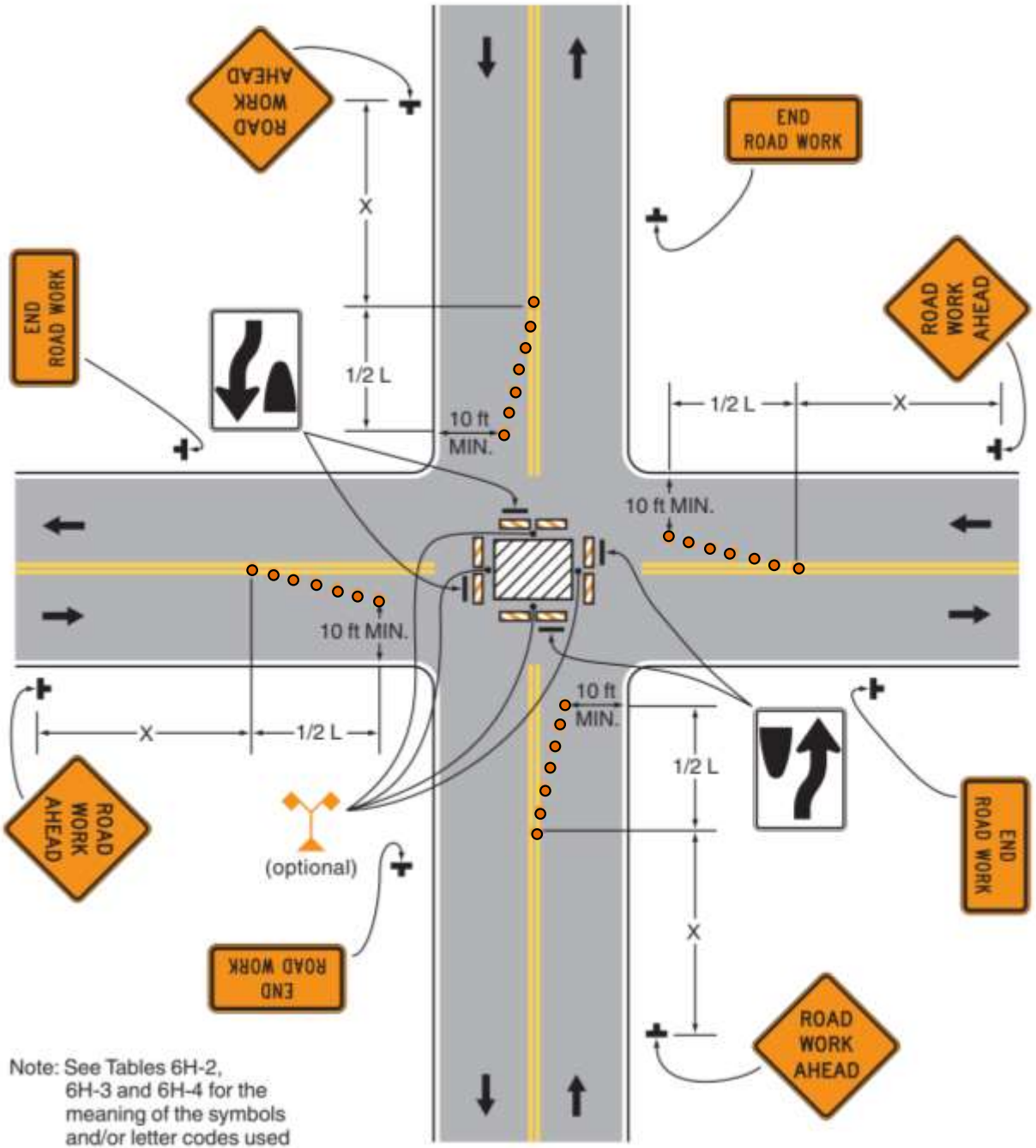


Typical Application 27

Consider Law Enforcement

Encroachment

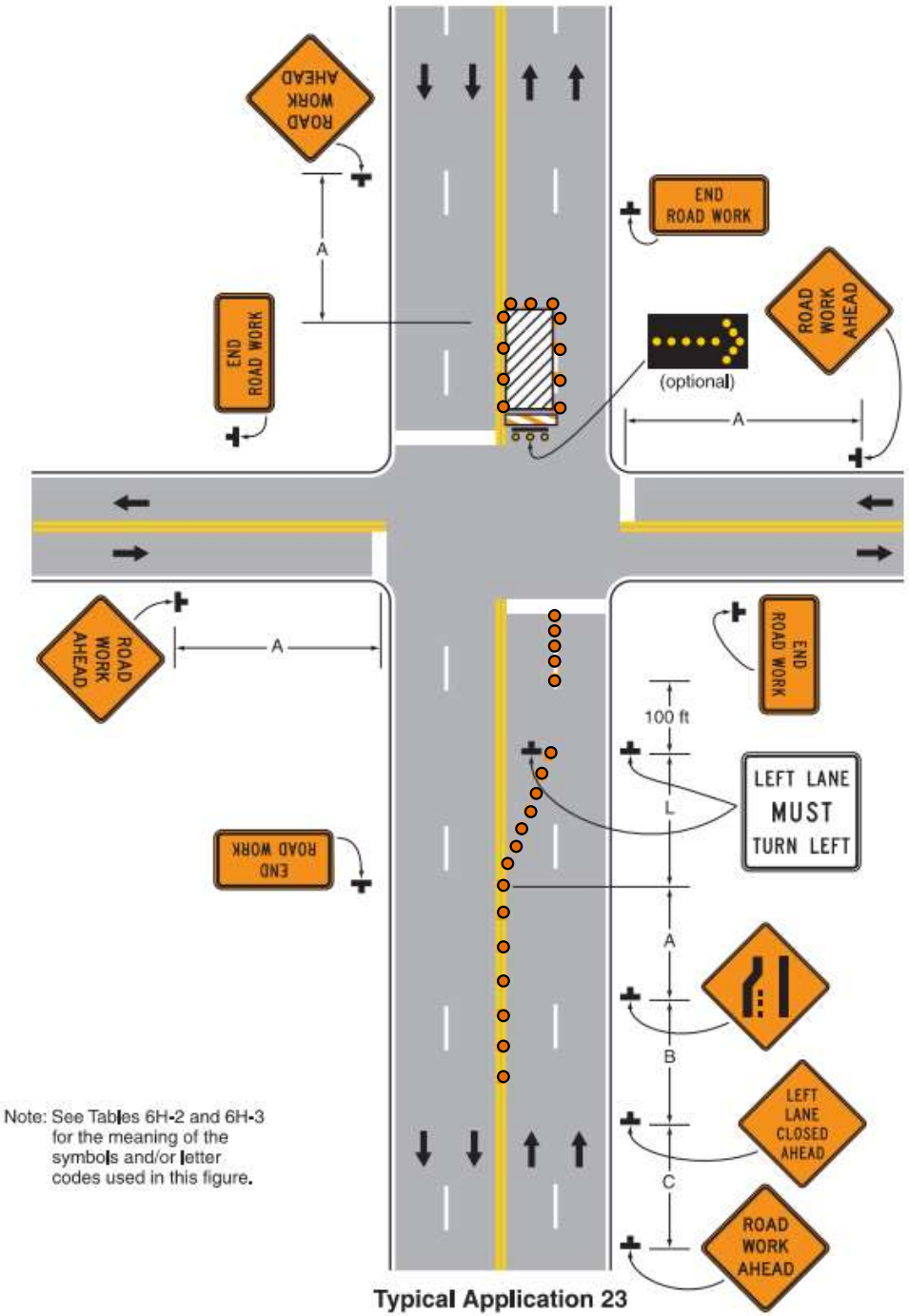
TA-26



Note: See Tables 6H-2, 6H-3 and 6H-4 for the meaning of the symbols and/or letter codes used in this figure.

Far Side of an Intersection

TA-23



Typical Application 23

ADA for Short Term Activities?

6D.01 Pedestrian Considerations

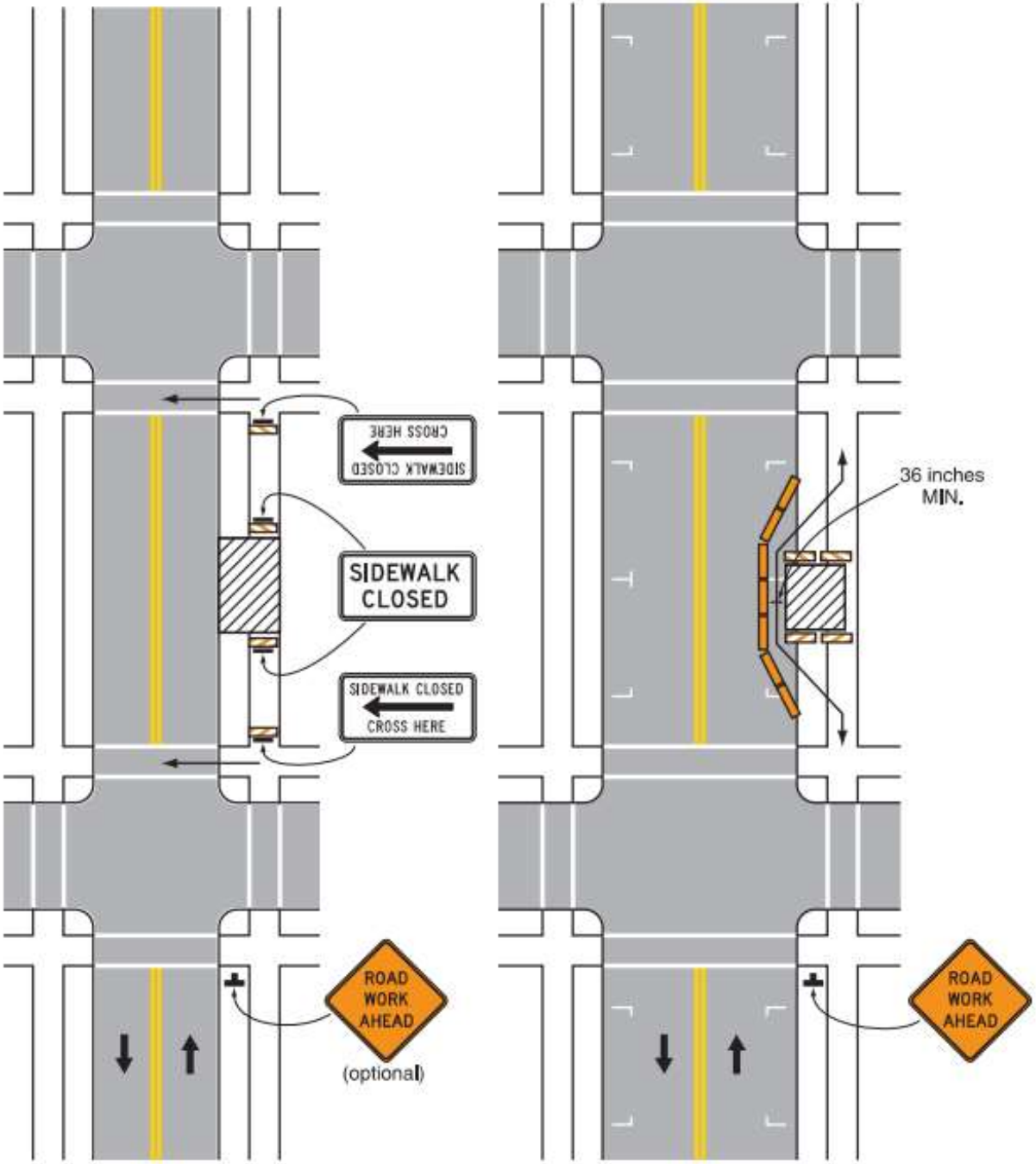
¶ 5 "If establishing or maintaining an alternate pedestrian route is not feasible during the project, an alternate means of providing for pedestrians may be used, such as adding free bus service around the project or **assigning someone the responsibility to assist pedestrians** with disabilities through the project limits."

¶ 6-12 relate to longer term work

Source: Stomp, Sim

Sidewalk Detours & Run-Arounds

TA-28



Addressing Other Site Conditions

- Over extended lengths of road with hills and curves

– A pilot vehicle may be necessary to control the motorists' speed
– Intersections may require flaggers
  – If not using a pilot vehicle
  – or high volumes exist
– In some cases driveway and intersection traffic can be controlled with signage

Source: Virginia DOT, Flagger Training Video, Cropped

Source: MIDOT & MRBA, Cropped

Source: Texas Transportation Institute, Texas A&M University (TTI-TAMU) & Transportation Training Institute, LLC (TTI-LLC)

From Managing Flagging Operations on Low Volume Roads

Low-Volume Access Point Considerations

"Evaluation of innovative devices to control traffic
entering from low-volume access points."
Texas Transportation Institute, Texas A & M University, (TTI-TAMU) 2014
By Melisa Finley, Praprut Songchitruksa and Srinivasa Sunkari

Describes methods to address intersecting roadways
and driveways including the following:

- Use "barricades and cones to close low-volume access points;"
- "Visit property owners and residents to notify them of the changes in traffic control and what they should do when exiting their driveway;"
- Station "flaggers at all access points;" and
- Hold traffic at the access point until the pilot vehicle arrives.

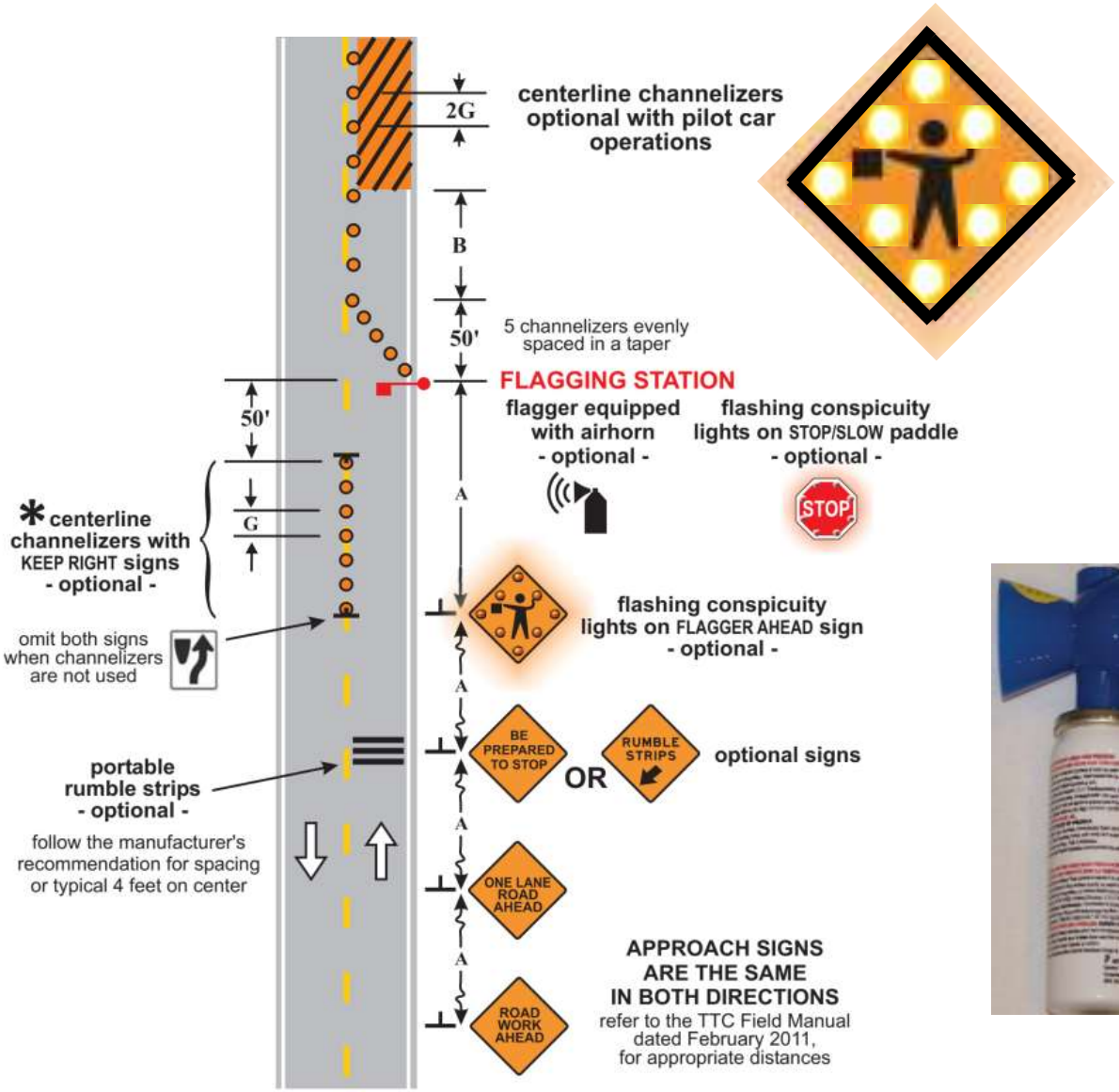
Gaining the Motorists' Attention

Section 6E.03 Hand-Signaling Devices

¶ 6 The STOP/SLOW paddle may be modified to improve conspicuity by incorporating either white or red flashing lights on the STOP face, and either white or yellow flashing lights on the SLOW face.

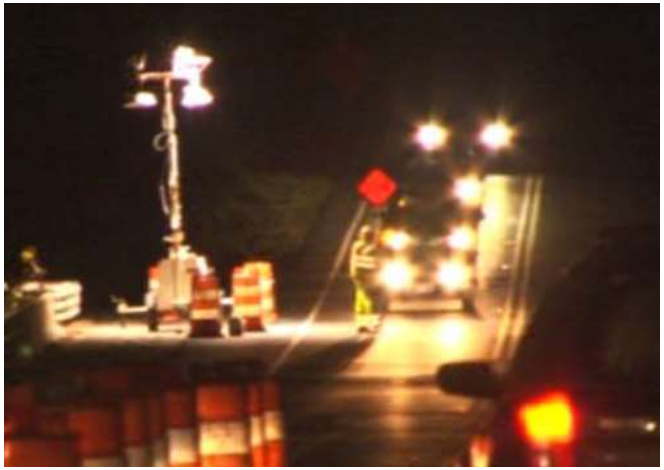
Gaining the Motorist's Attention

Centerline Cones – Portable Rumble Strips – Flashing Signs …



Source: TTI-LLC

Source: FHWA, Retroreflectivity Implementation Toolbox



Source: ARTBA

Source: ARTBA, Cropped

Visibility Challenges for Motorists

GLARE

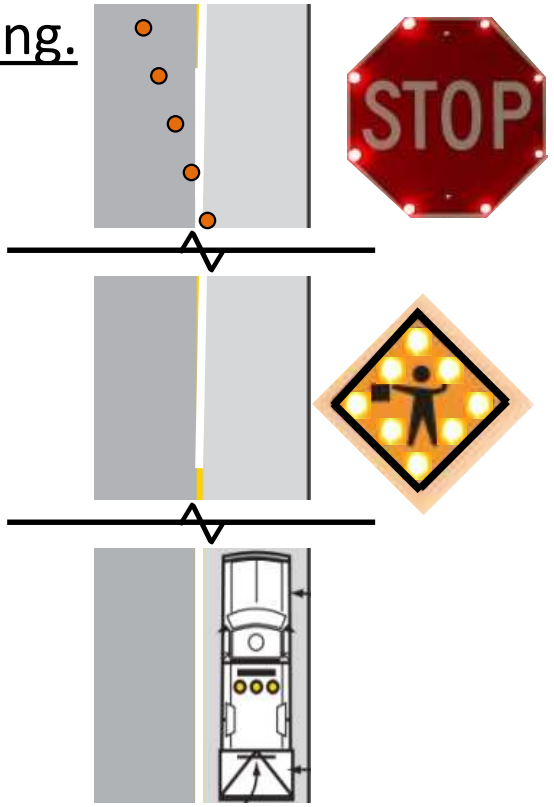
Be cautious of too much lighting
at a flagger station.
The flagger here is becoming hard to see

Other Visibility Issues – Rain, Snow, Fog, Dust The Sun

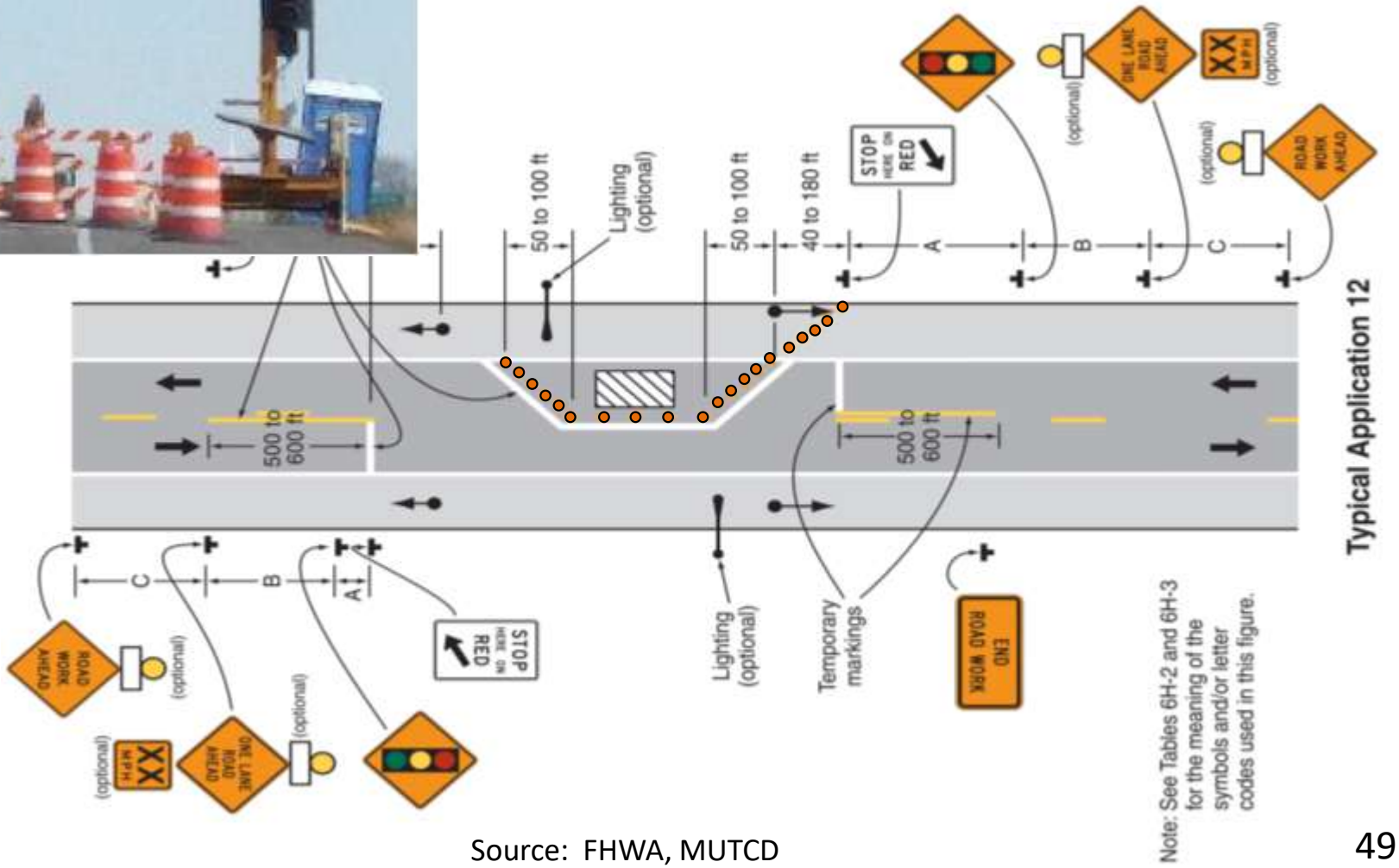
Cancel Operations?

Emergency? Can't Cancel? Need Clear Advance Warning.

Buffer Space
Shadow Vehicles
Truck Mounted
Attenuators



How about eliminating flaggers all together?

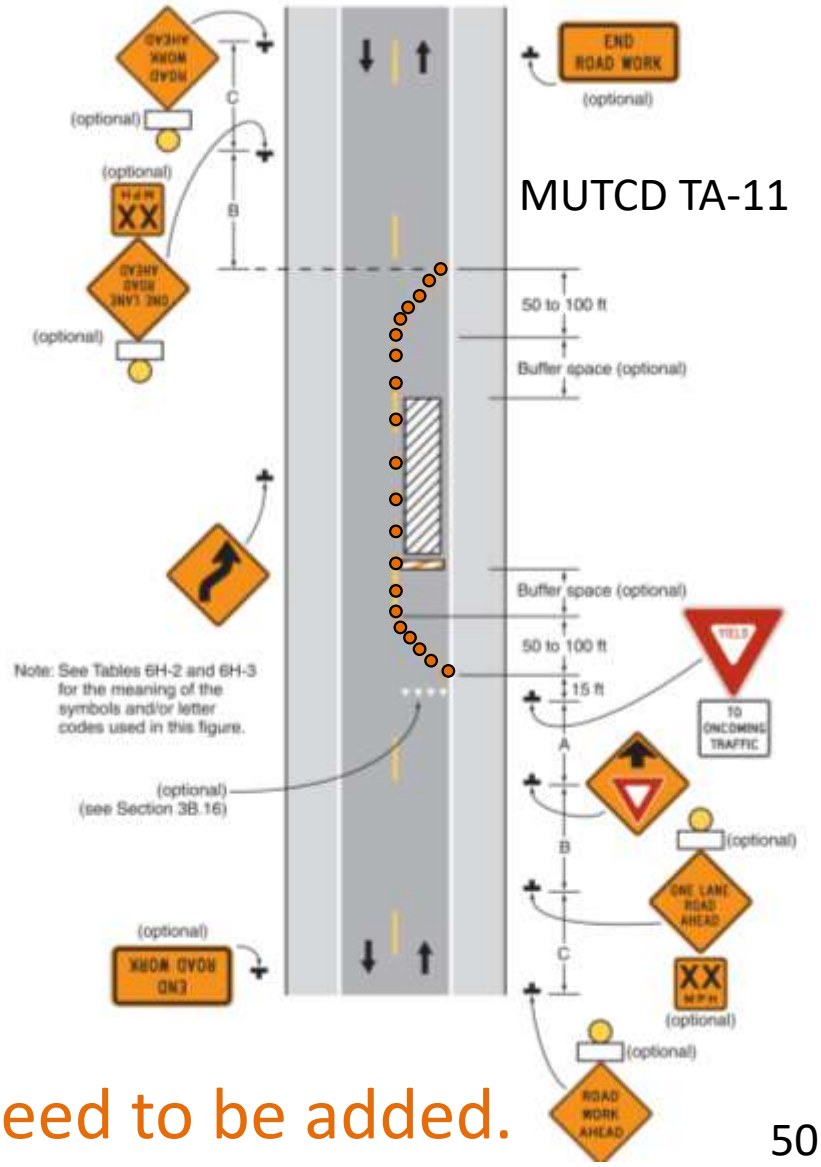


Source: FHWA, MUTCD

MUTCD Language Regarding Self Regulating TTC Zones

6C.10

¶ 5 "If the work space on a low-volume street or road is short and road users from both directions are able to see the traffic approaching from the opposite direction through and beyond the worksite, the movement of traffic through a one-lane, two-way constriction may be self-regulating."



MUTCD TA-11

TA-11 Applicability Notes

A. Vehicular traffic volume is such that sufficient gaps exist for vehicular traffic that must yield.

B. … and have sufficient visibility of approaching vehicles.

If conditions change flaggers may need to be added.

Reminder

6C15 Stop or Yield Control Method

¶ 2 "If the STOP or YIELD sign is installed for only one direction, then the STOP or YIELD sign should face road users who are driving on the side of the roadway that is closed for the work activity area."

Source: "Quality Standards for Temporary Traffic Control Devices," July 2013. Missouri DOT (MODOT), Modified

Guidance from other States

"Managing Flagging Operations on Low Volume Roads."

- When planning a self regulating Temporary Traffic Control (TTC) Operation
  - Consult local jurisdictional requirements
  - Conduct a field investigation to assess sight distance
  - Assess traffic volumes
  - Monitor volumes during the work
  - Cease operations or add flaggers and appropriate signing if sufficient gaps no longer exist
- Example Specific State Department of Transportation (DOT) Constraints

Iowa

Type	Limit
Volume	Less Than 2000 Vehicles Per Day
Work Space	250' or Less, 350' Maximum from the beginning of the taper to the end of the termination
Sight Distance	Do not use if a no passing zone exists between the start of the taper and end of the termination

Oregon

Type	Limit
Duration	Short-term or Intermediate (3 days or less)
Volume	Less Than 400 Average Daily Traffic
Work Space	Less than 200 Feet
Sight Distance	More than 750 Feet at Each End
Speed Limit	40 Miles Per Hour and Below

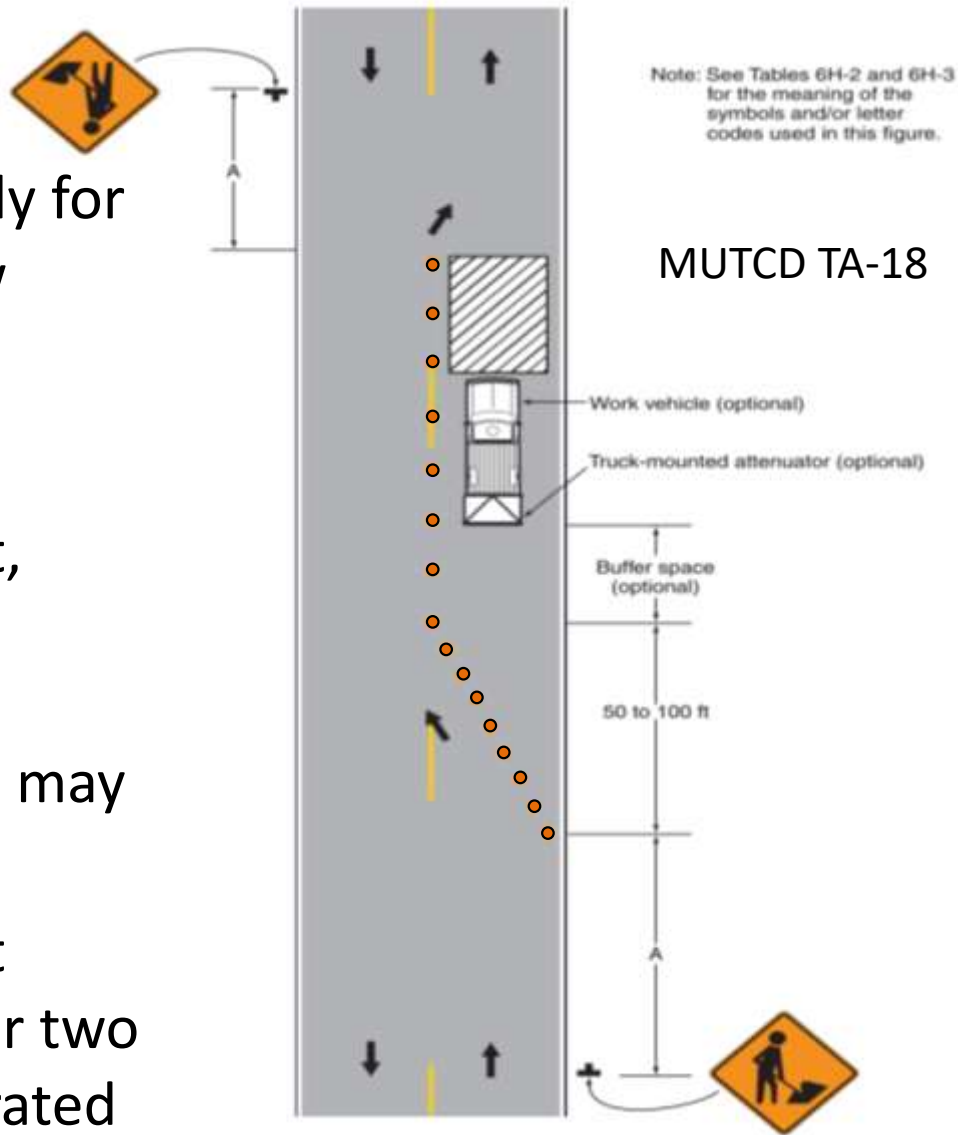
Lane Closure on a Minor Street TA-18

TA-18 Applicability Notes

1. This TTC plan shall be used only for low-speed facilities having low traffic volumes.

   (< 40 Miles Per Hour?)

2. Where the work space is short, where road users can see the roadway beyond, and where volume is low, vehicular traffic may be self-regulating.
3. Where vehicular traffic cannot effectively self-regulate, one or two flaggers shall be used as illustrated

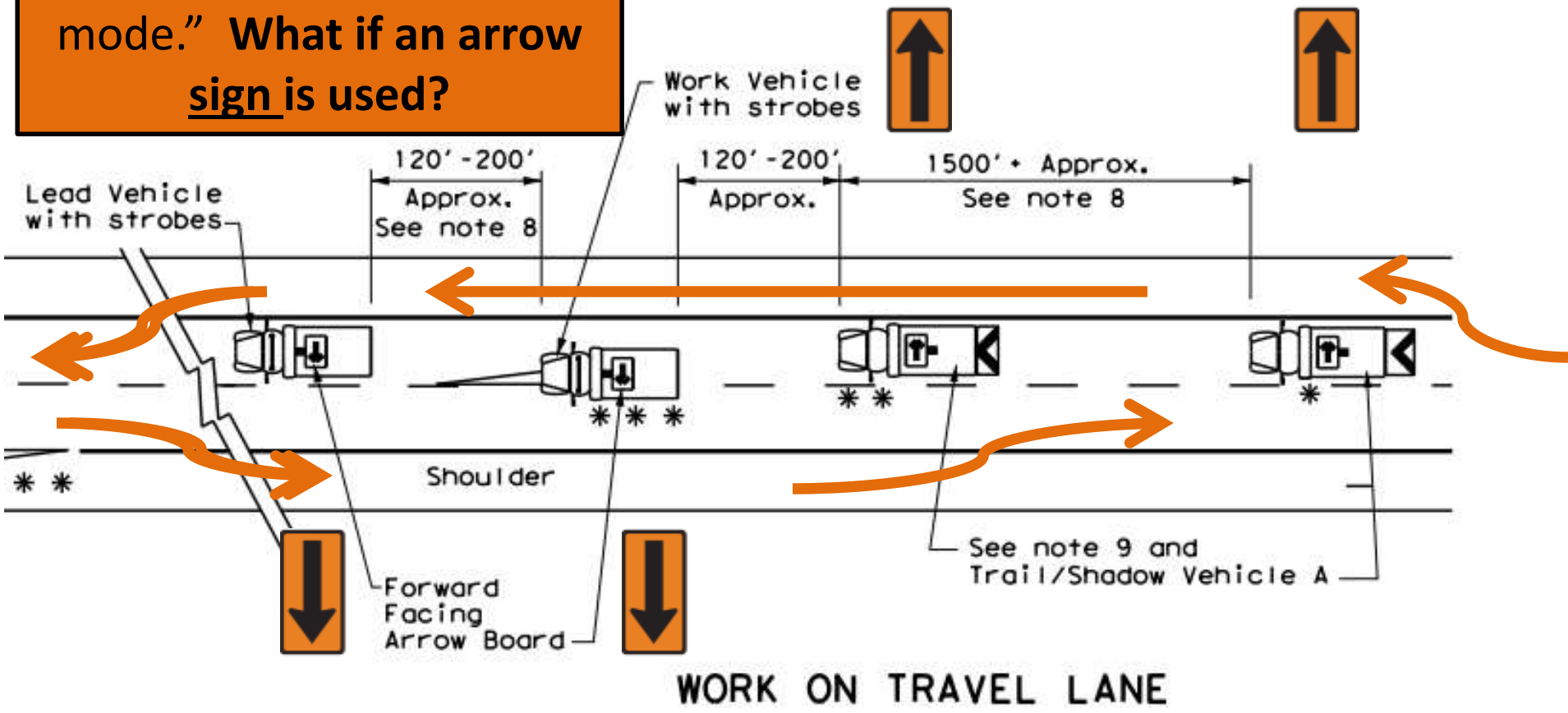


MUTCD TA-18

If conditions change flaggers may need to be added.

3: "If an arrow board is used, it shall be in caution mode." **What if an arrow sign is used?**

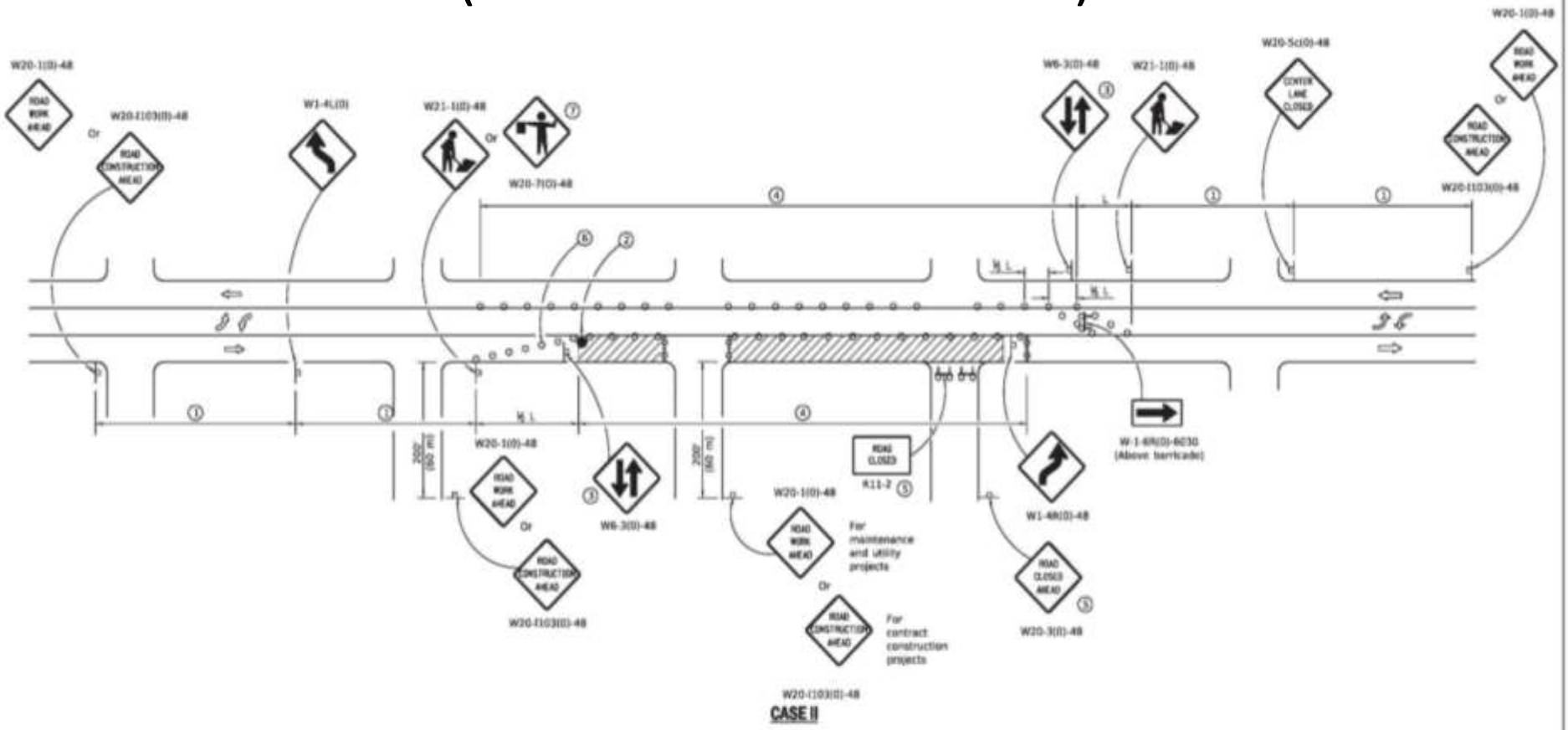
What about the one we saw earlier
(No Flaggers & Traffic on the Shoulder)



Source: TXDOT

Note: TXDOT Modified the MUTCD Language
to Allow an Arrow Board in Arrow Mode on a Two Lane Road

Another Shift with No Flaggers
(Traffic in the Turn Lane)



Illinois Department of Transportation

URBAN LANE CLOSURE, 2L, 2W, WITH BIDIRECTIONAL LEFT TURN LANE

(Sheet 2 of 2)

STANDARD 701502-08

Other Considerations

Addressing Site Conditions

6C.04 Advance Warning **¶ 3, 4, 5, 6**

… placement of advance warning signs on freeways and expressways should be longer … should extend on these facilities as far as 1/2 mile or more.

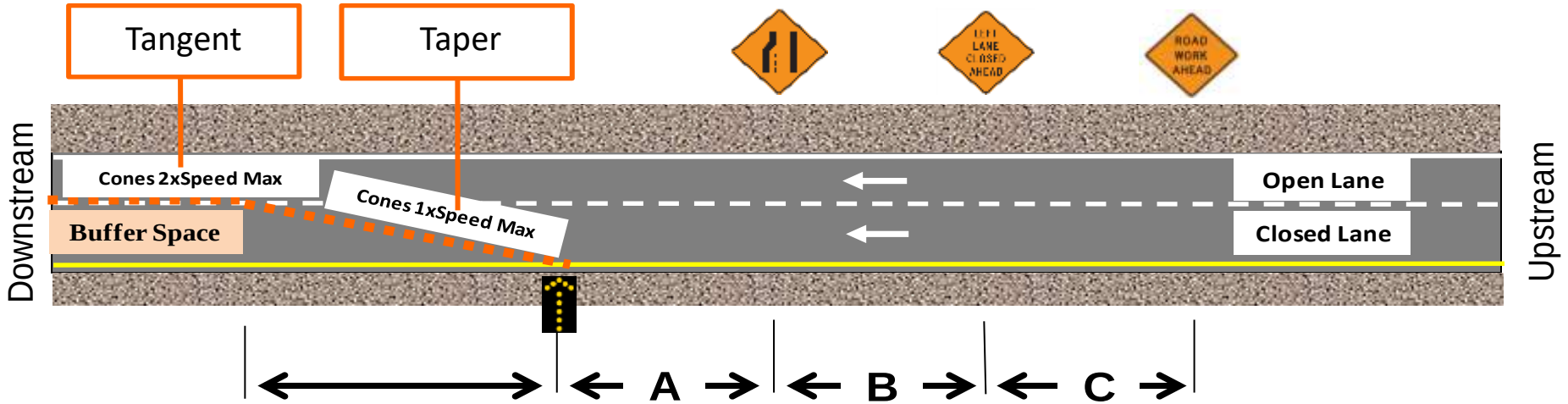
On urban streets, the effective placement of the first warning sign in feet should range from 4 to 8 times the speed limit in mph … can be as short as 100 feet … on higher-speed streets, such as major arterials, the advance warning area should extend a greater distance (see Table 6C-1).

… rural highways … the effective placement of the first warning sign in feet should be substantially longer—from 8 to 12 times the speed limit in mph.

The distances contained in Table 6C-1 are approximate, are intended for guidance purposes only, and should be applied with engineering judgment. These distances should be adjusted for field conditions, if necessary, by increasing or decreasing the recommended distances.

Advance Warning

Sign Placement



Merging Taper Length (L)

Road Type	Distance Between Signs		
	A	B	C
Urban (Low Speed)	100	100	100
Urban (High Speed)	350	350	350
Rural	500	500	500
Expressway / Freeway*	1000	1500	2640

… should be adjusted for field conditions …

Approx. 1 Mile
" ½ mile or more"

Source: Table 6C-1 2009 National MUTCD

Image Source: ARTBA, TTI-LLC

Advance Warning

Sign Placement

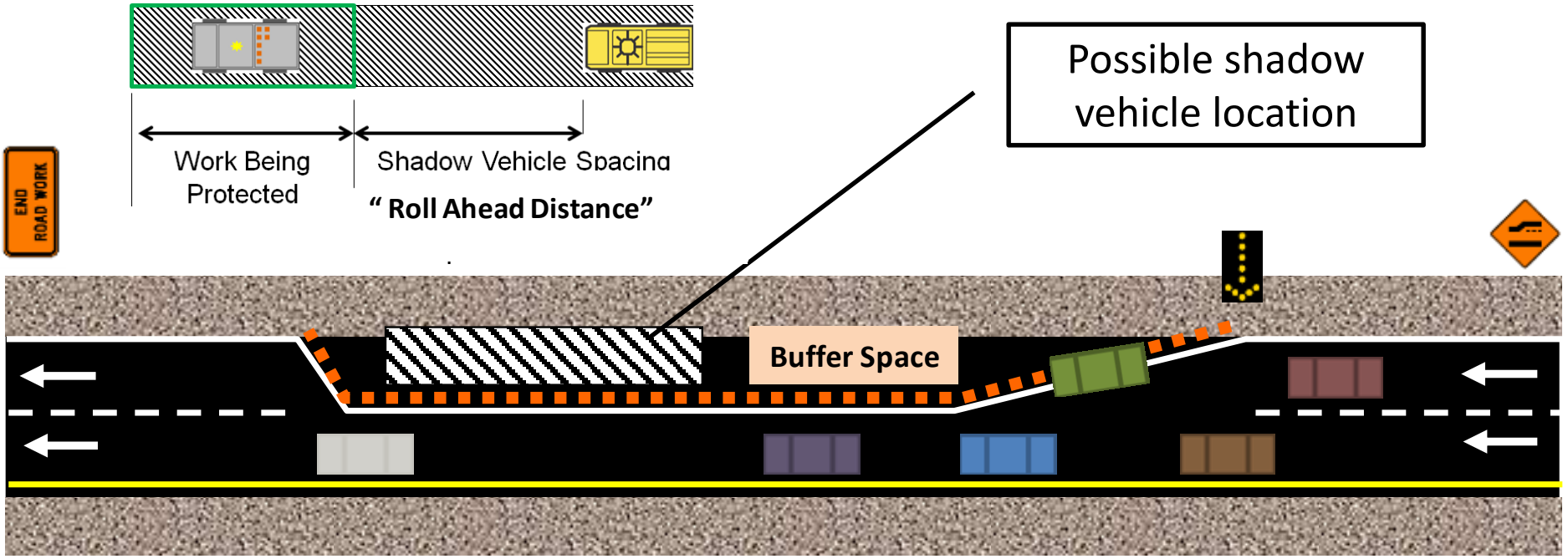
Speed in Miles Per Hour	Distance Between Signs**			Buffer Space Stopping Sight Distance in Feet
	4 x Speed Limit Urban Min	8 x Speed Limit Urban Max Rural Min	12 x Speed Limit Rural Max	
20	100	160	240	115
25	100	200	300	155
30	120	240	360	200
35	140	280	420	250
40	160	320	480	305
45	180	360	540	360
50	200	400	600	425
55	220	440	660	495
60	240	480	720	570
65		520	780	645
70		560	840	730
75		600	900	820

Source: TTI-LLC, Calculated from the MUTCD

Buffer Space

6C.06 Activity Area

¶ 6 The 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.



Source: ARTBA, TTI-LLC

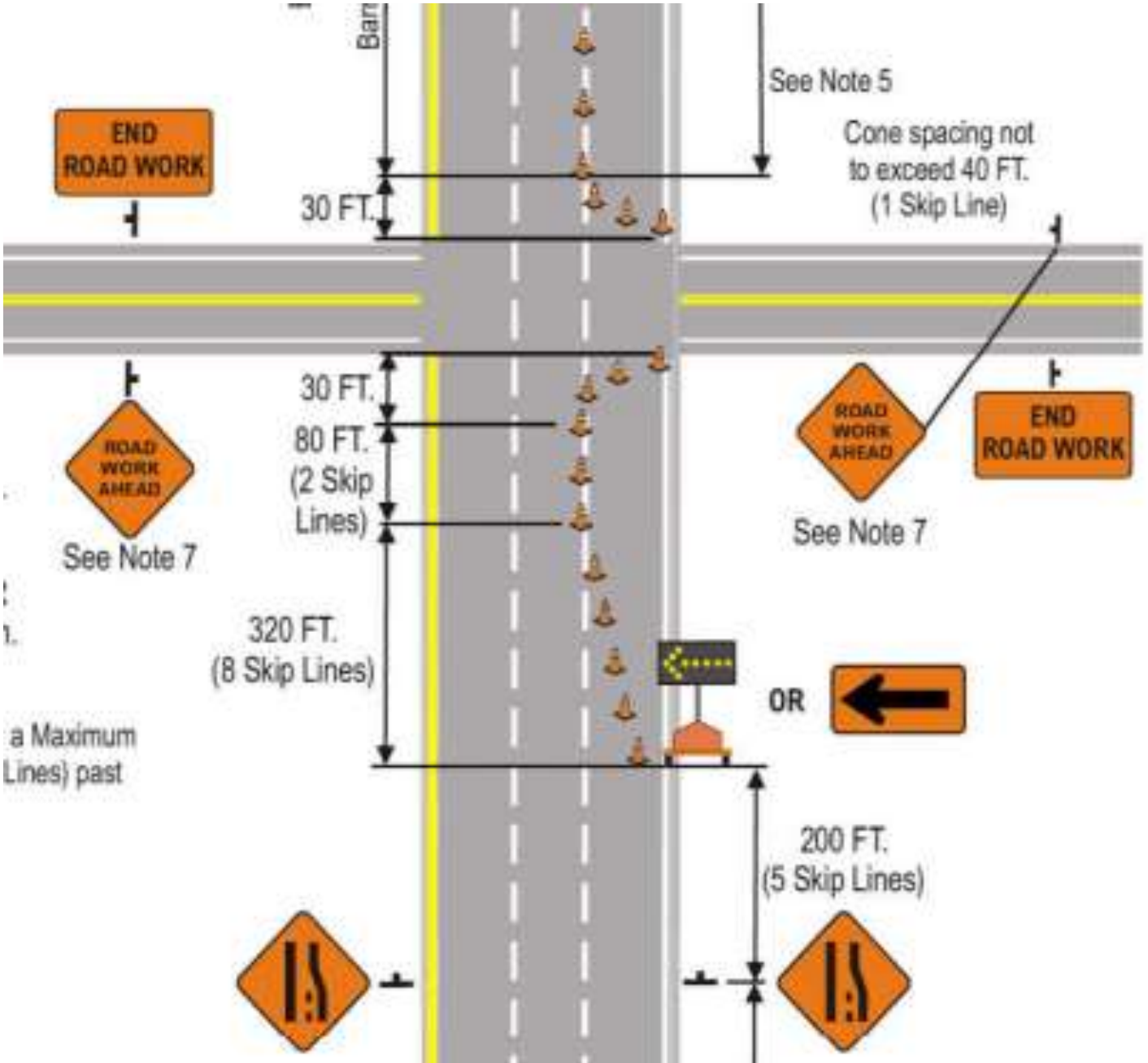
¶ 7 Neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space.

Tapers and Cone Spacing

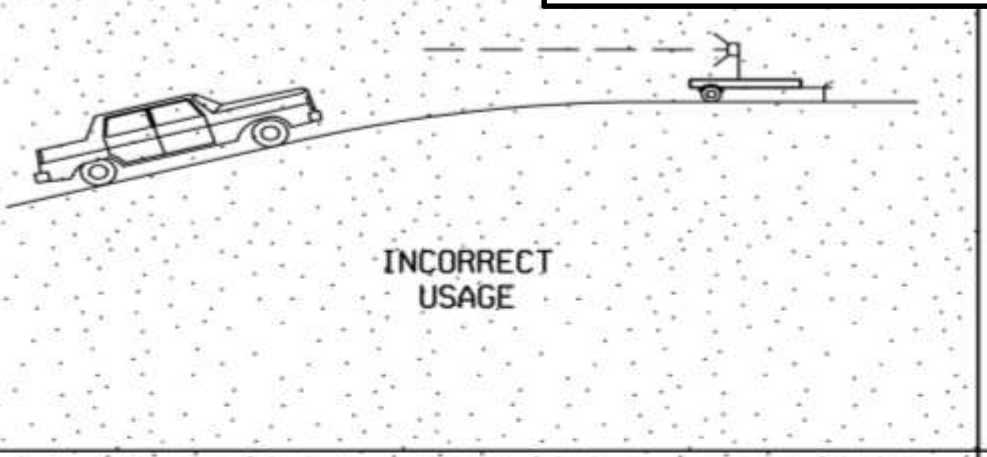
Speed in Miles Per Hour	Distance Between Cones - Max.		12' Lane Example	
	Taper 1 x Speed Limit Max.	Tangent 2 x Speed Limit Max.	Merging Taper Length (L) in Feet	Shifting Taper Length (.5L) in Feet
20	20	40	80	40
25	25	50	125	63
30	30	60	180	90
35	35	70	245	123
40	40	80	320	160
45	45	90	540	270
50	50	100	600	300
55	55	110	660	330
60	60	120	720	360
65	65	130	780	390
70	70	140	840	420
75	75	150	900	450
Typical One-Lane Two-Way (Flagger) Taper 50' Min to 100' Max				

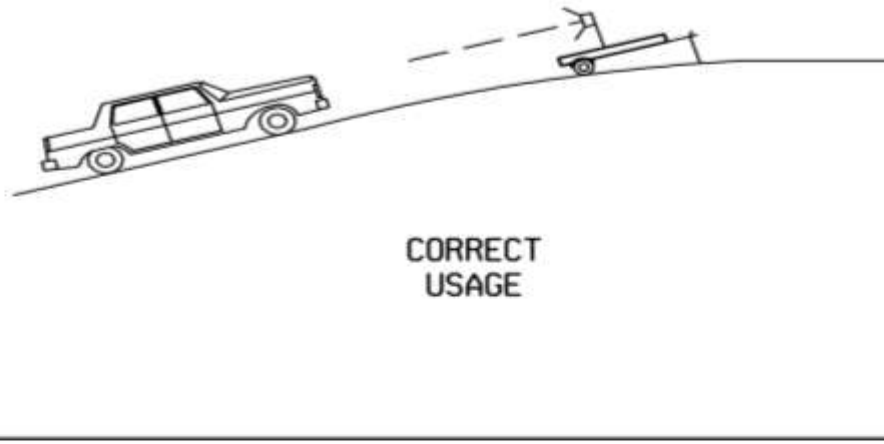
Source: TTI-LLC

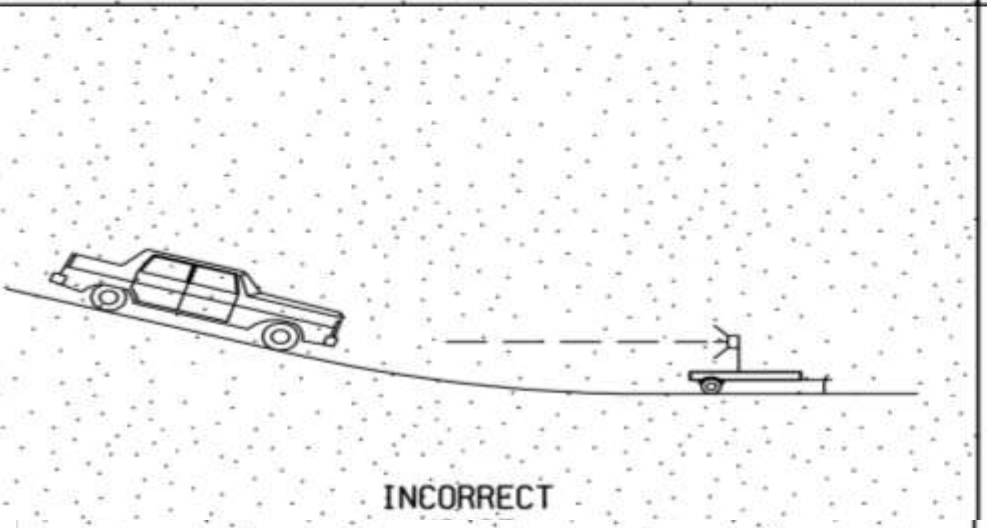
Be sure to close off your closed lanes

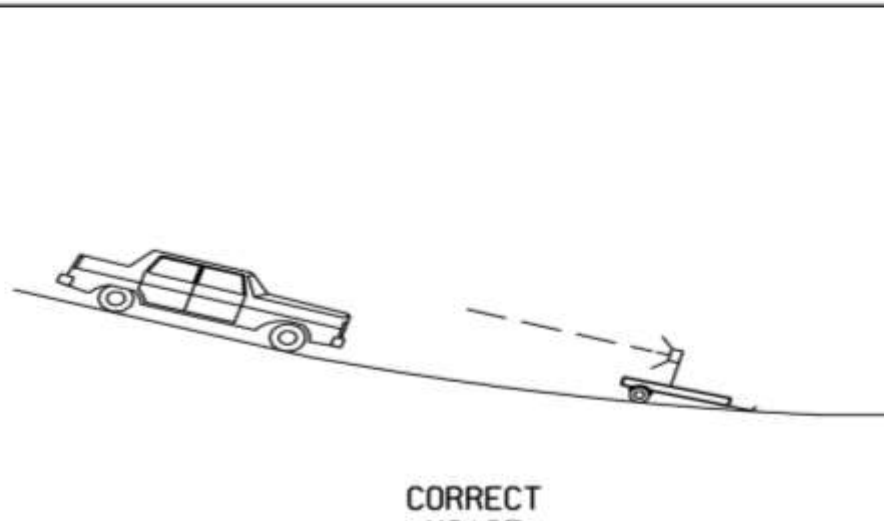


One Final Consideration









NOT TO SCALE

MDOT
Michigan Department of Transportation
OPERATIONS

NOTE:
EXERCISE CARE WHEN PLACING "LIGHTED ARROW" ON VERTICAL OR HORIZONTAL CURVES. ADJUST ALIGNMENT OF "LIGHTED ARROW" TO ALLOW MAIN BEAM OF LAMPS TO BE SEEN BY DRIVER FOR MAXIMUM EFFECTIVENESS.

USE OF LIGHTED ARROW
ON A HILL OR CURVE

01/01/07 REV. DATE:	MD - LAP	PAGE A1

Source: Michigan DOT Maintenance Work Zone Traffic Control Guidelines 2007

Implementing Safe Work Zone Operations Strategies

Thanks for Coming

Please leave your registration and evaluation forms