Temporary Traffic Control Devices

TTC 5 Basic Requirements (DE MUTCD)

1. **Fulfill a need**
2. **Command attention**
3. **Convey a clear, simple meaning**
4. **Command respect**
5. **Give adequate time for response**

- All roadside devices shall be crashworthy, including:
  - Channelizing devices
  - Barrier
  - Crash cushions
  - Sign supports

- Performance criteria contained in NCHRP Report 350 and/or MASH (Manual for Assessing Safety Hardware)

- FHWA provides a listing of NCHRP 350-compliant devices and acceptance letters:

  http://safety.fhwa.dot.gov/roadway_dept/

U.S. Department
of Transportation
Federal Highway
Administration

400 Seventh St., S.W.
Washington, D.C. 20590

Refer to: HSA-10\WZ-74

MR. HENRY ROSS
DIRECTOR OF SALES AND MARKETING
UNITED RENTALS HIGHWAY TECHNOLOGIES
880 NORTH ADDISON ROAD
P.O. BOX 7050
VILLA PARK, IL 60181-7050

Dear Mr. Ross:

Thank you for your letters of January 24 requesting Federal Highway Administration (FHWA) acceptance of your company's "Lo-Pro 350" and "High-Pro 350" portable sign stands as crashworthy traffic control devices for use in work zones on the National Highway System (NHS). Accompanying your letter were reports from E-Tech Testing Services, Inc., and videos of the crash tests. You requested that we find your company's temporary sign stands acceptable for use on the NHS under the provisions of National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

Sign Types

- Regulatory
  - Inform motorists of traffic laws and regulations
  - Color: Black on white or red on white
  - Shape: Rectangle

- Warning
  - Warn and alert motorists
  - Color: Black on yellow, fluorescent yellow-green, fluorescent orange, or coral (incident management)
  - Shape: Diamond

- Guide
  - Direct and inform motorists
  - Color: White on green (except for route markers)
  - Shape: Rectangle

- DE Guidance: *Traffic Control Device Authorization* approved by DelDOT Traffic for modifications to regulatory conditions

Signed authorization on file for speed reduction from 45 mph to 30 mph on temporary road

TRAFFIC CONTROL DEVICE
AUTHORIZATION

Bethel Church Rd (N433) SR286
New Castle County

WHEREAS, The Secretary of the Department of Transportation by letter dated January 12, 1971, granted authority of the Chief Traffic Engineer to draw up and validate such restrictions as are needed to provide for the movement of traffic related to construction and maintenance projects; and

WHEREAS, it has been determined that the following traffic control devices are necessary for the safe movement of traffic in the area noted:

Reduce **45 mph** to **30 mph Speed Limit** on the temporary portion of **Bethel Church Rd (N433) SR286**. The speed limit reduction will be established on the temporary roadway, beginning at a point 584 feet west of the existing intersection of Bethel Church Rd and Choptank Rd SR15 to a point 780 feet north of the same intersection. The speed limit will be applied in both directions the time that the project demands to support State contract **#22-120-01**.

This reduced speed limit will be implemented 24 hours a day, and remain in effect from the beginning of the project until the end of the construction of the project.

NOW, THEREFORE, BE IT RESOLVED, by authority so granted, that the speed limit signs noted above were declared approved and effective when properly posted.

Donald D. Weber, P.E.
Chief Traffic Engineer

Date: 9/28/09

SR 15, Choptank Rd from N437 to N433

Warning Signs

DelDOT

DELDOT WORK ZONE TRAINING

- DE Standard: TTC warning signs consisting of black legend on fluorescent orange sheeting

- DE Standard:
  - Prismatic, retroreflective sheeting used for all TTC signs
  - Mesh flexible signs prohibited

Shallcross Lake Rd at Greylag Rd

- DE Guidance: Owner's name and contact information on back of sign

Main Street, Newark

COMMON PROBLEMS

Non-compliant sign layouts

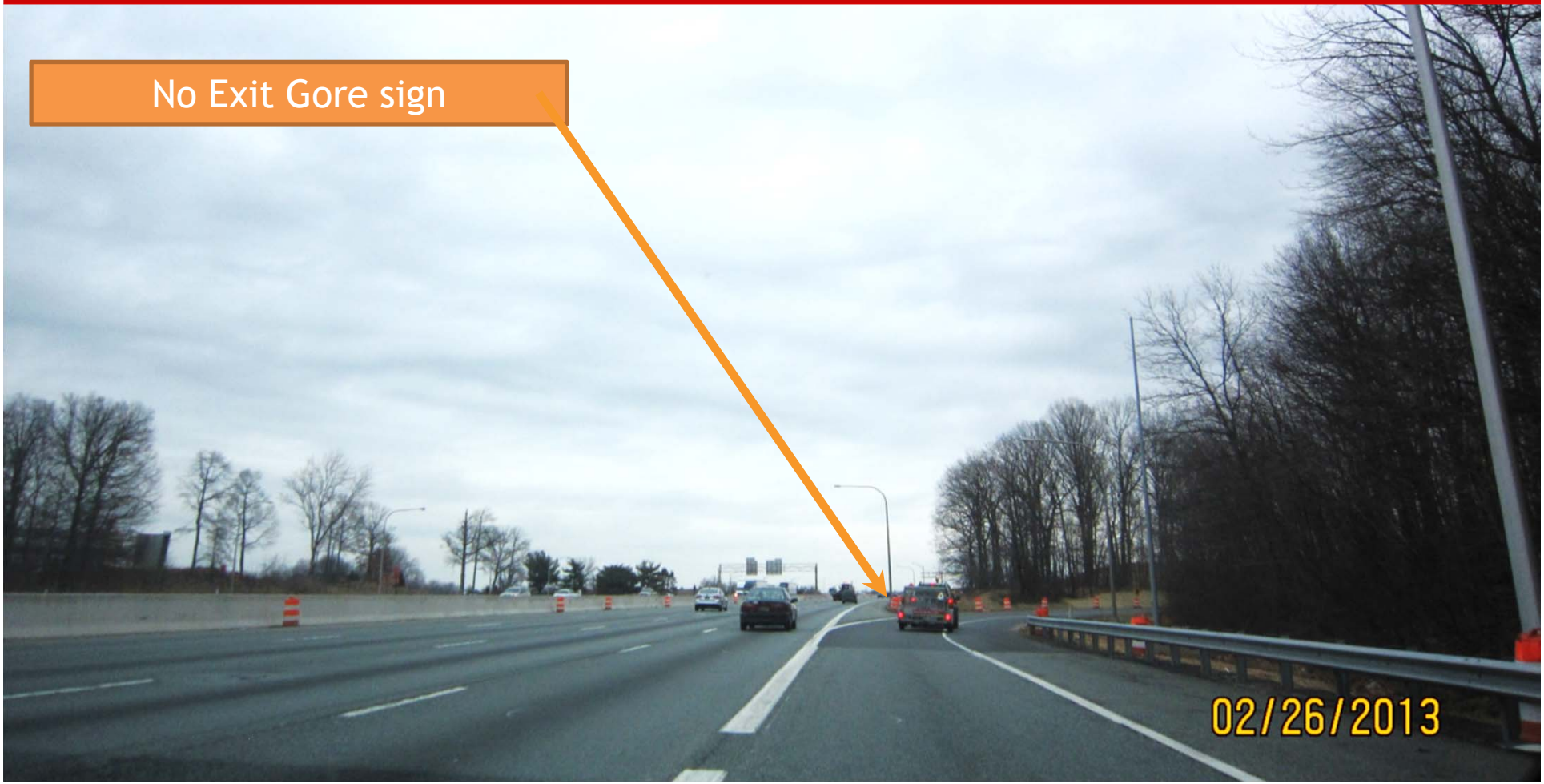
Exit Gore sign has incorrect layout/shape

Incorrect Merge sign layout

Incorrect Added Lane sign layout

COMMON PROBLEMS

Missing signs



COMMON PROBLEMS

Conflicts between “permanent” and “temporary” work zone signs

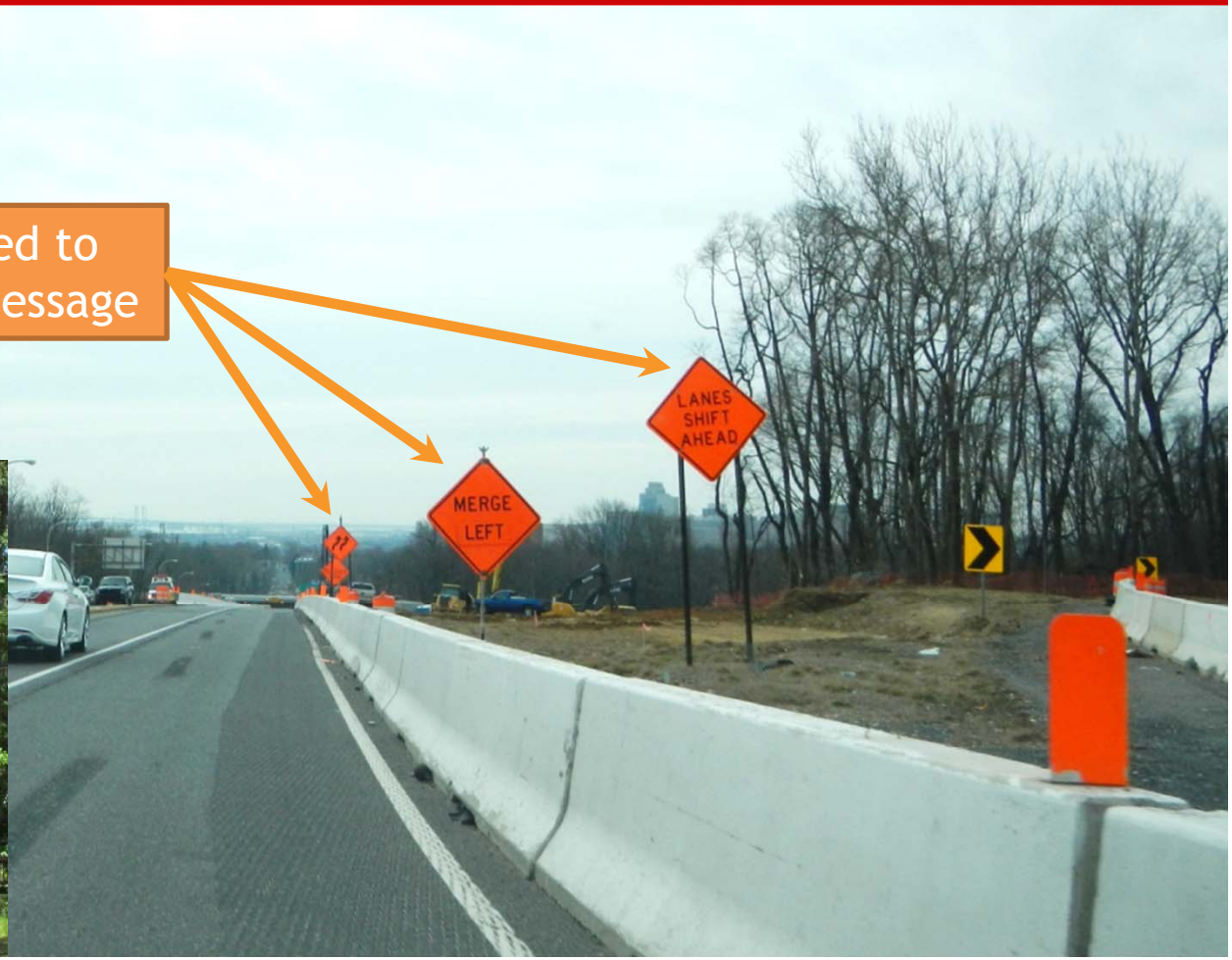
- DE Guidance: Specific TTC “application” signs should not conflict with “permanent” advance warning signs

Elkton Rd, Casho Mill Rd to Delaware Ave

COMMON PROBLEMS

Conflicting messages

Conflicting messages – need to prioritize most important message



COMMON PROBLEMS

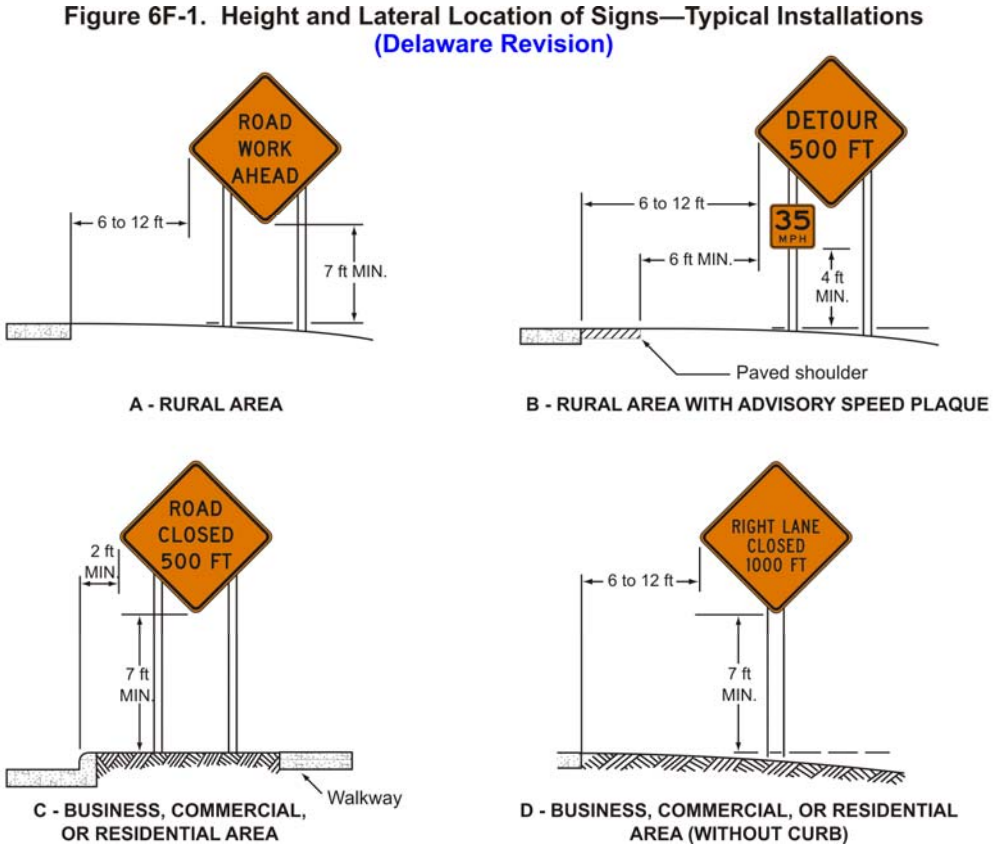
Improper covering methods

- Right-hand side of road
- DE Guidance: Signs installed on left and right-hand side of multi-lane, divided highways

US 13 / DE 404 Intersection Realignment and Bridgeville Service Road

Post-Mounted Sign Placement

- DE Standard: 7-ft (MIN.) mounting height along rural roads
- 7-ft (MIN.) mounting height along urban roads
- 7-ft (MIN.) mounting height above sidewalks



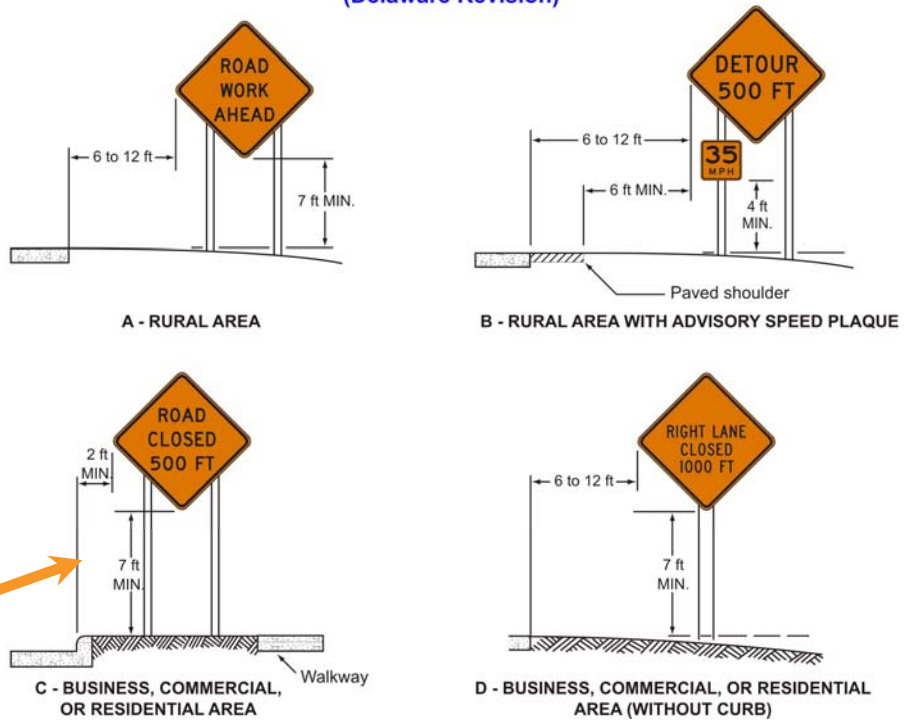
COMMON PROBLEMS

Inadequate lateral offset

Sign post spacing and lateral offset should comply with Figure 6F-1

S. Governors Ave, Webbs Ln to Water St

Figure 6F-1. Height and Lateral Location of Signs—Typical Installations
(Delaware Revision)

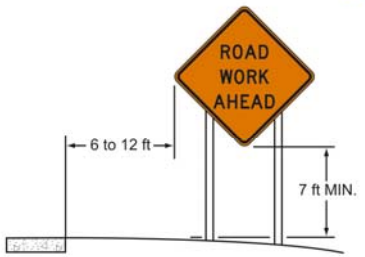


COMMON PROBLEMS

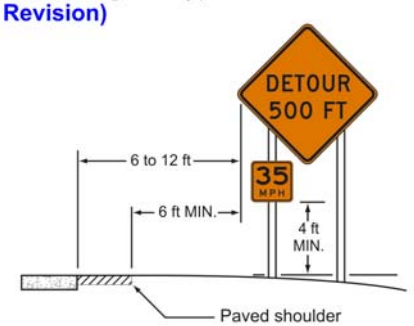
Inadequate mounting height

Mounting height shall comply with Figure 6F-1

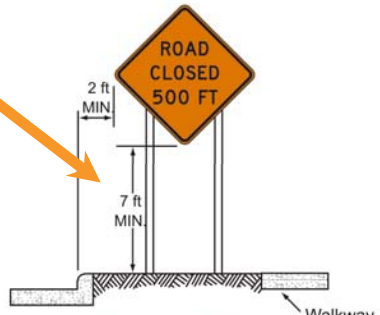
Figure 6F-1. Height and Lateral Location of Signs—Typical Installations
(Delaware Revision)



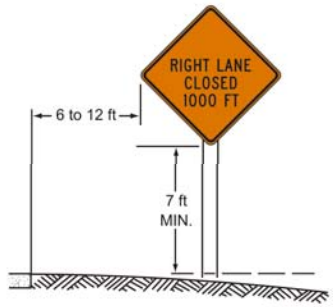
A - RURAL AREA



B - RURAL AREA WITH ADVISORY SPEED PLAQUE



C - BUSINESS, COMMERCIAL, OR RESIDENTIAL AREA



D - BUSINESS, COMMERCIAL, OR RESIDENTIAL AREA (WITHOUT CURB)

COMMON PROBLEMS

Incorrect breakaway support installation

Portable Sign Mounting Heights

- > 3 days: 7-ft (MIN.)
- ≤ 3 days: 5-ft (MIN.)

BR 1-325 on Otts Chapel Rd over Persimmon Run

S. Governors Ave, Webbs Ln to Water St

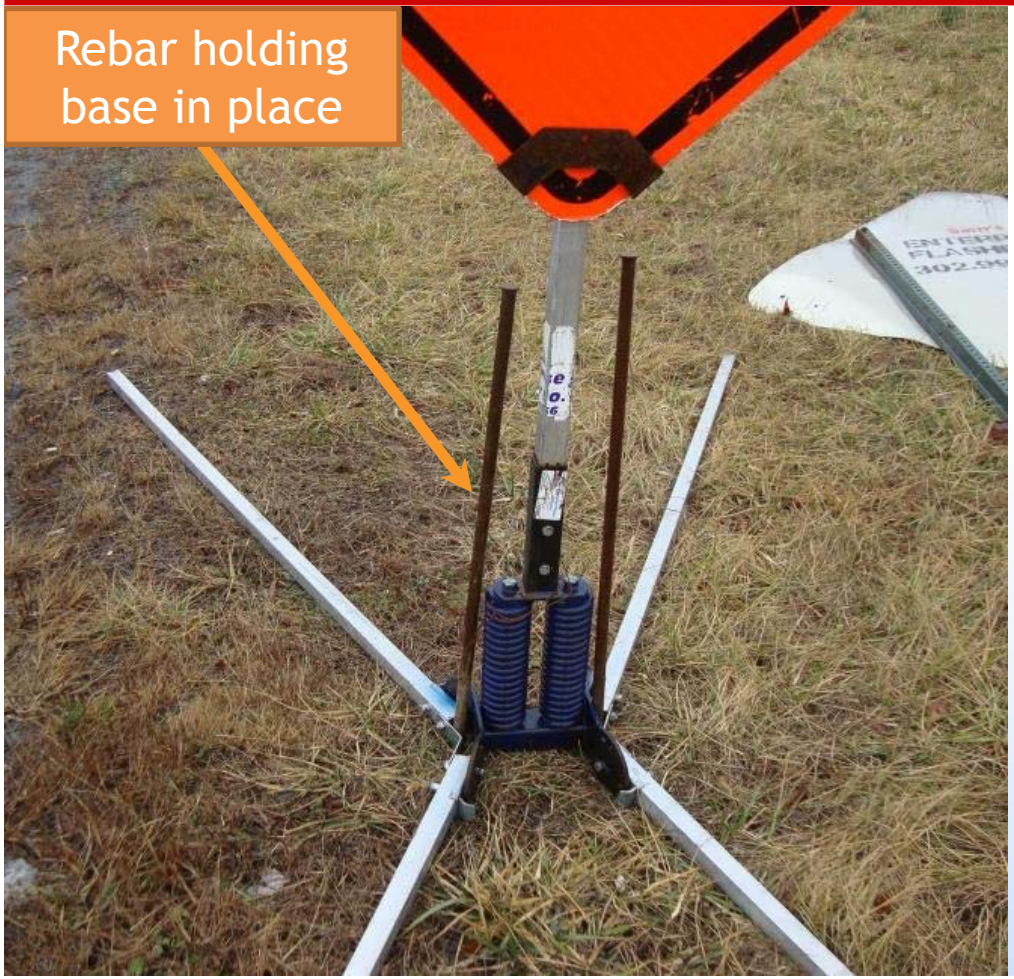
Portable signs with a mounting height less than 5 ft should be in place for 1 hr or less

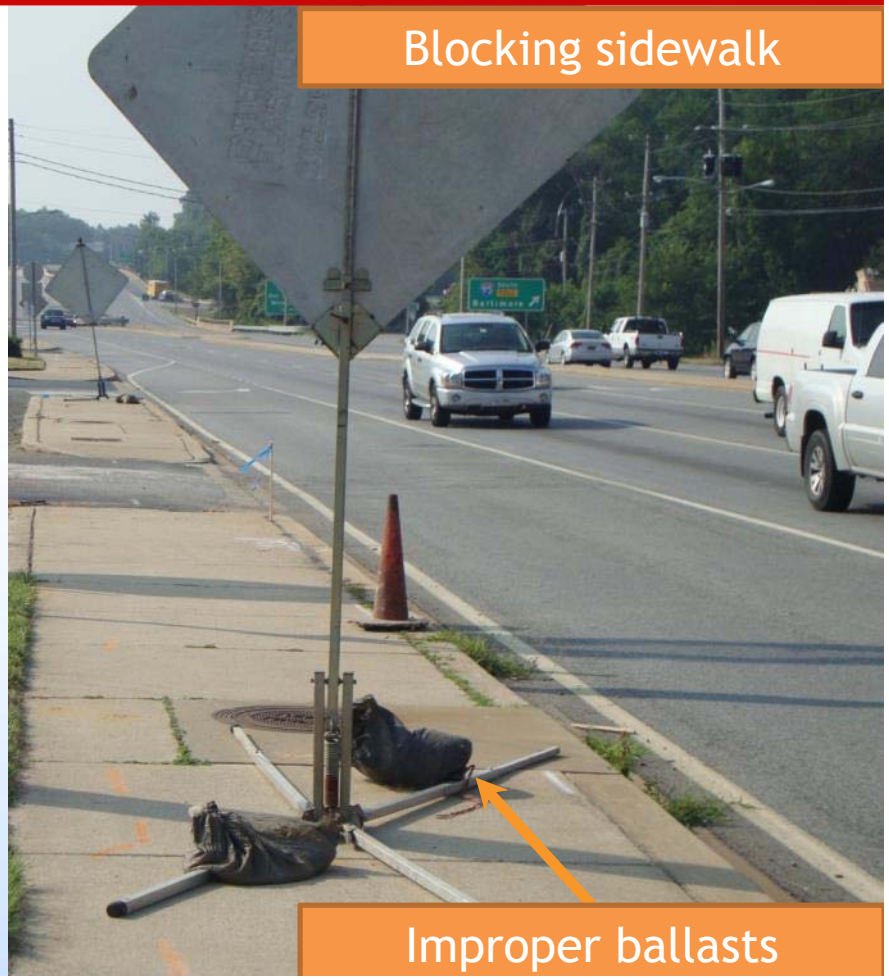
Portable Sign Stands

- Temporary sign stands may be used for more than 3 days where there is a documented conflict (e.g., utility conflict, avoid drilling in asphalt/concrete)

COMMON PROBLEMS

Unacceptable portable sign mounting





COMMON PROBLEMS

Improper use of skid-mounted sign stands

- Contractor-fabricated skid mounts are not permitted

COMMON PROBLEMS

Portable signs not removed when not in use

- DE Standard: Remove or place behind positive protection when not in use

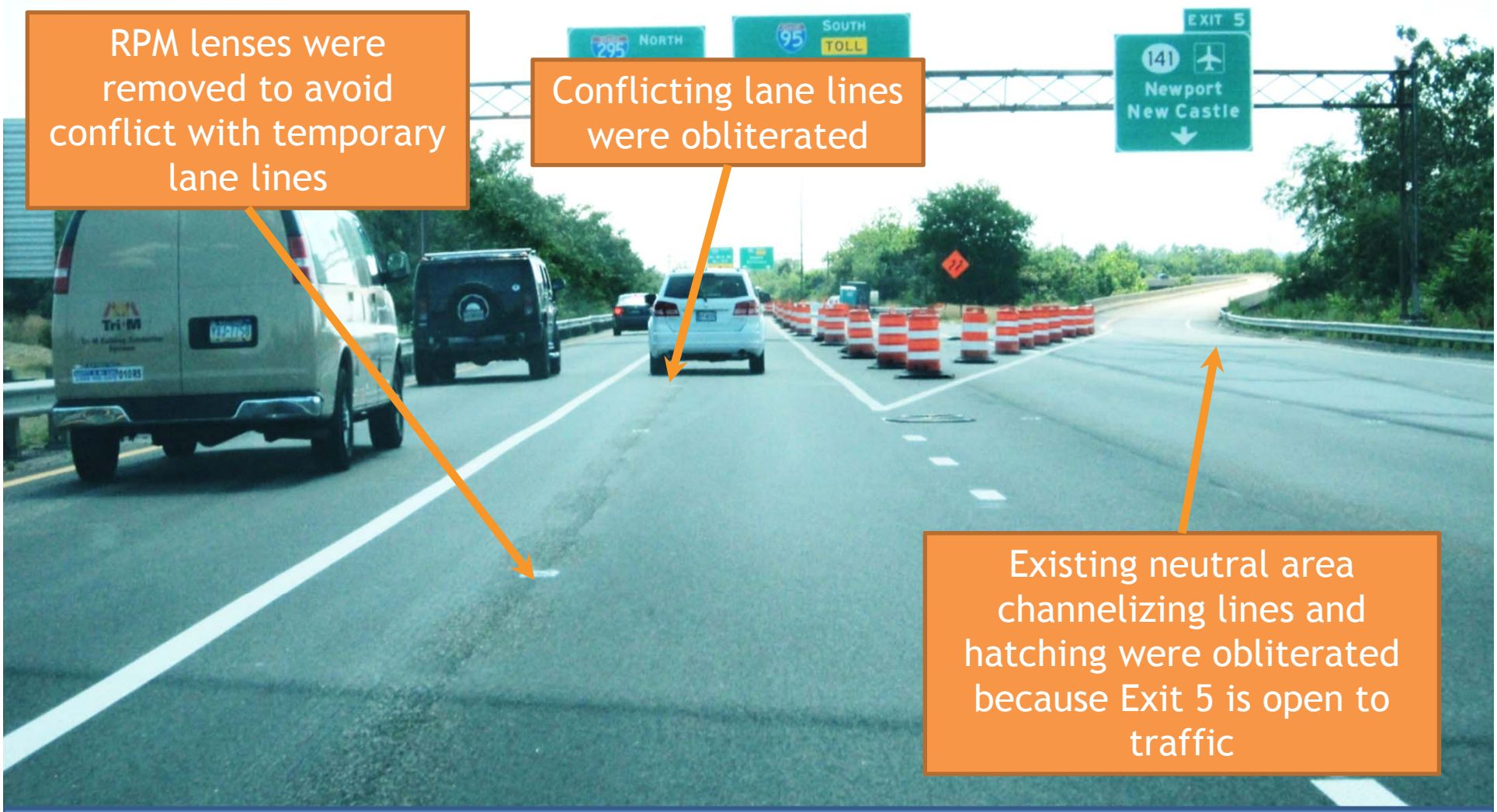
SR 1 north of SR 16

COMMON PROBLEMS

Sign stands left at end of work operation

I-95/SR 1 Interchange

- DE Standard: Conflicting markings, including RPMs, shall be removed or obliterated
- "Blackout" tape used to cover conflicting markings only if tape is approximately same color as pavement
- DE Option: Remove RPM lens rather than entire housing



Interstate Bridge Maintenance, I-495

COMMON PROBLEMS

Conflicts between RPMs and temporary markings

US 13 / DE 404 Intersection Realignment and Bridgeville Service Road

COMMON PROBLEMS

"Blackout" tape used on concrete

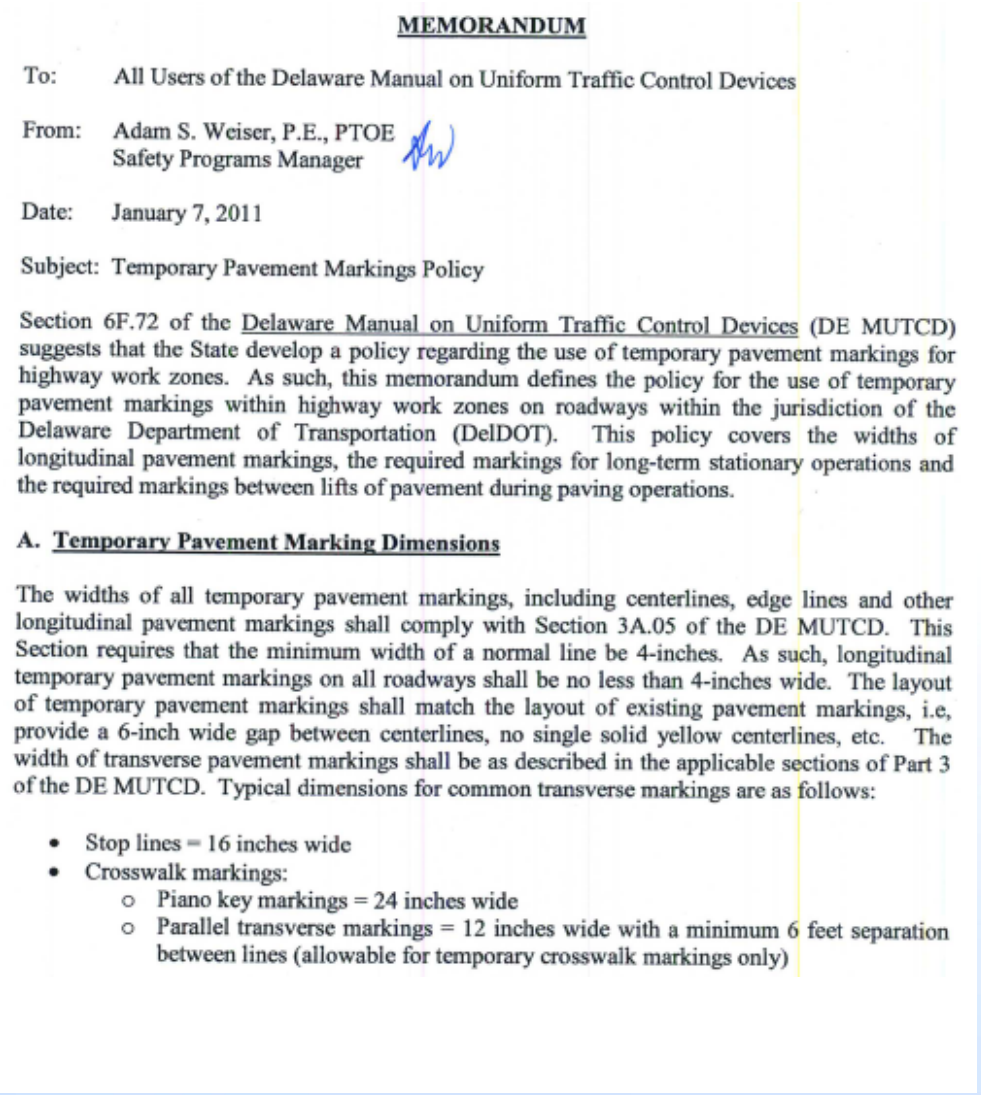
SR 141, Kirkwood Hwy to Faulkland Rd

COMMON PROBLEMS

Eradication issues

Temporary Pavement Markings

- DE Guidance: Should not remain in place longer than 30 days
- Installed based on DelDOT's Temporary Pavement Markings Policy
  - Shall comply with Part 3
  - Width of longitudinal lines: 4 in MIN.



MEMORANDUM

To: All Users of the Delaware Manual on Uniform Traffic Control Devices

From: Adam S. Weiser, P.E., PTOE
Safety Programs Manager

Date: January 7, 2011

Subject: Temporary Pavement Markings Policy

Section 6F.72 of the Delaware Manual on Uniform Traffic Control Devices (DE MUTCD) suggests that the State develop a policy regarding the use of temporary pavement markings for highway work zones. As such, this memorandum defines the policy for the use of temporary pavement markings within highway work zones on roadways within the jurisdiction of the Delaware Department of Transportation (DelDOT). This policy covers the widths of longitudinal pavement markings, the required markings for long-term stationary operations and the required markings between lifts of pavement during paving operations.

A. Temporary Pavement Marking Dimensions

The widths of all temporary pavement markings, including centerlines, edge lines and other longitudinal pavement markings shall comply with Section 3A.05 of the DE MUTCD. This Section requires that the minimum width of a normal line be 4-inches. As such, longitudinal temporary pavement markings on all roadways shall be no less than 4-inches wide. The layout of temporary pavement markings shall match the layout of existing pavement markings, i.e, provide a 6-inch wide gap between centerlines, no single solid yellow centerlines, etc. The width of transverse pavement markings shall be as described in the applicable sections of Part 3 of the DE MUTCD. Typical dimensions for common transverse markings are as follows:

- Stop lines = 16 inches wide
- Crosswalk markings:
  - Piano key markings = 24 inches wide
  - Parallel transverse markings = 12 inches wide with a minimum 6 feet separation between lines (allowable for temporary crosswalk markings only)

COMMON PROBLEMS

Noncompliant temporary markings

S. Governors Ave, Webbs Ln to Water St

COMMON PROBLEMS

Insufficient pavement marking width

State St, Millsboro

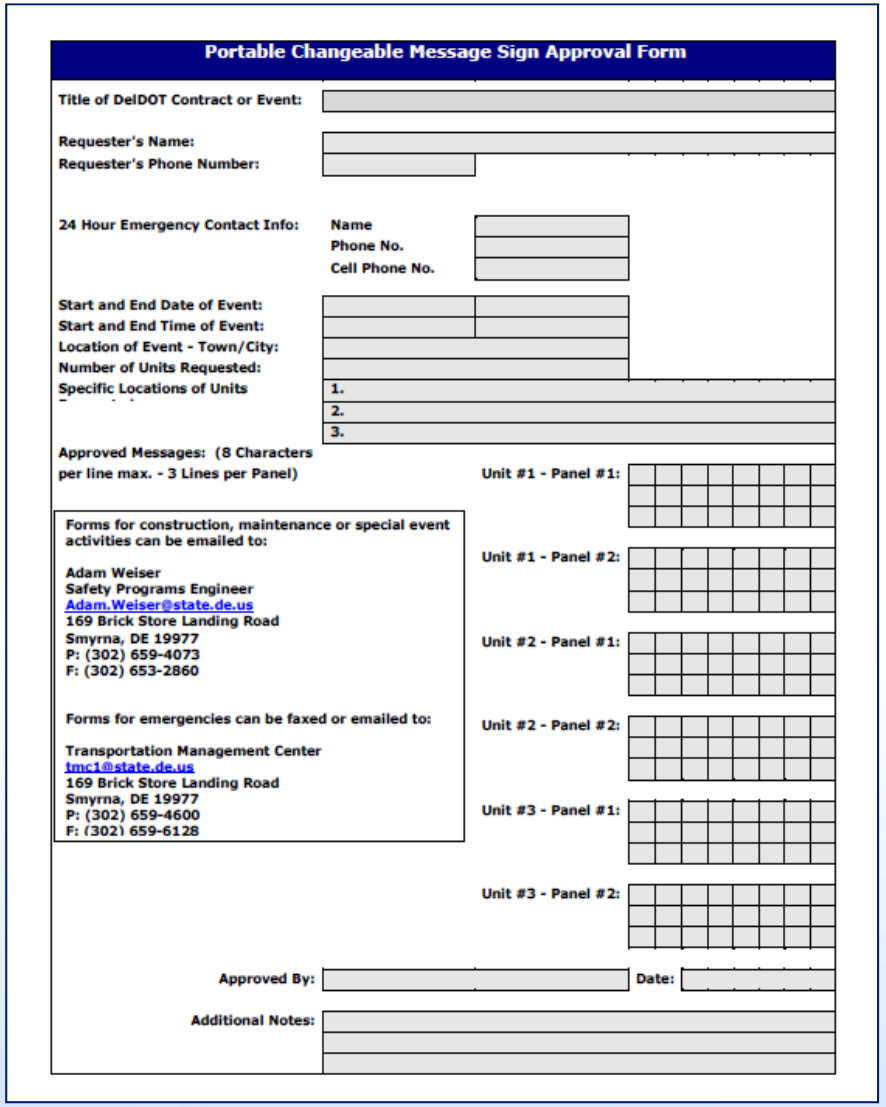
COMMON PROBLEMS

Conflicting temporary markings

I-95/US 202 Interchange

Portable Changeable Message Signs

- Supplemental devices – use in addition to signing and markings
- Display only operational, regulatory, warning, or guidance information
- Use in both stationary and mobile operations
- Installations and message must be approved by DelDOT Traffic Safety (unless emergency)
  - Use PCMS approval form if display messages are not included in plans



Portable Changeable Message Sign Approval Form

Title of DelDOT Contract or Event:

Requester's Name:
Requester's Phone Number:

24 Hour Emergency Contact Info: Name / Phone No. / Cell Phone No.

Start and End Date of Event:
Start and End Time of Event:
Location of Event - Town/City:
Number of Units Requested:
Specific Locations of Units
1.
2.
3.

Approved Messages: (8 Characters per line max. - 3 Lines per Panel)

Unit #1 - Panel #1:
Unit #1 - Panel #2:
Unit #2 - Panel #1:
Unit #2 - Panel #2:
Unit #3 - Panel #1:
Unit #3 - Panel #2:

Forms for construction, maintenance or special event activities can be emailed to:

Adam Weiser
Safety Programs Engineer
Adam.Weiser@state.de.us
169 Brick Store Landing Road
Smyrna, DE 19977
P: (302) 659-4073
F: (302) 653-2860

Forms for emergencies can be faxed or emailed to:

Transportation Management Center
tmc1@state.de.us
169 Brick Store Landing Road
Smyrna, DE 19977
P: (302) 659-4600
F: (3021 659-6128

Approved By:
Date:
Additional Notes:

Typical applications of PCMSs:

- Speed expected to drop substantially
- Significant queuing and delays are expected
- Adverse environment conditions are present
- Changes in alignment or surface conditions
- Advance notice of ramp, lane or road closure
- Crash or incident management
- Changes in road user pattern

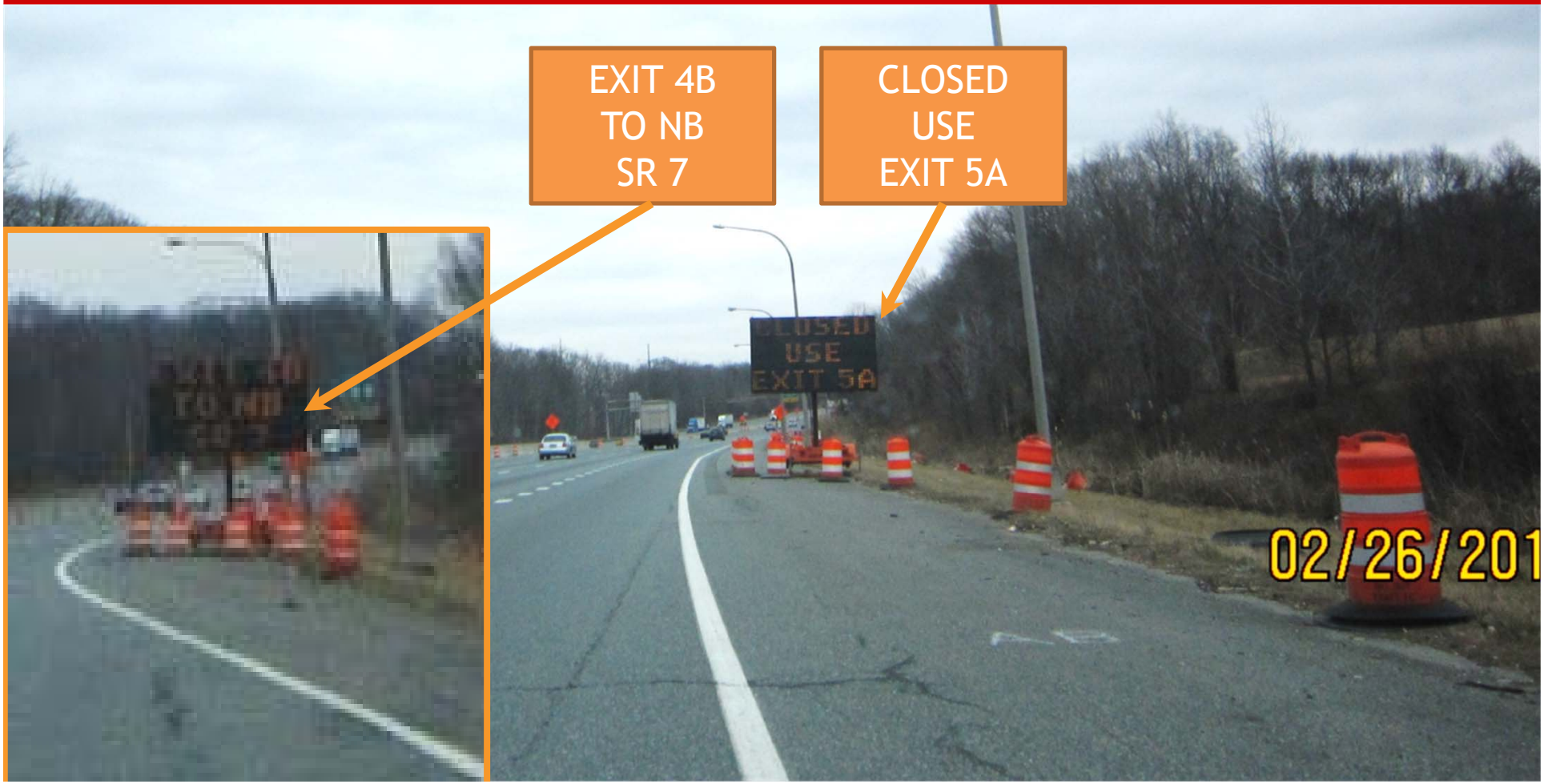
Message should be brief and contain 3 thoughts :

1. Problem or situation that the road user will encounter
2. Location of or distance to the problem or situation
3. Recommended driver action

Each phase shall be understood by itself regardless of the sequence in which it is read

COMMON PROBLEMS

Messages do not convey a complete thought



- Maximum message criteria:
  - 2 phases per PCMS
  - 3 lines per phase
  - 8 characters per line
- Messages should be centered
- Word messages in all upper-case
- Bottom of the sign shall be ≥ 7 feet above the roadway in urban areas and ≥ 5 feet above the roadway in rural areas (or as high as permitted by device)
- Visible from ½ mile (day and night)

PCMS message shall be in all upper-case letters

COMMON PROBLEMS
Improper abbreviations

- Table 1A-2 lists acceptable PCMS abbreviations

SR 4 Railroad Crossing Improvement

Table 1A-2. Abbreviations that Shall be Used Only on Portable Changeable Message Signs

Word Message	Standard Abbreviation	Prompt Word That Should Precede the Abbreviation	Prompt Word That Should Follow the Abbreviation
Access	ACCS	—	Road
Ahead	AHD	Fog	—
Blocked	BLKD	Lane	—
Bridge	BR*	[Name]	—
Cannot	CANT	—	—
Center	CNTR	—	Lane
Chemical	CHEM	—	Spill
Condition	COND	Traffic	—
Congested	CONG	Traffic	—
Construction	CONST	—	Ahead
Crossing	XING	—	—
Do Not	DONT	—	—
Downtown	DWNTN	—	Traffic
Eastbound	E-BND	—	—
Emergency	EMER	—	—
Entrance, Enter	ENT	—	—
Exit	EX	Next	—
Express	EXP	—	Lane
Frontage	FRNTG	—	Road
Hazardous		—	Driving
Highway-Rail Grade Crossing	RR XING	—	—
Interstate	I*	—	[Number]
It is	ITS	—	—
Lane	LN	[Roadway Name]*,Right, Left, Center	—
Left	LFT	—	—
Local	LOC	—	Traffic
Lower	LWR	—	Level
Maintenance	MAINT	—	—
Major	MAJ	—	Accident
Minor	MNR	—	Accident
Normal	NORM	—	—
Northbound	N-BND	—	—
Oversized	OVRSZ	—	Load
Parking	PKING	—	—
Pavement	PVMT	Wet	—
Prepare	PREP	—	To Stop
Quality	QLTY	Air	—
Right	RT	Keep, Next	—
Right	RT	—	Lane
Roadwork	RDWK	—	Ahead, [Distance]
Route	RT, RTE	Best	—
Service	SERV	—	—
Shoulder	SHLDR	—	—
Slippery	SLIP	—	—
Southbound	S-BND	—	—
Speed	SPD	—	—
State, county, or other non-US or non-Interstate numbered route	[Route Abbreviation determined by highway agency]**	—	[Number]
Tires With Lugs	LUGS	—	—
Traffic	TRAF	—	—
Travelers	TRVLRS	—	—
Two-Wheeled Vehicles	CYCLES	—	—
Upper	UPR	—	Level
Vehicle(s)	VEH, VEHS	—	—
Warning	WARN	—	—
Westbound	W-BND	—	—
Will Not	WONT	—	—

* This abbreviation, when accompanied by the prompt word, may be used on traffic control devices other than portable changeable message signs.
** A space and no dash shall be placed between the abbreviation and the number of the route.

COMMON PROBLEMS

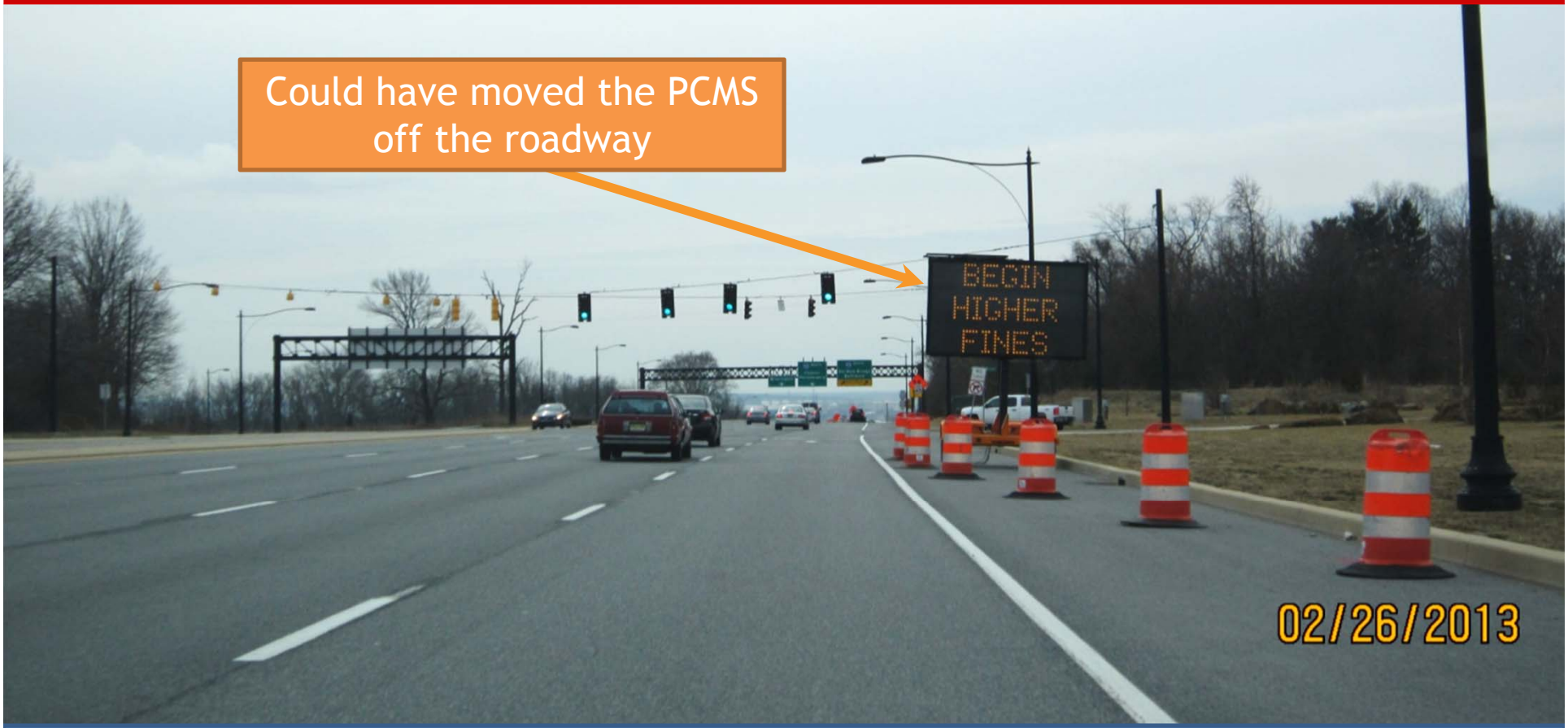
Placed inside clear zone without protection

- Not crashworthy; should be placed behind barrier or outside clear zone, if practical

I-295 northbound north of I-95 diverge

COMMON PROBLEMS

Placed inside clear zone without protection



US 202 at I-95

COMMON PROBLEMS

Improper/insufficient drum placement

- DE Standard: 6 drums shall be used to close shoulder in advance of PCMS

SR 4 Railroad Crossing Improvement

COMMON PROBLEMS

Improper/insufficient drum placement

- DE Guidance: 6 drums should be installed in each direction within median of divided highway if PCMS is within 30 ft of travel lane

SR 4 Railroad Crossing Improvement

COMMON PROBLEMS

PCMSs not removed promptly

- DE Standard: PCMSs no longer in use shall be removed within 48 hrs unless approved by DelDOT Traffic

- Arrow boards are used:
  - in lane and shoulder closure operations
  - on shadow vehicles
  - on vehicles in mobile operations
- Never used independent of other TTC devices
- DE Standard: When not in use, remove from roadway

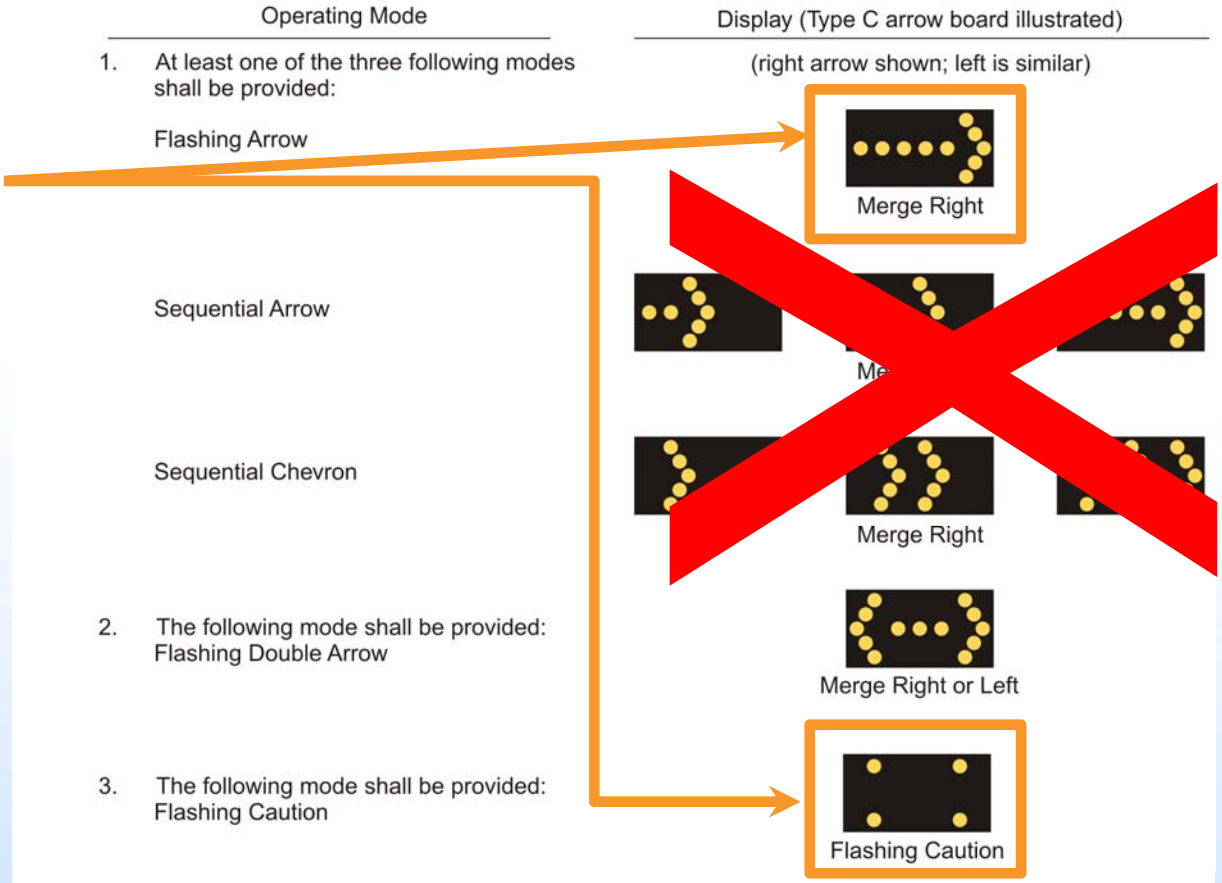
- Type A - low-speed urban streets
- Type B - intermediate-speed facilities and for maintenance or mobile operations on high-speed roadways
- Type C - high-speed, high-volume roadways ← ***Typically used***
- Type D - use on authorized vehicles

Arrow Board Type	Minimum Size	Minimum Legibility Distance	Minimum Number of Elements
A	48 x 24 inches	1/2 mile	12
B	60 x 30 inches	3/4 mile	13
C	96 x 48 inches	1 mile	15
D	None*	1/2 mile	12

*Length of arrow equals 48 inches, width of arrowhead equals 24 inches

- DE Guidance: Only Flashing Arrow or Flashing Caution modes on state-maintained roads
- Shall not be used for lane shifts or on two-lane, two-way roadways

Figure 6F-6. Advance Warning Arrow Board Display Specifications
(Delaware Revision)

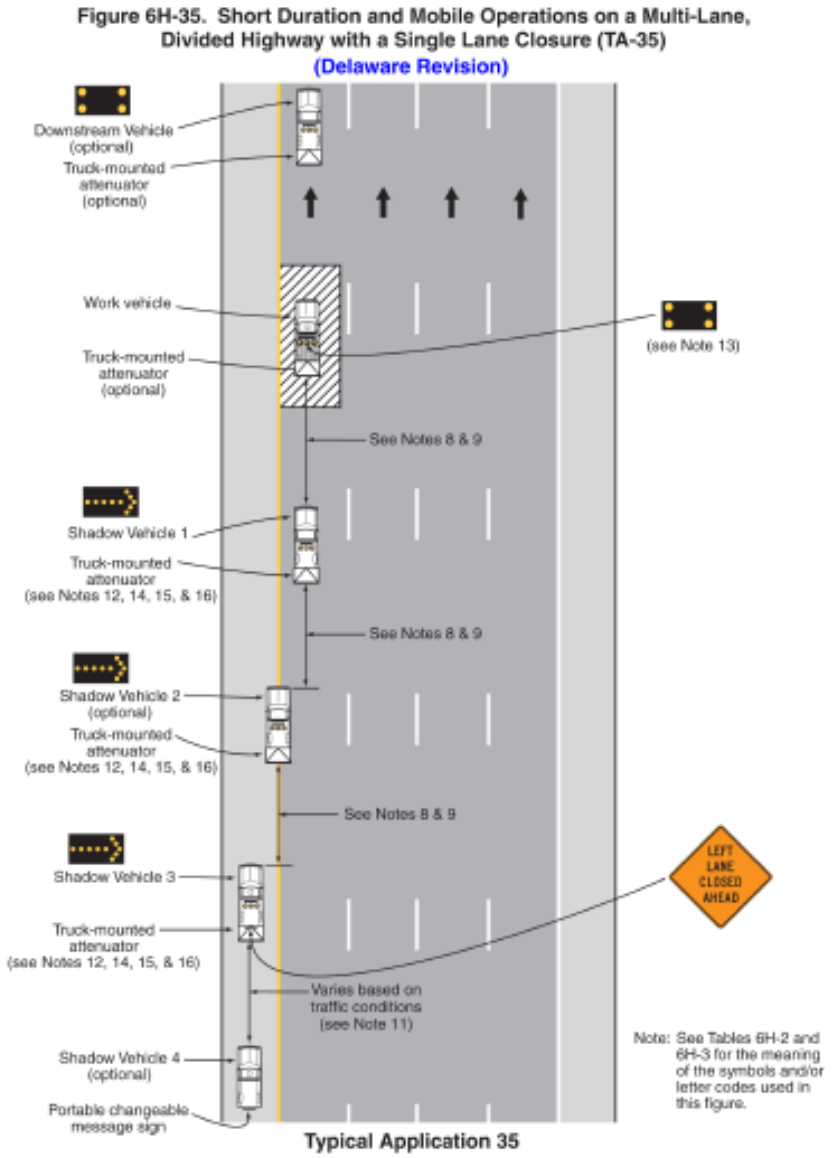


- **Flashing Arrow** is used at the beginning of the lane closure taper or to close a lane in a mobile operation

Flashing Arrow:
Full arrow flashes on & off

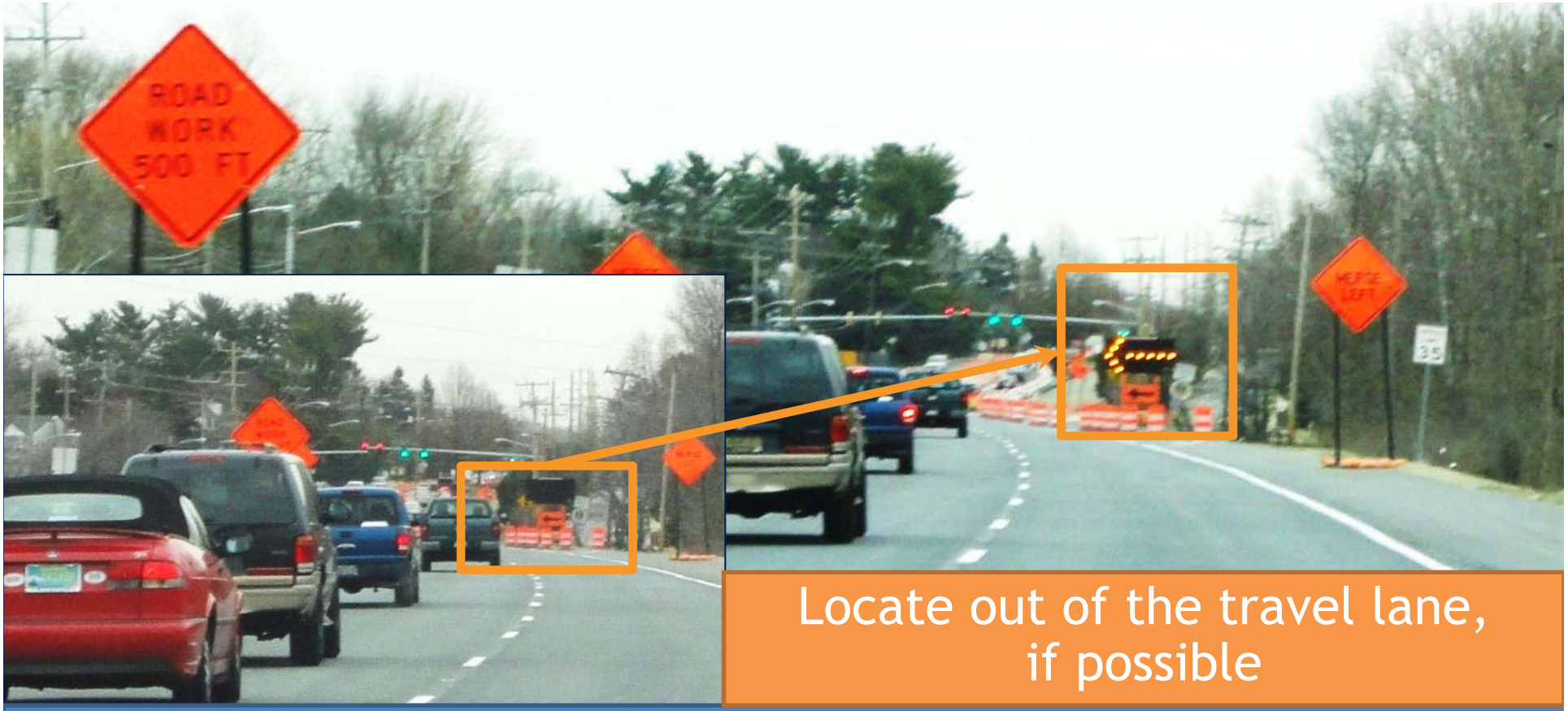
- **Flashing Caution** is used on the shadow vehicle in advance of the work crew

Flashing Caution:
Four corners flash on & off



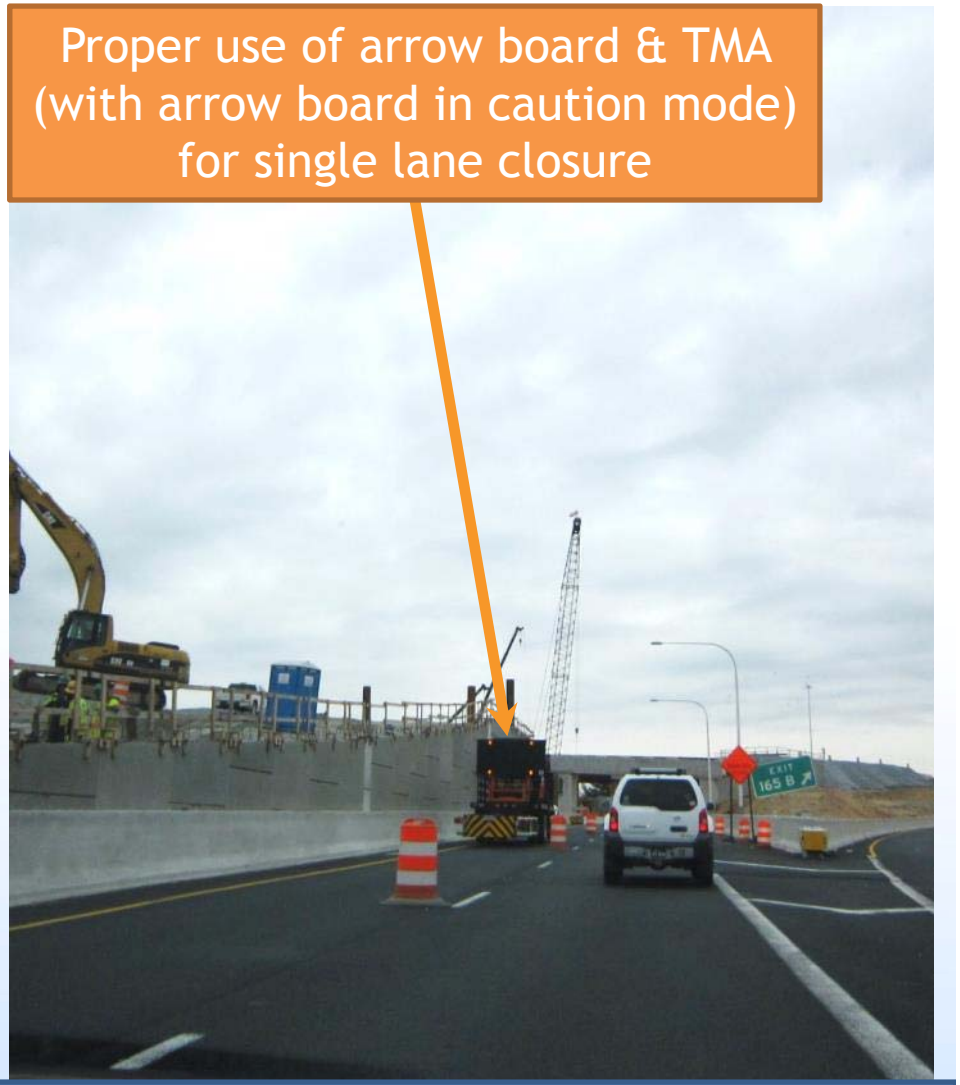
Arrow Boards

- Flashing Arrow mode used at the beginning of the lane closure taper along state-maintained roads



Elkton Rd, Casho Mill Rd to Delaware Ave

Proper use of arrow board & TMA (with arrow board in caution mode) for single lane closure



SR 1/I-95 Interchange

COMMON PROBLEMS

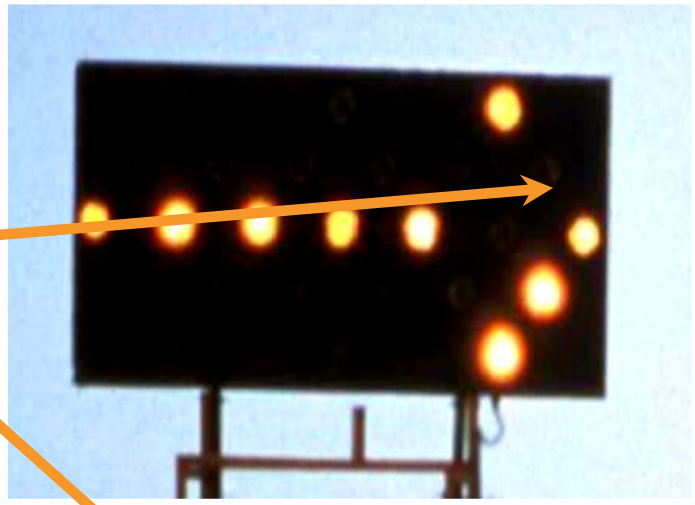
Missing or improper installation of Large Arrow sign

- DE Standard: Large Arrow (W1-6) sign shall match direction of arrow board
- DE Standard: Large Arrow sign removed or covered during caution mode

Missing Large Arrow sign

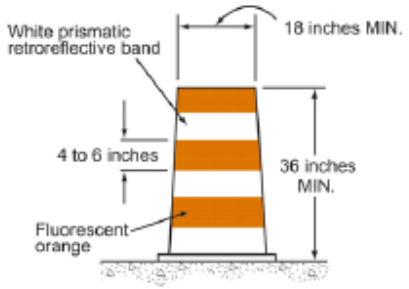
COMMON PROBLEMS

- Not properly aimed to provide maximum visibility
- Maintenance, especially bulb replacement (see *ATSSA Quality Guidelines*)
- Not dimmed during nighttime
- In Arrow Mode within lane closure - should be in Caution mode
- Inadequate sight distance
- Wrong indication/display

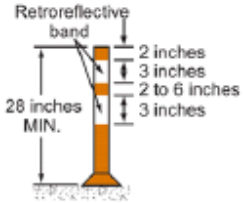


Channelizing Devices

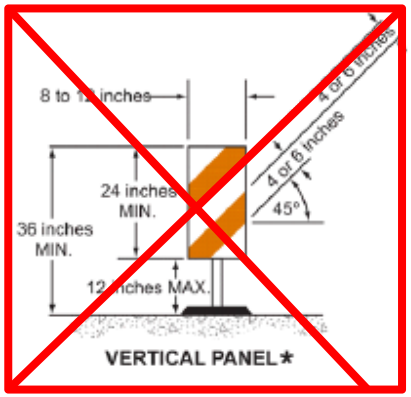
- Shall be crashworthy - NCHRP 350 or MASH tested
- DE Standard: Retroreflective sheeting displaying similar color day or night
- DE Guidance:
  - Prismatic retroreflective sheeting
  - Vertical panels should not be used on state-maintained roads



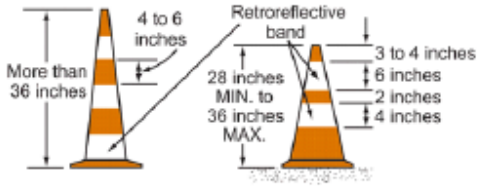
DRUM



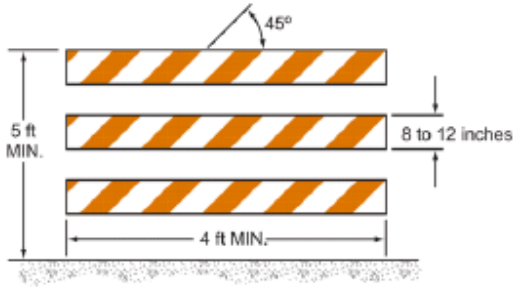
TUBULAR MARKERS



VERTICAL PANEL*



CONES



TYPE 3 BARRICADE **

- 6-inch and 4-inch reflective bands
- DE Standard:
  - Shall not be used at night
  - Shall be a minimum of 28 inch in height
- DE Option: May only be used at night during:
  - Special events requiring complex traffic shifts for ingress and egress traffic
  - Emergencies
  - Mobile striping operations to protect wet markings

COMMON PROBLEMS

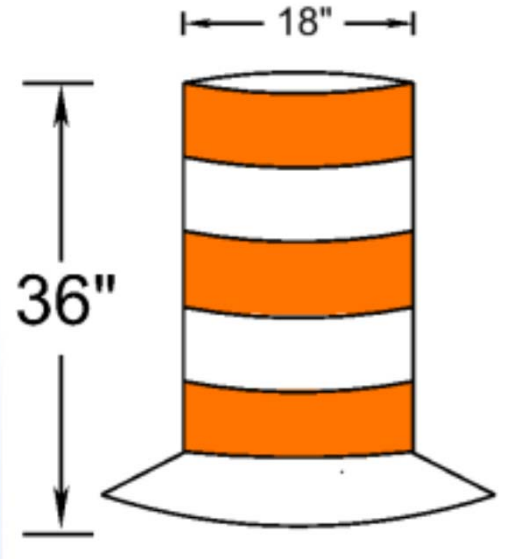
Inadequate/missing retroreflective sheeting

I-95 Sign Structure Inspection

COMMON PROBLEMS

Device quality

- Fluorescent alternating orange & white stripes
- DE Standard: Prismatic retroreflective sheeting
- Weights/ballast place at the bottom of the drum
- No weight on top of drum



COMMON PROBLEMS

Non-compliant drums / Device quality

ACCEPTABLE

UNACCEPTABLE

- DE Option: Two ballast rings to minimize drum displacement on high-speed roads or in areas with high winds

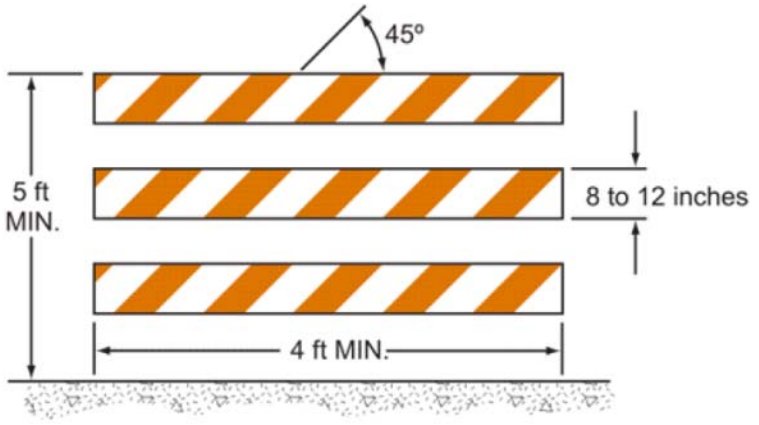
Interstate Bridge Maintenance, I-495

COMMON PROBLEMS

Improper weighting of drums

Type 1, 2, or 3 Barricades

- DE Standard:
  - Type 1 barricades prohibited
  - If used, Type 2 barricades for ped diversions only



TYPE 3 BARRICADE **

COMMON PROBLEMS

Signs not placed completely across roadway / Incorrect angle of stripes

- DE Standard: At road closure, Type 3 barricades placed completely across roadway with stripes pointing toward center of road

SR 15, Choptank Rd from N437 to N433

COMMON PROBLEMS

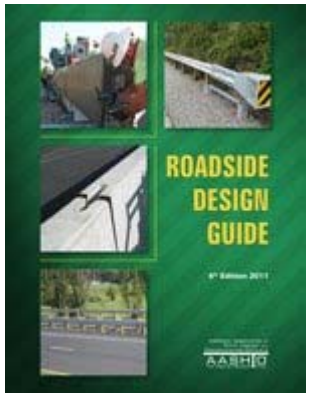
Signs covering too large of a portion of barricade

- DE Guidance: Signs should not cover more than 50 percent of top two rails or 33 percent of all three rails

ACCEPTABLE	UNACCEPTABLE

- DE Guidance: Warning lights no longer required on TTC devices

SR 2 at Hazel Ave / VA Hospital



Clear zone: Total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles (see *AASHTO Roadside Design Guide:* Table 3.1)

- Values depend on:
  - Speed
  - AADT
  - Slope
  - Curvature

AASHTO Roadside Design Guide: **Table 3.1**

Design Speed (mph)	Design ADT	Foreslopes			Backslopes		
		1V:6H or flatter	1V:5H to 1V:4H	1V:3H	1V:3H	1V:5H to 1V:4H	1V:6H or flatter
≤ 40	UNDER 750[c]	7-10	7-10	[b]	7-10	7-10	7-10
	750-1500	10-12	12-14		12-14	12-14	12-14
	1500-6000	12-14	14-16		14-16	14-16	14-16
	OVER 6000	14-16	16-18		16-18	16-18	16-18
45-50	UNDER 750[c]	10-12	12-14	[b]	8-10	8-10	10-12
	750-1500	14-16	16-20		10-12	12-14	14-16
	1500-6000	16-18	20-26		12-14	14-16	16-18
	OVER 6000	20-22	24-28		14-16	18-20	20-22
55	UNDER 750[c]	12-14	14-18	[b]	8-10	10-12	10-12
	750-1500	16-18	20-24		10-12	14-16	16-18
	1500-6000	20-22	24-30		14-16	16-18	20-22
	OVER 6000	22-24	26-32[a]		16-18	20-22	22-24
60	UNDER 750[c]	16-18	20-24	[b]	10-12	12-14	14-16
	750-1500	20-24	26-32[a]		12-14	16-18	20-22
	1500-6000	26-30	32-40[a]		14-18	18-22	24-26
	OVER 6000	30-32[a]	36-44[a]		20-22	24-26	26-28
65-70[d]	UNDER 750[c]	18-20	20-26	[b]	10-12	14-16	14-16
	750-1500	24-26	28-36[a]		12-16	18-20	20-22
	1500-6000	28-32[a]	34-42[a]		16-20	22-24	26-28
	OVER 6000	30-34[a]	38-46[a]		22-24	26-30	28-30

Barrier/Positive Protection

- DelDOT DGM 1-21 provides guidance for use of positive protection in work zones
  - Work area with no escape route
  - Long-term stationary projects
  - Vertical differences (Table 6G-1)
  - Storage of equipment (Table 6G-2)

Delaware Department of Transportation
Division of Transportation Solutions
Design Guidance Memorandum

Memorandum Number 1-21

1. Road Design Manual	2. Bridge Design Manual	3. Utilities Design Manual
4. Real Estate Manual	5. Standard Specifications	6. Standard Construction Details

Title: Use of Temporary Traffic Barrier in Work Zones Effective date: 12/4/2008

Sections to Implement:

X Project Development	X Planning	X DTC
X Bridge	X Quality	X Construction
X Team Support	X Maintenance & Operations	X Traffic
X Utilities		_ Other _____

I. Purpose

To provide guidance on the use of positive protection devices to decrease the likelihood of fatalities and injuries to road users and workers in accordance with FHWA's ruling on Temporary Traffic Control Devices (23 CFR 630 Subpart K).

II. Design Guidance

Applicability: Applies to all projects on streets and highways under the Department's jurisdiction.

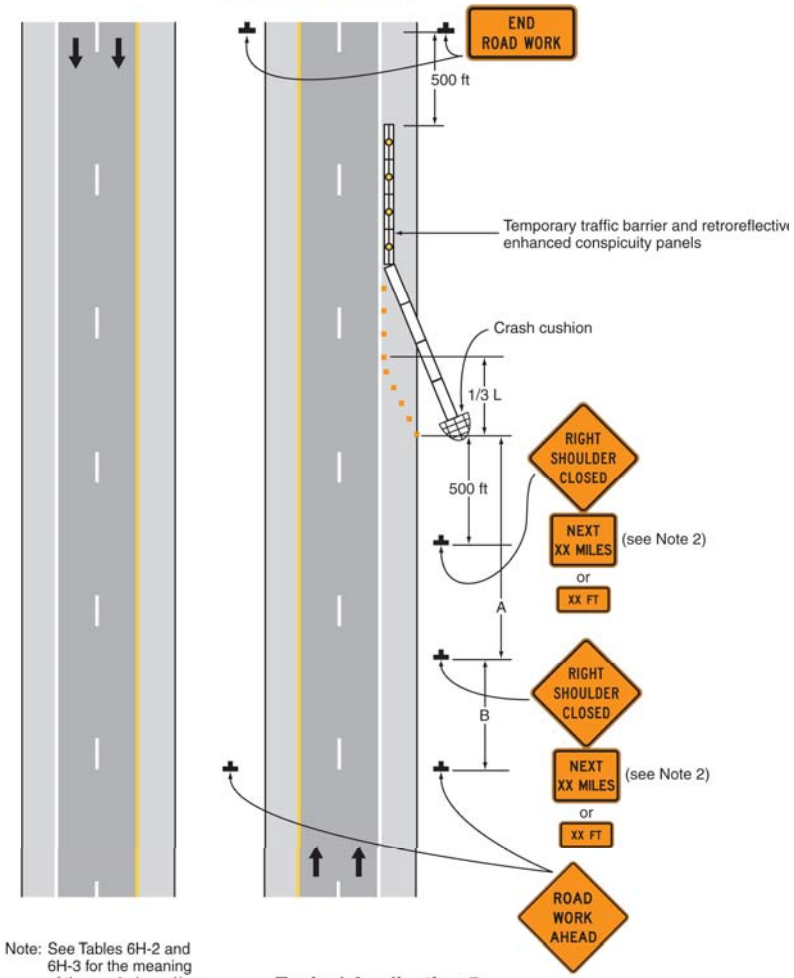
These guidelines should be applied to all new projects and all existing projects that have a semi-final plan due date after December 4, 2008. For existing projects with a semi-final plan due date before December 4, 2008, these guidelines may be applied on a case-by-case basis. These guidelines apply to all projects not requiring plans (e.g., maintenance projects, utility projects, etc.) as of December 4, 2008. These guidelines do not apply to work related to emergency repairs.

Temporary Traffic Barrier Evaluation: As part of the development of a Traffic Control Plan (TCP), the need for and usefulness of temporary traffic barrier protection should be evaluated throughout the project development process. In general, temporary traffic control barriers should only be installed if it is determined that the barrier offers the least hazard potential. During concept development and design, exposure control measures should be considered to avoid or minimize worker exposure to motorized traffic and road user exposure to work zone activities, while also providing adequate consideration to the potential impacts on mobility. Example exposure control measures include:

- Full road closures
- Ramp closures
- Median crossovers (i.e., half road closure)
- Full or partial detours
- Protection of work zone setup and removal operations using rolling road blocks

DE MUTCD typical applications depicting barrier applications

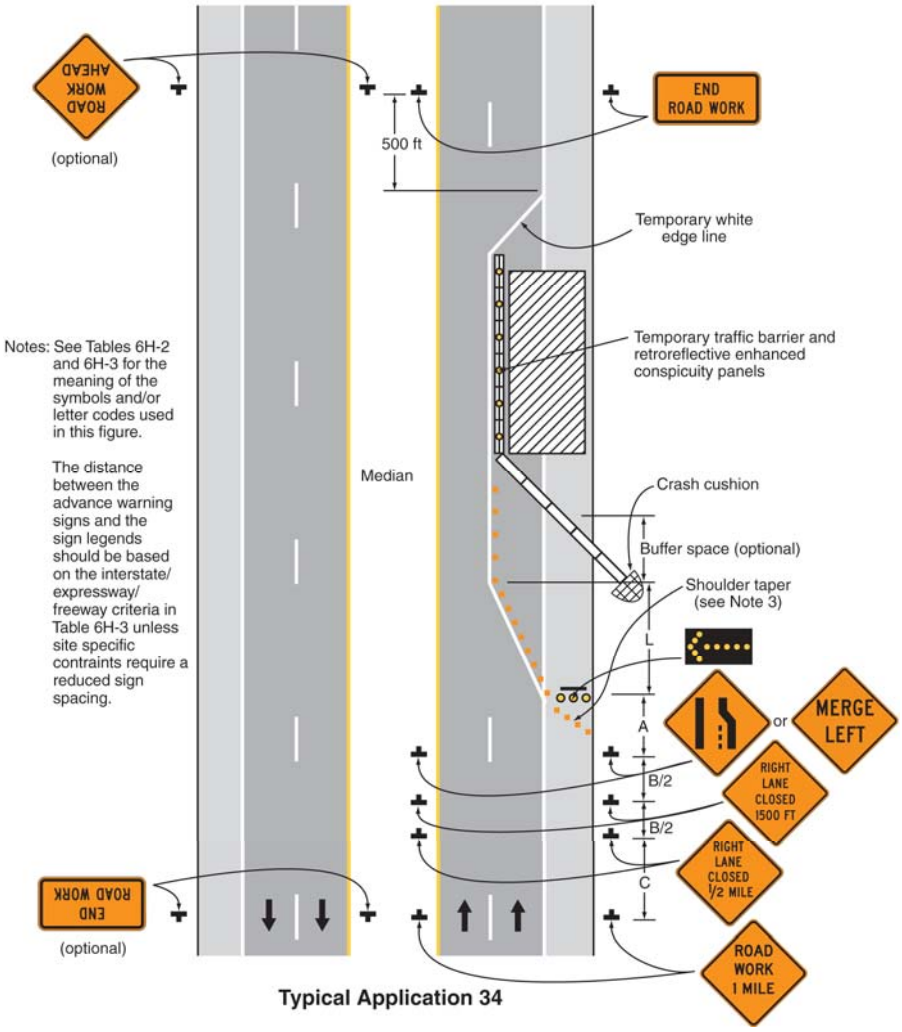
Figure 6H-5. Shoulder Closure on an Interstate, Freeway, or Expressway with a Temporary Traffic Barrier (TA-5)
(Delaware Revision)



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

Typical Application 5

Figure 6H-34. Lane Closure on a Multi-Lane, Divided Highway with a Temporary Traffic Barrier (TA-34)
(Delaware Revision)



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

The distance between the advance warning signs and the sign legends should be based on the interstate/ expressway/ freeway criteria in Table 6H-3 unless site specific contraints require a reduced sign spacing.

Typical Application 34

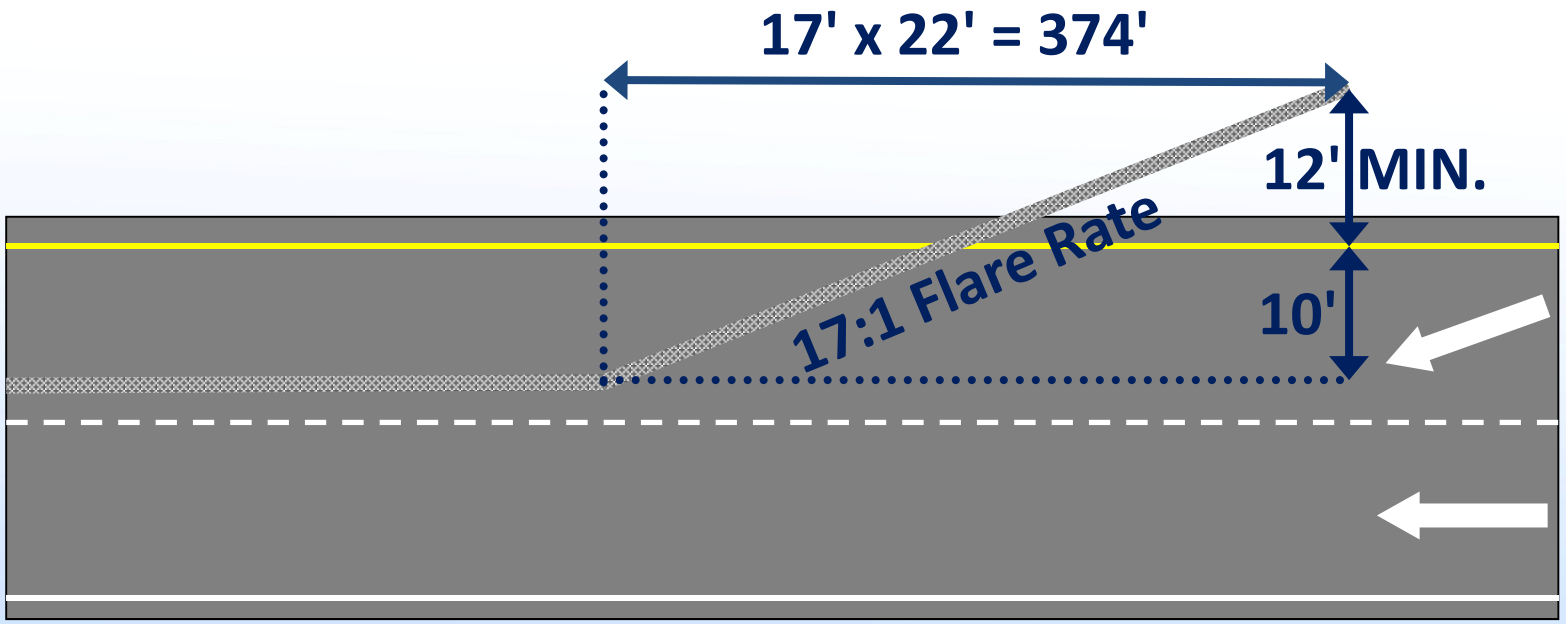
- DE Standard:
  - Enhanced conspicuity, non-directional retroreflective panels used to delineate barrier
  - 50-ft panel spacing; first panel within 10 ft of leading edge

Elkton Rd, Casho Mill Rd to Delaware Ave

- DE Guidance: Consider pinned barrier if working less than 5 ft behind barrier

Interstate Bridge Maintenance, I-495

- DE Guidance:
  - 17:1 flare rate
  - 12 ft MIN. lateral offset at leading edge
  - Buffer space along tangent



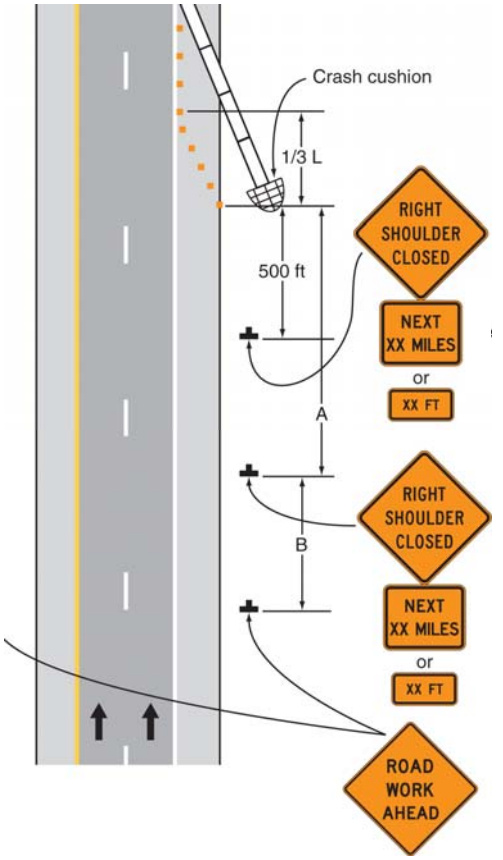
COMMON PROBLEMS

Insufficient lateral offset to travel lane

SR 1, North Frederica Grade Separated Intersection

COMMON PROBLEMS

Lack of channelization in advance of barrier



SR 1, North Frederica Grade Separated Intersection

- Barrier and corresponding end treatment shall be crashworthy
- End treatments per *AASHTO Roadside Design Guide*
  - Flare end outside clear zone
  - Install crashworthy cushion
- "Length of need" per *AASHTO Roadside Design Guide*
  - No storage of equipment or working within "length of need" without additional protection

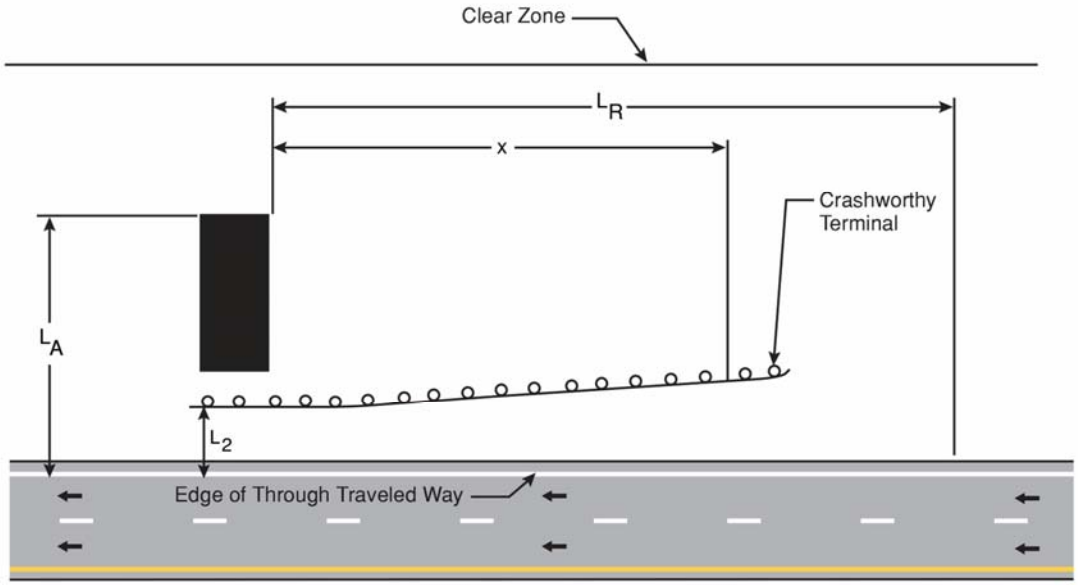
COMMON PROBLEMS

Improper end treatments


Tucking temporary traffic barrier behind existing guardrail
02/26/2013

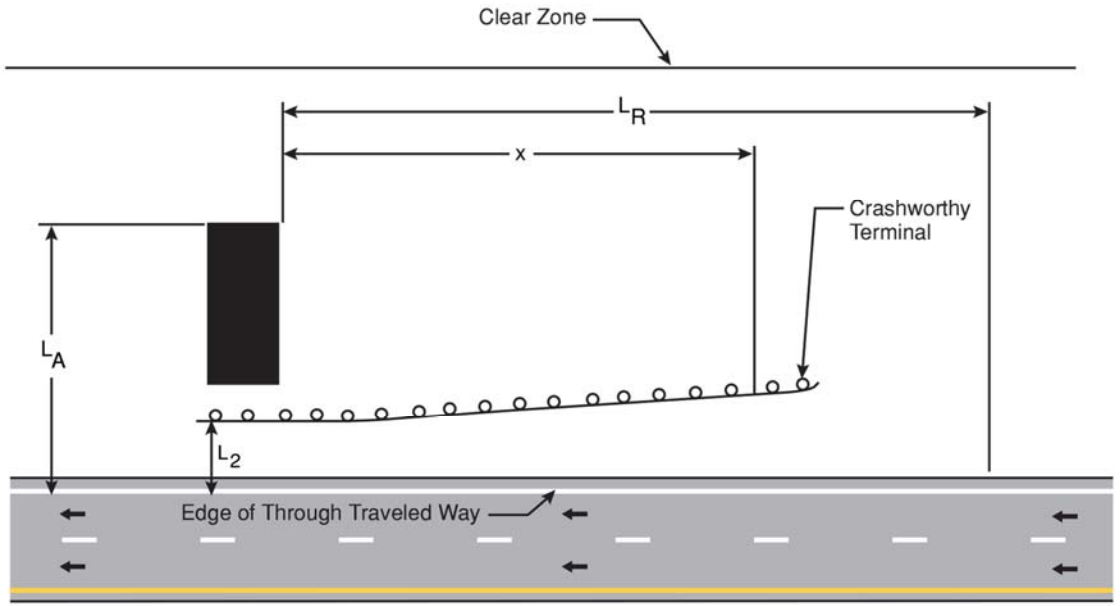
"Length of need" (per *AASHTO Roadside Design Guide)* calculations should be performed to establish length of barrier

- L_A = Lateral Extent of the Area of Concern (distance from edge of through lane to the far side of the fixed object)
- L_R = Runout Length (distance from the object being shielded to the vehicle departure location)
- L_2 = Offset from through lane
- x = Length of barrier required



Length of Need Calculation Example

- Design Speed = 70 mph
- Daily Traffic = 35,000
- L_A = 30 feet
- L_2 = 12 feet
- 17:1 flare rate



Length of Need (x) ~ 150 feet

- Type 3 Barricade with TMA permitted where construction access is only feasible on leading end of barrier and where it is impractical to provide “length of need”

I-95/SR 1 Interchange

COMMON PROBLEMS

Poor maintenance

- DE Guidance:
  - Painted prior to initial installation and once per year
  - Cleaned every 3 months
- DE Option: White cement barrier does not require painting

US 13 / DE 404 Intersection Realignment

SR 1, North Frederica Grade Separated Intersection

Crash Cushions

- In Delaware, typically refer to sand crash cushions and impact attenuators
- DE Guidance: Sand crash cushions generally reserved for short-duration maintenance
- DE Guidance: Sand crash cushions should not be installed where reverse strikes are possible

Impact attenuators strongly preferred by DelDOT

SR 12, Frederica

COMMON PROBLEMS

Improper installation of attenuators

Impact attenuators should be installed per manufacturer's instructions (to avoid "snagging" motorists)

Insufficient tightening of bolts ("hand tightening")

Truck-mounted Attenuators (TMA)

- DE Standard: Truck-mounted attenuator (TMA) required for shoulder and lane closures for long-term, intermediate, short-term, and mobile operations on roads greater than 40 mph
- DE Option: TMA can be omitted for short duration work less than 15 min if vehicle displays high-intensity, flashing, oscillating, or strobe lights
- DE Option: TMA can be omitted from specialized work vehicles that cannot support TMA installation

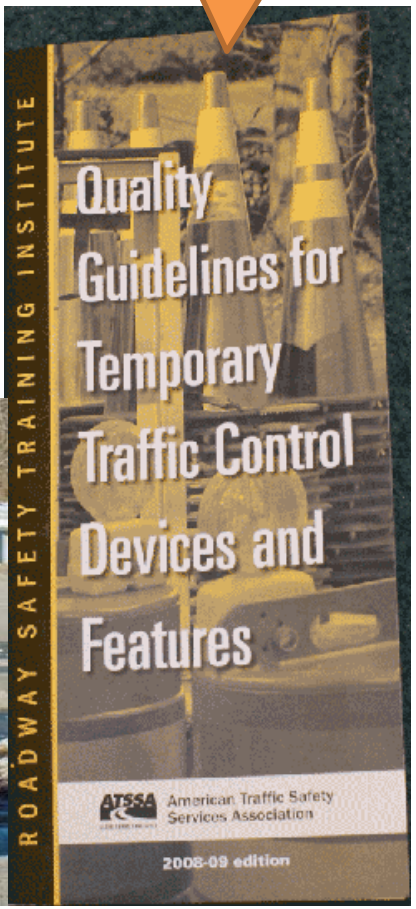
- DE Standard:
  - Flashing lights on all work-related vehicles and equipment
  - Large rotating amber beacon or strobe light(s) visible for 360 degrees for ≥ 3,000 ft

S. Governors Ave, Webbs Ln to Water St

Quality of Devices

- DelDOT has adopted ATSSA's *Quality Guidelines for Temporary Traffic Control Devices*
  - "Marginal" or better is the minimum requirement
  - Devices shall be removed if do not meet minimum requirements
- Quality devices warrant respect by drivers
- Devices should be inspected regularly

Acceptable
Marginal
Unacceptable



Vertical Difference

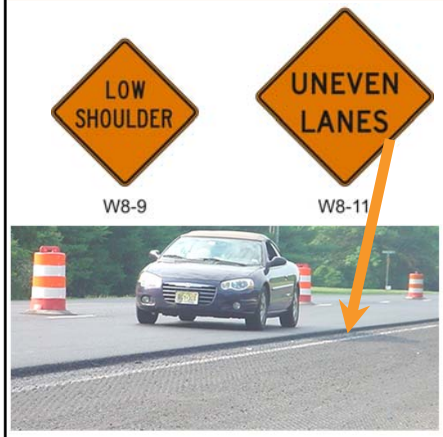
- "Vertical difference" when difference in grade of greater than 1 inch
- Based on Table 6G-1 criteria

LONGITUDINAL

TRANSVERSE

Vertical Difference

Longitudinal ≤ 10 ft from edge of traveled way

Type of Vertical Difference	Criteria	Height (H) of Vertical Difference			
		H ≤ 1 in	1 in < H ≤ 2 in	2 in < H ≤ 6 in	H > 6 in
Longitudinal ≤ 10 ft from edge of traveled way[1]	Standard	No channelizing devices required	- For differences along or between traveled ways, the UNEVEN LANES (W8-11) sign shall be used - For differences between the traveled way and shoulder or at the edge of pavement, the LOW SHOULDER (W8-9) sign shall be used  W8-9 W8-11	- No shoulder or shoulder < 4 ft wide: If the vertical difference is not eliminated by the end of the work day, a 4 to 1 fillet of wedge material shall be placed or temporary traffic barrier shall be installed. During the day of construction, channelizing devices shall be used to delineate the vertical difference until the vertical difference is eliminated, a 4 to 1 fillet of wedge material is placed, or temporary traffic barrier is installed. - Shoulder ≥ 4 ft wide: Drums shall be used to delineate the vertical difference for up to 5 calendar days. If the vertical difference is not eliminated by the end of the 5th calendar day, a 4 to 1 fillet of wedge material shall be placed or temporary traffic barrier shall be installed. - The Shoulder Drop Off (W8-17) sign shall be used until the vertical difference is eliminated	If the vertical difference is not eliminated by the end of the work day, a 4 to 1 fillet of wedge material shall be placed or temporary traffic barrier shall be installed.   W8-17 W8-17P

Longitudinal ≤ 10 ft from edge of traveled way

Type of Vertical Difference	Criteria	Height (H) of Vertical Difference			
		H ≤ 1 in	1 in < H ≤ 2 in	2 in < H ≤ 6 in	H > 6 in
Longitudinal ≤ 10 ft from edge of traveled way[1]	Guidance		- For differences between the traveled way and shoulder or at the edge of pavement, wedge material is not required if the vertical difference exists for less than 5 calendar days. If the vertical difference is not eliminated by the end of the 5th calendar day, a 4 to 1 fillet of wedge material should be placed. - Throughout the duration of the vertical difference condition, drums should be placed between the traveled way and shoulder or along the edge of pavement		
	Option			TTC devices and correction may be omitted for new pavement surfaces with the Safety Edge	

Vertical Difference

- Longitudinal >10 ft to ≤ 30 ft from edge of traveled way
- Transverse

Type of Vertical Difference	Criteria	Height (H) of Vertical Difference			
		H ≤ 1 in	1 in < H ≤ 2 in	2 in < H ≤ 6 in	H > 6 in
Longitudinal > 10 ft to ≤ 30 ft from edge of traveled way[1,2]	Standard	No channelizing devices required	No channelizing devices required	- Throughout the duration of the vertical difference condition, drums shall be placed between the traveled way and shoulder or along the edge of pavement - If the vertical difference is within the traveled way or shoulder, the Shoulder Drop Off (W8-17) sign shall be used until the vertical difference is eliminated	Throughout the duration of the vertical difference condition, drums shall be placed between the traveled way and shoulder or along the edge of pavement
	Guidance				Temporary traffic barrier should be considered
Transverse	Standard	No channelizing devices required	- Except for roadway obstacles such as manholes and utility valves, BUMP (W8-1) or DIP (W8-2) signs shall be installed - A ramp of bituminous temporary roadway material shall be installed at a slope of 20 to 1 across the limits of the vertical difference, including the perimeter of an obstacle	- Except for roadway obstacles such as manholes and utility valves, BUMP (W8-1) or DIP (W8-2) signs shall be installed - A ramp of bituminous temporary roadway material shall be installed at a slope of 20 to 1 across the limits of the vertical difference, including the perimeter of an obstacle	- Except for roadway obstacles such as manholes and utility valves, BUMP (W8-1) or DIP (W8-2) signs shall be installed - A ramp of bituminous temporary roadway material shall be installed at a slope of 20 to 1 across the limits of the vertical difference, including the perimeter of an obstacle

COMMON PROBLEMS

Wedge material not placed at edge of pavement

- DE Standard: Pavement millings (or similar) used for wedge material at edge of pavement
- DE Guidance: Base course material used for wedge material between traveled way and pavement box

HSIP NCC, SR 896 and Four Seasons Pkwy

Storage of Equipment

Table 6G-2. Storage of Equipment (Delaware Revision)

Road Type	Distance (L) from Edge of Traveled Way	Posted Speed Limit or 85th-Percentile Speed	Minimum Required Channelizing Devices
Equipment and Non-flammable Materials			
Interstate, Freeway, or Expressway	L ≤ 30 ft	All	Temporary traffic barrier
	L > 30 ft	All	Drums
All other roadways	0 ≤ L ≤ 10 ft	25 mph or less	Drums
		More than 25 mph	Temporary traffic barrier
	10 ft < L ≤ 30 ft	25 mph or less	None
		More than 25 mph	Drums
	L > 30 ft	All	None
Flammable Materials (fuel, propane, etc.)			
Interstate, Freeway, or Expressway	L ≤ 30 ft	All	Temporary traffic barrier
	L > 30 ft	All	Drums
All other roadways	L ≤ 30 ft	All	Temporary traffic barrier
	L > 30 ft	All	None

Barrier needed

Oak Orchard Rd

COMMON PROBLEMS

Improper storage of equipment

Storage of sign posts and supports on attenuators