Work Zone Safety

Guidelines *for* Temporary Traffic Control

Revised April 2015

VDOT
Virginia Department of Transportation

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Introduction

The purpose of this handbook is to present basic guidelines for work zone traffic control and to supplement the *2011 Virginia Work Area Protection Manual* with Revision 1. This handbook presents the requirements of Part VI of the Manual on Uniform Traffic Control Devices (MUTCD) with particular emphasis on short term work sites on roads and streets in rural and urban areas. These requirements apply to temporary traffic control zones, as found in construction, maintenance, and utility work areas.

This handbook presents information and gives examples of typical traffic control applications for two-lane and multilane work zones. This information is intended to illustrate the principles of proper work zone traffic control, but is **not** a standard. The *Virginia Work Area Protection Manual* contains the standards for temporary traffic control zones for roadways in Virginia and can be accessed at VirginiaDOT.org, Business Center.

Traffic Control Devices

The following are four types of traffic control devices commonly used in work zone traffic control:

- Signs
- Channelizing Devices
- Lighting Devices
- Truck Mounted Attenuators

Signs

Signs used in work zone traffic control are classified as regulatory, guide, or warning. Regulatory signs impose legal restrictions and may not be used without permission. Guide signs commonly show destinations, directions, and distances. Warning signs give notice of conditions that are potentially hazardous to traffic.

Warning Signs

Construction and maintenance warning signs are used extensively in street and highway work zones. These signs are normally diamond shaped, having a black symbol or message on an orange background. As a general rule, these signs are located on the right-hand side of the street or highway. On divided roadways with a median of 8' or greater, both left and right sides shall be signed. Smaller sign sizes may be used in the median when the median width is between 6.5 feet and 8 feet to provide left sign assemblies on a multilane roadway.

Size

The standard size for advance warning signs in work zones is generally 48" by 48". Where Right of Way or geometric conditions preclude use of 48" by 48" signs, 36" by 36" signs may be used.

Mounting

Standards for height and lateral clearance of post mounted roadside signs are included in the *Virginia Work Area Protection Manual*. Signs mounted on temporary supports may be at lower heights but the bottom of the sign shall not be less than one foot above the pavement elevation.

Warning Signs

Sheeting Requirement

Warning signs shall be fluorescent prismatic lens sheeting for daytime or nighttime use. Roll-up type material signs, or an approved composite type sign, may be used on portable sign supports for up to three (3) consecutive days (72 hours). Mesh signs are not allowed.

Recommended Spacing of Advance Warning Signs

Signs should be spaced as follows:

Spacing of Advance Warning Signs	
Urban Street with 25 mph or less posted speed.	100' - 200'
Urban Streets with 30 to 40 mph posted speed limit.	250' - 350'
*All Other Roadways with 45 mph or less posted speed limit.	350' - 500'
All Other Roadways with greater than 45 mph posted speed limit.	500' - 800'
Limited Access Highways	1300' - 1500'

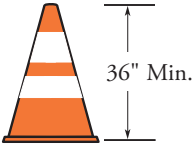
*Urban streets with greater than 40 mph posted speed limits fall into this category.

Removal of Signs

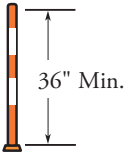
To retain the validity and respect of advance warning signs, when operations have ceased or conditions have changed such that the warning signs are no longer warranted, the signs and portable sign supports shall be removed from the roadway.

Channelizing Devices

GROUP 1

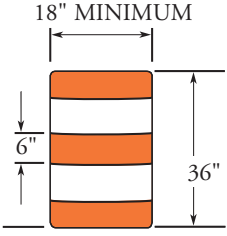


Cones

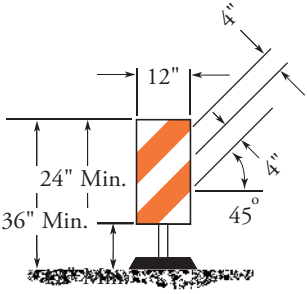


Tubular Marker

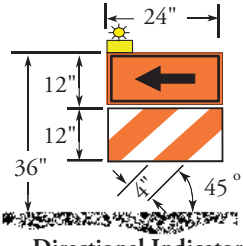
GROUP 2



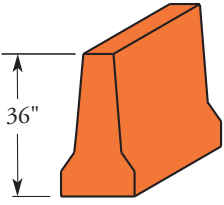
Drum



Vertical Panel



Directional Indicator

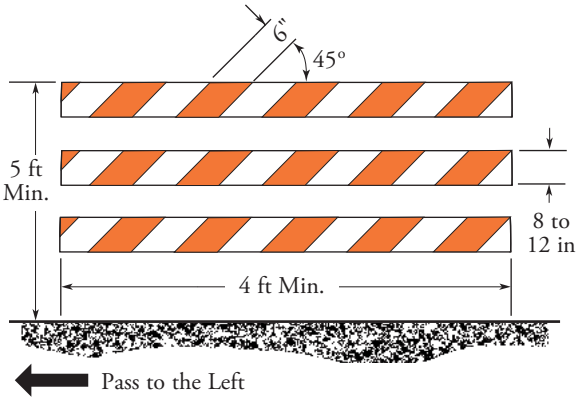


Longitudinal Channelizing Device

Notes:

1. Flashing or steady burn warning lights and signs, when used, shall be NCHRP 350 or MASH compliant with the type of device it is mounted on.

Channelizing Devices



TYPE 3 BARRICADE

Notes:

1. Six inch wide stripes on barricade rails slope downward at an angle of 45 degrees in the direction traffic is to pass.

2. Type 3 barricades shall be NCHRP 350 or MASH compliant.

3. Ballast shall not be placed on top of any striped rail.

4. Signs mounted on Type 3 Barricades should not cover more than the top rail.

Channelizing Devices (continued)

Channelizing devices are used to warn and alert drivers of hazards in work zones, to protect workers, and safely guide and direct drivers past the hazards. Channelizing devices include cones, tubular markers, drums, vertical panels, temporary raised islands, directional indicators, and longitudinal channelizing devices. The most common channelizing device used in short term work sites is the traffic cone.

Traffic Cones

Traffic cones shall be orange in color and a minimum of 36 inches in height. Cones used at night shall be retroreflectorized by a 6 inch band and a 4 inch band space 2 inches a part. Cones greater than 36" in height shall have four alternating orange and white retroreflective stripes respectively 4" to 6" wide.

Vertical Panels

Vertical panels shall be 12 inches in width and at least 24 inches in height. They shall have 6 inch orange and white diagonal stripes and shall be retroreflectorized. Vertical panels shall be mounted with the top a minimum of 36 inches above the roadway.

Directional Indicators and Longitudinal Channelizing Devices

Directional indicators and longitudinal channelizing devices shall comply with the descriptions on Page 7. Directional indicators shall only be used in tapers. Longitudinal channelizing devices shall interlock and may be used in place of cones or drums.

Channelizing Devices

Spacing

Channelizing devices should be spaced so that they make it apparent that the roadway or work area is closed to traffic. To accomplish this, the devices should be spaced based on the posted speed and by the following guidelines:

Spacing of Channelizing Devices

Work Zone Location	Posted Speed Limit	Spacing
In Tapers and Curves	35 mph or less	20'
Parallel to the Travelway	35 mph or less	40'
Spot Construction Access*	35 mph or less	80'
In Tapers and Curves	Greater than 35 mph	40'
Parallel to the Travelway	Greater than 35 mph	80'
Spot Construction Access*	Greater than 35 mph	120'

* For easier access by construction vehicles into the work area, spacings may be increased to this distance, but shall not exceed one access per quarter mile.

Drums

Plastic drums must be a minimum of 36 inches in height and at least 18 inches in diameter with alternating orange and white retroreflective stripes 6 inches wide. Each drum shall have a minimum of two orange and white stripes, and the top stripe shall be orange. Spacing of drums shall be the same as for cones. To ensure that the work zone is properly protected, drums shall be used to delineate unmanned work areas.

Lighting Devices

Lighting devices for short term construction, maintenance, and utility work zones are designed to supplement the signs and channelizing devices used in these zones. Typical lighting devices include warning lights, vehicle lights, and flashing arrow board.

Warning Lights

The principal types and use of warning lights are:

1. **Low Intensity Flashing Lights (Type A)** used to warn of an isolated hazard at night.
2. **High Intensity Flashing Lights (Type B)** normally mounted on advance warning signs to draw attention to a hazard both day and night.
3. **Low Intensity Steady-Burn Lights (Type C)** used in a series to delineate the edge of the travelway and channelize traffic at night.
4. **Low Intensity 360º Steady-Burn Lights (Type D)** used in a series same as type C lights when delineation is required from multiple sides.

Vehicle Lights

Lighting greatly enhances the visibility of work vehicles and increases their recognition factor as a slow moving hazard. Amber high intensity rotating, oscillating, or flashing lights shall be used on vehicles performing moving and mobile operations, and should be used on vehicles entering and exiting the work zone at night. Lights shall be mounted as to be viewed 360 degrees. Lights shall be visible for 1/2 mile on Limited Access highways and 1500 feet on all other roadways.

Lighting Devices

Flashing Arrow Boards

Flashing Arrow Boards are used on vehicles in mobile operations, and placed at the beginning of lane closure tapers. Arrow displays shall have the following mode selections:

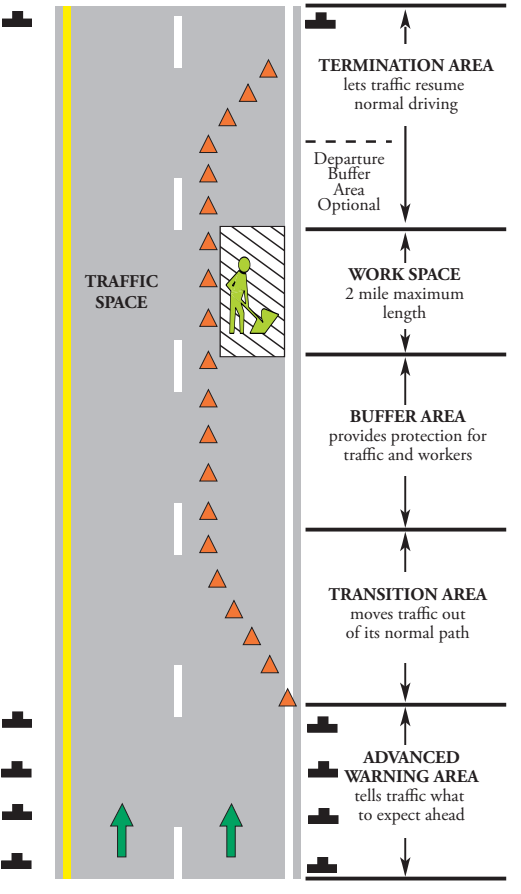
- flashing arrow
- flashing double arrow
- flashing caution (four corners)
- sequential chevron

Arrow Board Size Requirements			
Type	**Min. Size**	**Min. No. Lamps**	**Min. Legibility Distance**
A	48" x 24"	12	1/2 mile
B	60" x 30"	13	3/4 mile
C	96" x 48"	15	1 mile

Notes:

1. Arrow Boards in the typical application diagrams shall be a Type B or C unless otherwise noted.

Component Parts of a Temporary Traffic Control Zone



Five Parts of a Temporary Traffic Control Zone

The temporary traffic control zone is the distance between the first advance warning sign and the point beyond the work area where the traffic is no longer affected. Above is a diagram showing the five parts of a temporary traffic control zone.

Buffer Area

The length of a longitudinal buffer is determined by the posted speed limit and should be as shown in the chart below.

Length of the Longitudunal Buffer Area	
Posted Speed (MPH)	**Distance (Feet)**
20	115 - 120
25	155 - 165
30	200 - 210
35	250 - 260
40	305 - 325
45	360 - 380
50	425 - 445
55	500 - 530
60	570 - 600
65	645 - 675
70	730 - 760
75	820 - 850

Taper Length Criteria for Work Zones

There are five types of tapers used in work zone traffic control. The length of each type of taper is based on the speed of traffic and the width of the offset (or lane width). The following are the five types of tapers and their lengths.

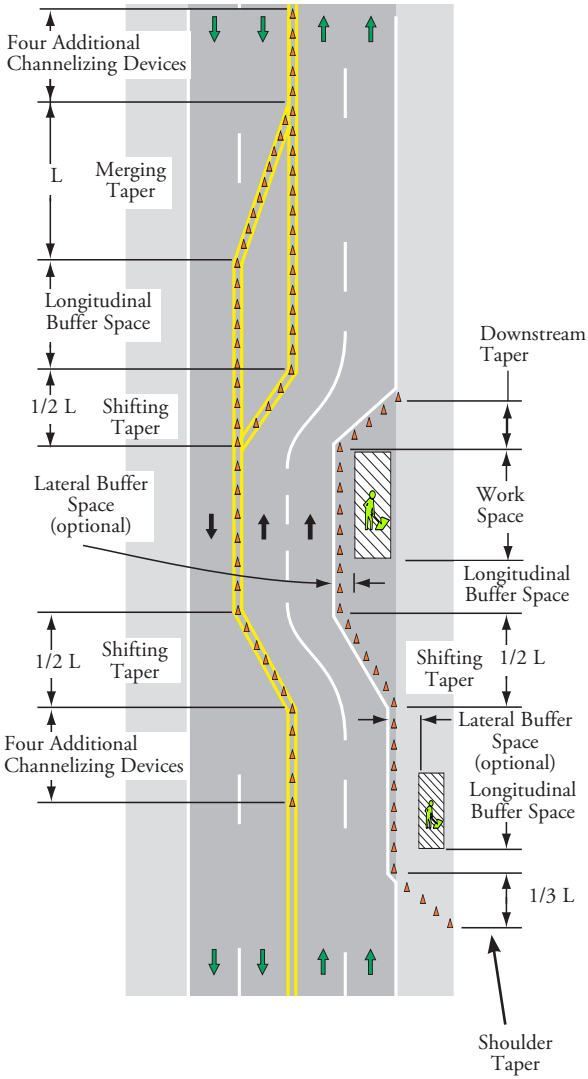
Type of Taper	Taper Length
Merging	L Minimum
Shifting	L Desired, 1/2 L Min.
Shoulder	1/3 L Minimum
Two-way	50 to 100 Feet
Downstream	50 to 100 Feet per Lane

Taper Length (L) Chart:

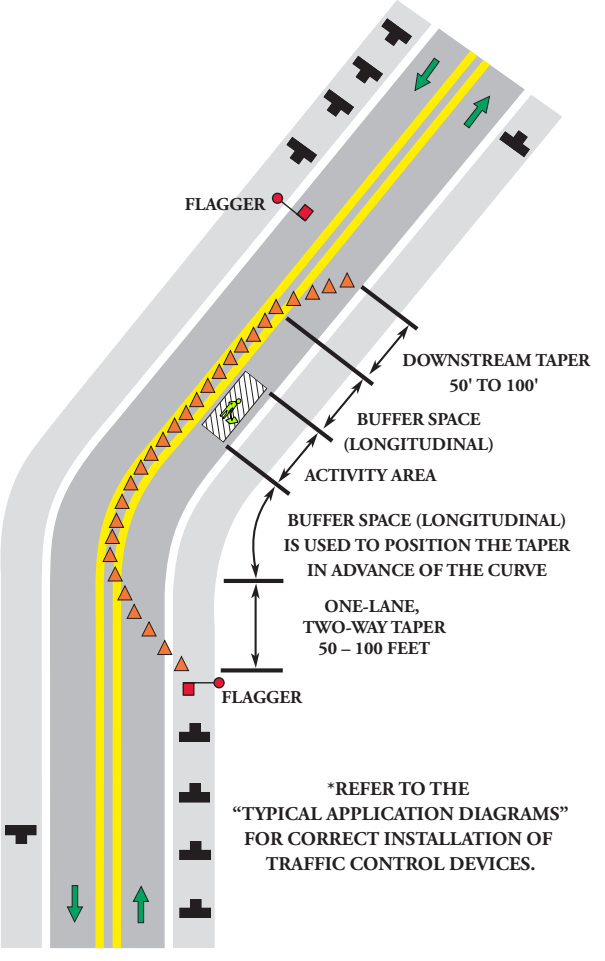
Taper Length (L)					
Speed (S) in MPH	Width of Offset (W) in Ft.				Remarks
	9	10	11	12	
25 or below	**95**	**105**	**115**	**125**	**$L=S^2W/60$**
30	135	150	165	180	"
35	**185**	**205**	**225**	**245**	**"**
40	240	270	295	320	"
45	**405**	**450**	**495**	**540**	**L=SW**
50	450	500	550	600	"
55	**495**	**550**	**605**	**660**	**"**
60	540	600	660	720	"
65	**585**	**650**	**715**	**780**	**"**
70	630	700	770	840	"

Minimum Merging Taper Length (L) for Limited Access Highways Shall Be 1000 Feet. Minimum Shifting Taper Shall Be ½L with L Desirable.

Types of Tapers and Buffer Spaces



Work Zone Applications in Curves and Hills



Work Zone Applications in Curves and Hills

When the work activity occurs in a curve or the down side of a hill, consideration should be given to the placement of the advance warning devices. It is always best to place the warning signs, arrow board, and taper devices in a tangent or straight section of roadway for maximum visibility. This may involve extending the lane closure and increasing the buffer space to accomplish. The figure above shows an application of this concept. If the lane closure cannot be lengthened due to roadway constrains, then the length of the taper should be increased to provide additional merge area for vehicles. On hills, the signs, taper and arrow board should be seen prior to reaching the crest of the hill. This also applies to the placement of flagger stations.

Shadow Vehicles

A shadow vehicle (see Truck Mounted Attenuators) shall be placed 80′ to120′ in advance of the first work crew encountered by traveling motorists. A shadow vehicle should be used when installing and removing TTC devices and be placed 80′ to 120′ in advance of the each work crew. **Each shadow vehicle shall have at least one amber high intensity rotating, oscillating, or flashing light functioning while in operation. A work vehicle shall be used to store, install and remove TTC devices.**

Truck Mounted Attenuators

A shadow vehicle requires a truck or trailer mounted attenuator (TMA) in all lane and/or partial ramp closures on four or more lane roadways when the posted speed limit is 45 mph or greater, and for mobile operations which fully or partially block a lane on roadways posted 45 mph or greater. All TMA units shall conform to the requirements of NCHRP 350 - Test Level 3 or MASH regardless of where the unit will be used.

Placement of shadow vehicle with the TMA shall be 80' to 120' in front of the first work crew, equipment, or hazard encountered by traveling motorists. A shadow vehicle should be placed 80′ to 120′ in advance of the each work crew. Each TMA vehicle shall have at least one amber high intensity rotating, oscillating, or flashing light functioning while in operation.

Installing/Removing Lane Closures

Care must be exercised when installing and removing lane closures. All stationary lane closures begin and end as mobile operations. **TTC devices shall not be stored, installed or removed from a shadow vehicle. All TTC devices shall be stored, installed or removed from a work operation vehicle.** The traffic control needed to perform the operation safely is dictated by the location on the roadway the mobile operation will occur; either on the shoulder or partially or fully in the lane. A shadow vehicle with a TMA shall be used to protect workers and their work vehicle during the installation and removal of TTC devices.

Installing Lane Closures

Stationary lane closures should be installed with the flow of traffic in the following sequence:

1. Install all advance warning signs.

2. Install shoulder taper if necessary.

3. Place arrow board on the shoulder at the beginning of the merging taper.

4. Install channelizing devices to form a merging taper.

5. Install channelizing devices along the buffer space.

6. Continue placing channelizing devices along the work area at the appropriate spacing.

7. Install channelizing devices for the termination area.

8. Install the "END ROAD WORK" sign approximately 500' beyond the last device in the lane closure.

9. Place a TMA vehicle, if required, 80'-120' from first work crew or hazard approached by motorists.

A "ride through" through the entire lane closure should be performed (with adjustments made to the traffic control devices if needed) to ensure that the lane closure is installed and functioning properly. Major adjustments to the work zone should be documented.

Removing Lane Closures

Stationary lane closures should be removed against the flow of traffic in the following sequence:

1. Remove channelizing devices from end of closure back to the widest part of the merging taper.
2. Place removal vehicle on shoulder and remove devices from taper by hand onto the work vehicle.
3. Remove arrow board after ensuring roadway is clear.
4. Moving with the flow of traffic, remove all of the advance warning signs beginning with the "ROAD WORK AHEAD" sign and ending with the "END ROAD WORK" sign.

Use of a TMA vehicle when installing and removing lane closures on multi-lane roadways increases the safety of the operation for both the worker and the traveling public, and shall be used whenever the shoulder width prevents these operations from being performed completely off of the travelway. Workers running accross an open travel lanes of traffic to install and remove TTC devices is a dangerous practice and should not be performed unless slow roll temporary traffic control operations are being performed (see Sections 6G.24 and 6G.25, as well as TTC-62 in the *Virginia Work Area Protection Manual*).

Definitions

The following are several important definitions for terms used in these guidelines. These definitions were developed to aid the supervisor at the job site in determining the appropriate traffic control for the existing street or highway conditions.

If the traffic conditions or work status changes during the course of the work, then the traffic control must change also.

Low Speed
As a general rule, a low speed road can be considered one on which the posted speed is less than 30 miles per hour (MPH).

Low Volume
As a general rule, a low volume road can be considered one which the average daily traffic (ADT) volume does not exceed 500 vehicles per day. If the traffic volumes are not known, the following rule of thumb can be used to determine if the road can be treated as low volume for the purposes of installing work zone traffic control:

Count the number of vehicles that pass a single reference point over a five minute period. If no more than 3 vehicles pass the reference point in that period, then the road can be considered low volume.

Definitions (continued)

The following are categories of work duration and their time at a location:

Mobile Operation
Work that moves intermittently or continuously (0-15 minutes) and does not occupy the immediate area for more than 15 minutes. The immediate area is typically defined as a 1000± linear foot distance.

Short Duration
Occupies a location from 15 minutes to 1 hour.

Short-term Stationary
Occupies a location for more than 1 hour but less than 12 hours within a single daylight period.

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

Long Term Stationary
Occupies a location longer than 3 days.

Nighttime Activities
Traffic control should be installed for nighttime operations from 30 minutes before sunset to 30 minutes after sunrise.

Typical Application Diagrams

The diagrams on the following pages represent examples of the application of principles and procedures for safe and efficient traffic control in temporary traffic control zones and are not intended to be standards. It is not possible to include illustrations to cover every situation that requires temporary traffic control. These typical layouts are not intended as a substitute for engineering judgement and should be altered to fit the conditions of a particular site.

The information presented in these diagrams are minimums for standard highway (non-Limited Access) conditions with posted speeds of 55 mph or less. For urban conditions (a low speed, two-lane street located inside a municipality's corporate limit) shorter spacings and lengths may be required. Limited Access highway conditions will require longer distances. For further information, refer to the *Virginia Work Area Protection Manual*; the standard for temporary traffic control in the Commonwealth of Virginia.

Legend

Channelizing Device

Flagger

Portable Sign Support

Warning Sign

Flashing Arrow Board

Work Area

Flashing Light

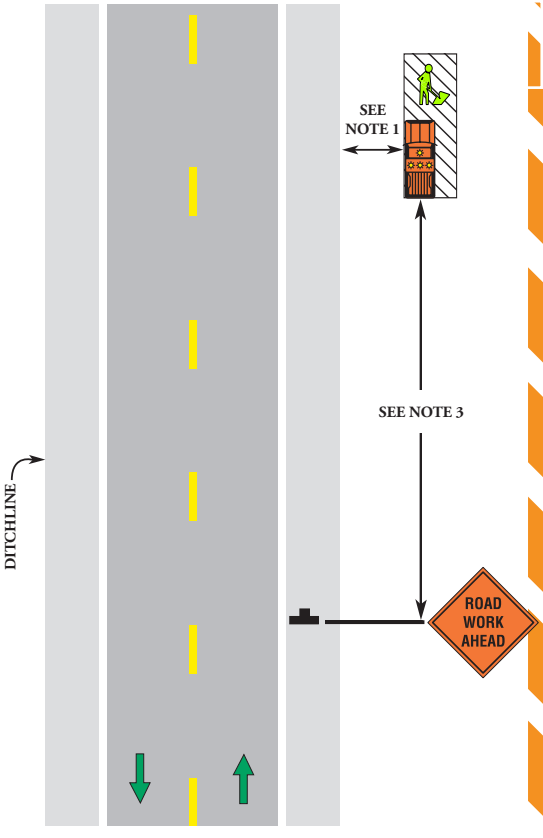
TMA Vehicle

Travel Direction

Shadow Vehicle

Work Outside the Shoulder

(15' or More From the Edge of Travel Way)



Work Outside the Shoulder

Notes:

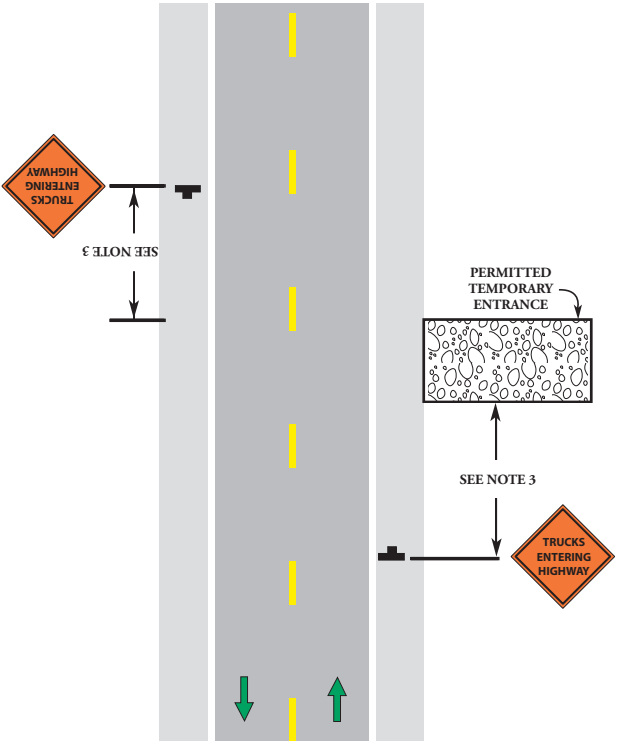
1. If vehicle and work activity are both outside the right-of-way, behind the guardrail or barrier, more than 4' behind vertical curb on urban roadways, or outside the clear zone for all other roadways, then only an activated amber high intensity rotating, oscillating, or flashing light is needed.

2. An advance warning sign should be used: if the work will be performed immediately adjacent to the shoulder, if equipment will cross or move along the roadway, or if the activity may distract motorists.

3. Sign spacing: limited access 1300' - 1500'; posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

4. Other acceptable advance warning signs are those indicating shoulder work or utility work ahead.

Permitted Temporary Entrance



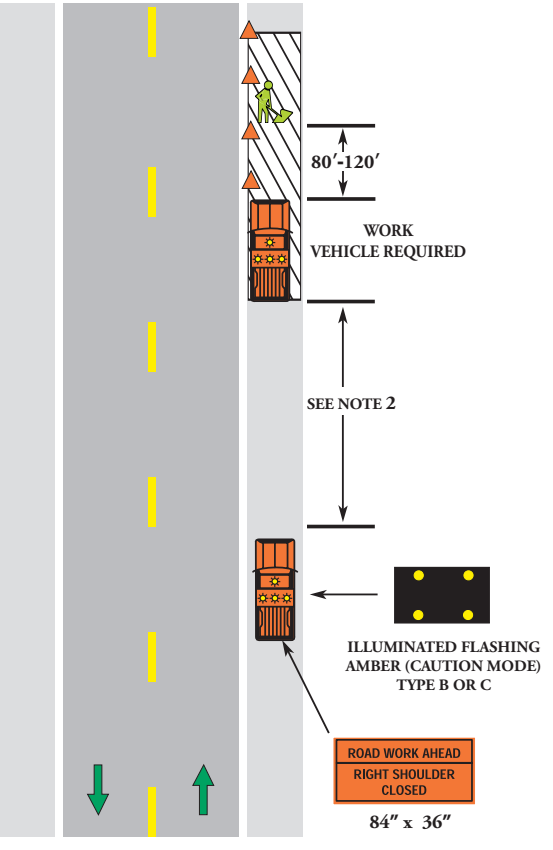
Permitted Temporary Entrance

Notes:

1. Notify the appropriate state or local agencies prior to the installation of the entrance and placement of any traffic control devices.
2. The organization receiving the entrance permit is responsible for removal of all debris (gravel, mud, dust, hauled materials, etc.), obstructions and irregularities caused by the operation. A flagging operation is required for removing debris on a two-lane roadway. A mobile operation is required to remove debris on a multi-lane roadway.
3. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

Shoulder Work
Mobile or Short Duration Operation

(60 Minutes or less in Intermediate Area)



Shoulder Work
Mobile or Short Duration Operation

Notes:

1. The first shadow vehicle may be replaced with a 48"x 48" “ROAD WORK AHEAD” or “UTILITY WORK AHEAD” sign.

2. The minimum distance between sign and shadow vehicle should be 350'-500' where the posted speed limit is 45 mph or less, and 500'-800' where the posted speed limit is greater than 45 mph. The maximum distance between sign and work vehicle is 2 miles.

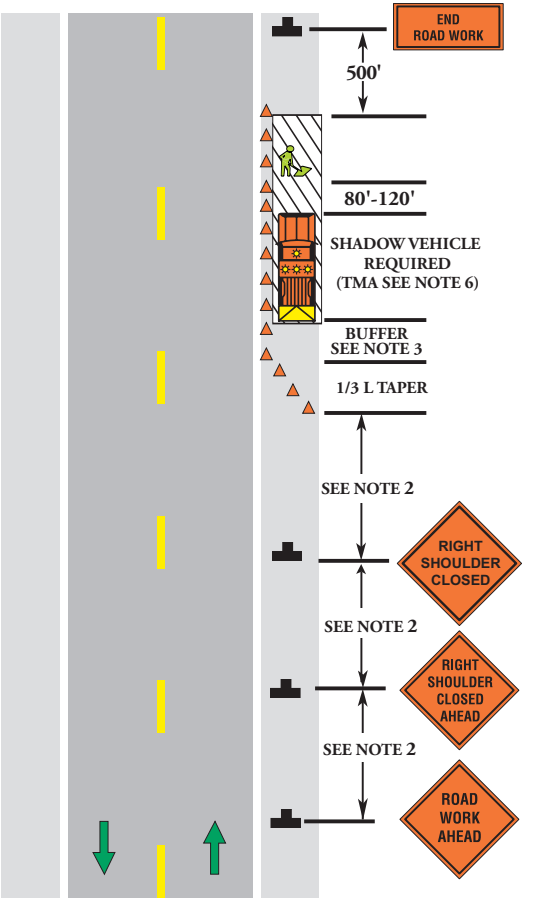
3. Each shadow vehicle involved in the operation shall have at least an arrow board operating in the caution mode or at least one amber high intensity rotating, oscillating, or flashing light.

4. When the work operation is off the shoulder with a work duration of 15-60 minutes, vehicle warning lights and a truck mounted sign (W20-V3, W20-V6, W20-V1, etc.) or a sign on a portable sign support should be placed behind the work operations vehicle.

5. The work area may be delineate by installing channelizing devices.

Shoulder Work - Stationary Operation

(Greater Than 60 Minutes in the Immediate Area)



Shoulder Work - Stationary Operation

Notes:

1. For operations less than 3 days in duration, sign assemblies will only be required on the side where the shoulder is being closed (as shown). For long-term stationary work (more than 3 days) on divided roadways having a median wider than 8', sign assemblies on both sides of the roadway shall be required (ROAD WORK AHEAD and RIGHT SHOULDER CLOSED AHEAD).

2. Sign spacing: limited access 1300' - 1500'; posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

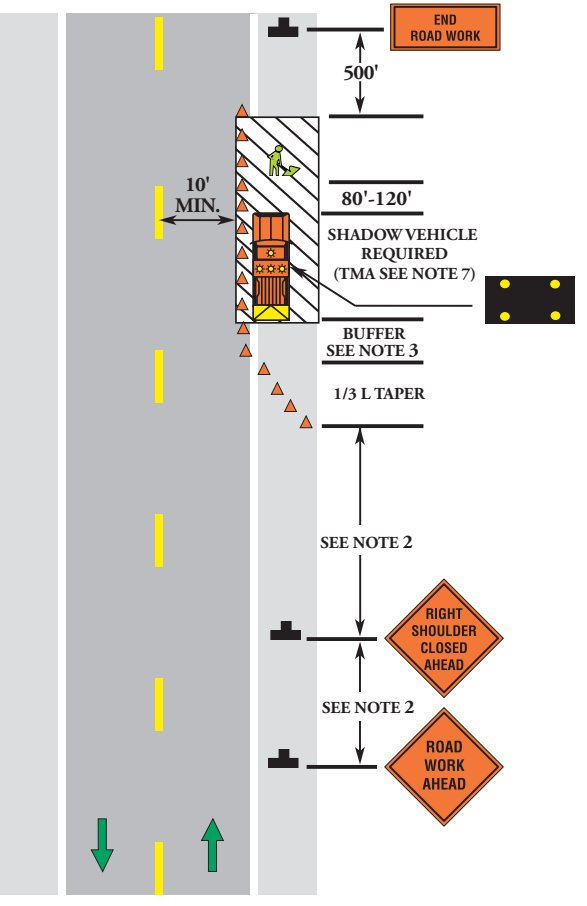
3. For length of the buffer space, see Buffer Space Length Chart on page 14.

4. A vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew.

5. A “UTILITY WORK AHEAD” sign may be used in place of the “ROAD WORK AHEAD”.

6. A truck/trailer-mounted attenuator (TMA) shall be used on the shadow vehicle on Limited Access highways and multi-lane roadways with a posted speed limit equal to or greater than 45 mph.

Shoulder Work With Minor Encroachment - Stationary Operation



Shoulder Work With Minor Encroachment - Stationary Operation

Notes:

1. On divided roadways having a median wider than 8', left and right sign assemblies shall be required.

2. Sign spacing: limited access 1300' - 1500'; posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

3. For length of the buffer space, see Buffer Space Length Chart on page 14.

4. A vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew.

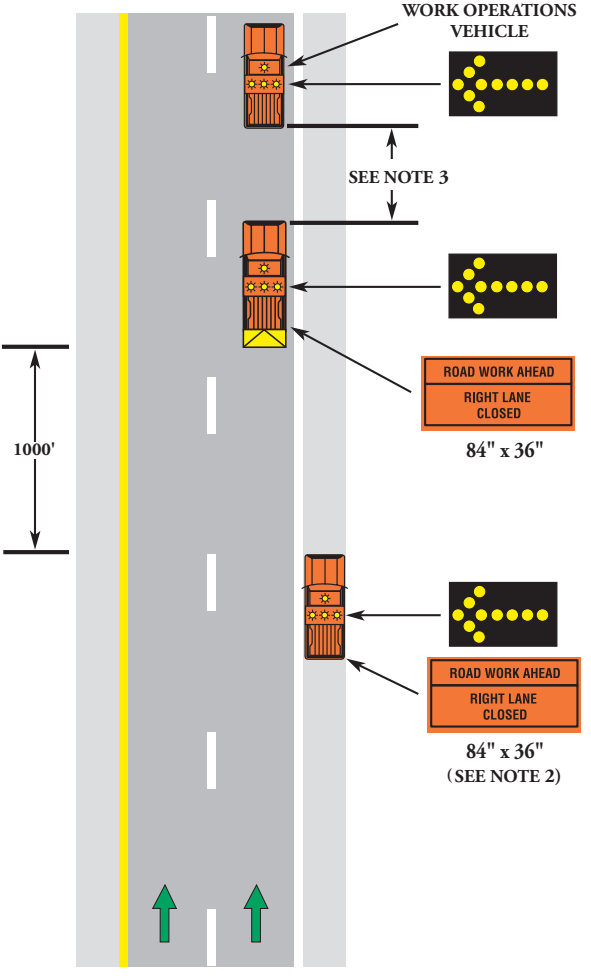
5. A "UTILITY WORK AHEAD" sign may be used in place of the "ROAD WORK AHEAD".

6. Lane widths less than the 10 foot minimum must be approved by the Regional Traffic Engineer.

7. A truck/trailer-mounted attenuator (TMA) shall be used on the shadow vehicle on Limited Access highways and multi-lane roadways with a posted speed limit equal to or greater than 45 mph.

Four-lane Road - Mobile Operation

(15 Minutes or Less in the Immediate Area)



Four-lane Road - Mobile Operation

Notes:

1. Each vehicle involved in the mobile operation shall be equipped with at least one amber high intensity rotating, oscillating, or flashing light. All vehicles shown shall have an arrow panel operating in the flashing arrow mode.

2. If the shadow vehicle occupies any part of the travel lane, it shall have a TMA.

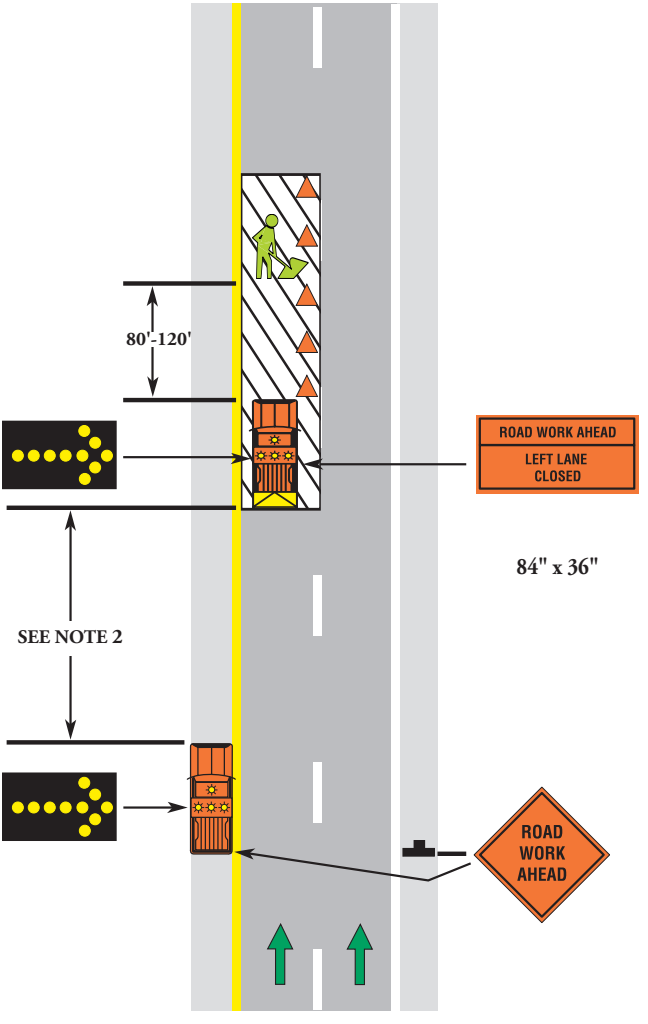
3. When the work operations vehicle is stationary, the TMA vehicle shall be in a position 80' – 120' in advance of the work operations vehicle. When the work operations vehicle is moving, the TMA vehicle shall follow at a distance of 240'±.

4. The static warning sign and arrow board may be replaced with a vehicle mounted changeable message sign (CMS) with a minimum of 10" height characters.

5. On Limited Access highways an additional TMA vehicle (not shown) is required. Shadow vehicle 1 is on the shoulder, TMA vehicle 2 and TMA vehicle 3 are in the closed lane.

Four-lane Road - Non Limited Access Short Duration Operation

(16 Minutes to 60 Minutes in the Immediate Area)



Four-lane Road - Non Limited Access Short Duration Operation

Notes:

1. Each vehicle involved in the mobile operation shall be equipped with at least one amber high intensity rotating, oscillating, or flashing light. All vehicles shown shall have an arrow board operating in the flashing arrow mode.

2. Minimum distance between sign/shadow vehicle and the TMA vehicle should be 350'-500' where the posted speed is 45 mph or less, and 500'-800' where the posted speed is greater than 45 mph.

3. The shadow vehicle on the shoulder may be replaced with a “ROAD WORK AHEAD” sign on low speed, low volume roadways. If the shadow vehicle occupies any part of the travel lane, it shall have a TMA or be replaced with the “ROAD WORK AHEAD” sign.

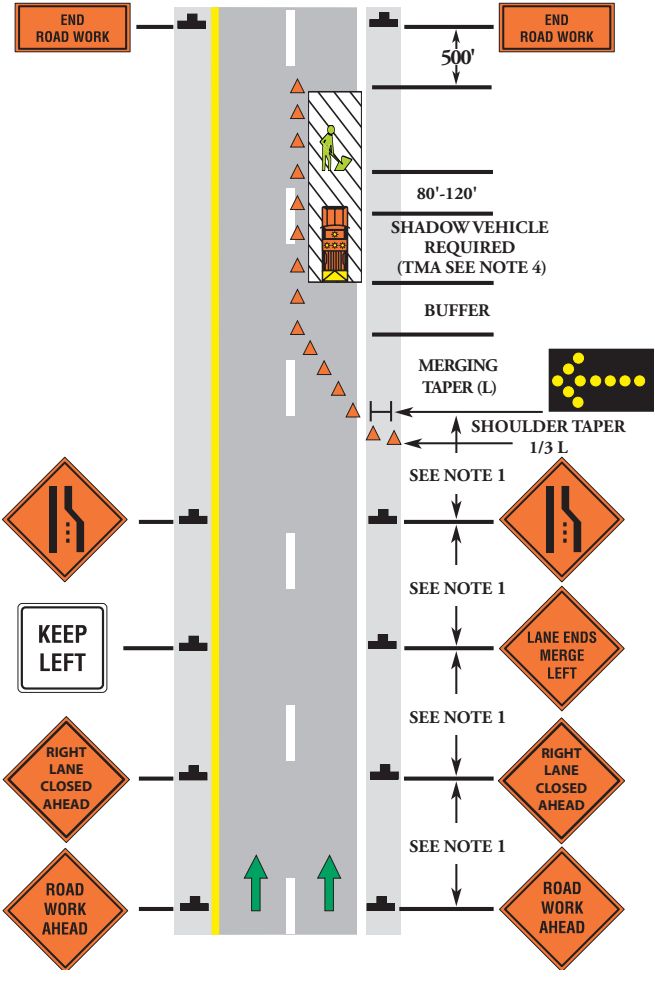
4. A TMA vehicle shall be used in the travel lane.

5. The static warning sign and arrow board may be replaced with a vehicle mounted changeable message sign (CMS) with a minimum of 10" height characters.

6. The work area may be delineate by installing channelizing devices.

Four-lane Road - Stationary Right Lane Closure

(Greater Than 60 Minutes in the Immediate Area)



Four-lane Road - Stationary Right Lane Closure

Notes:

1. Sign spacing: Limited Access highway 1300' - 1500'; posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. For the length of the shoulder taper (1/3 L) and merging taper (L), see Taper Length Chart on page 15.

3. For length of the buffer space, see Buffer Space Length Chart on page 14.

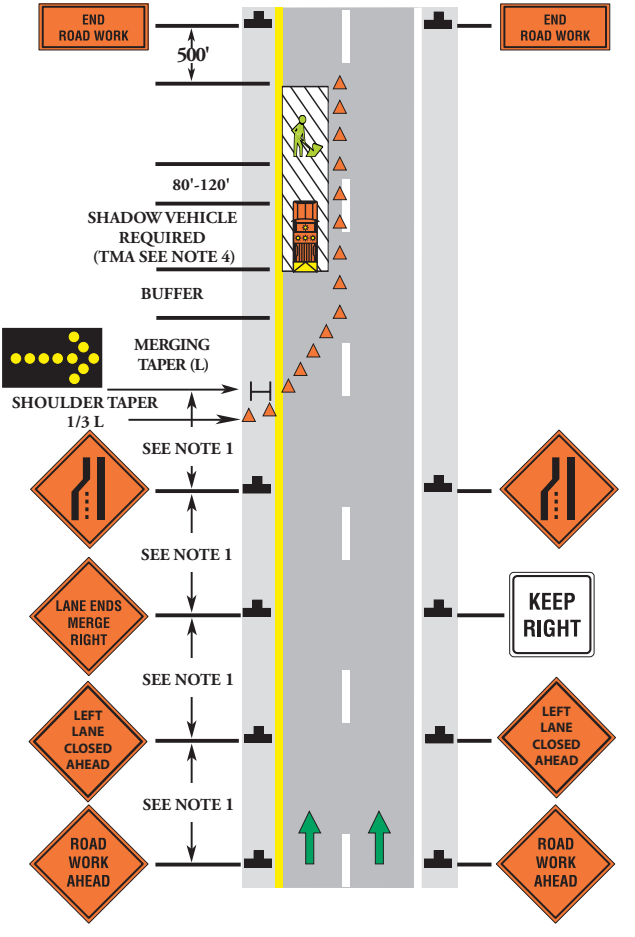
4. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew. When posted speed limit is 45 mph or greater, a TMA shall be used.

5. The flashing arrow board shall be a **Type C** only.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Four-lane Road - Stationary Left Lane Closure

(Greater Than 60 Minutes in the Immediate Area)



Four-lane Road - Stationary Left Lane Closure

Notes:

1. Sign spacing: Limited Access highway 1300' - 1500'; posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. For the length of the shoulder taper (1/3 L) and merging taper (L), see Taper Length Chart on page 15.

3. For length of the buffer space, see Buffer Space Length Chart on page 14.

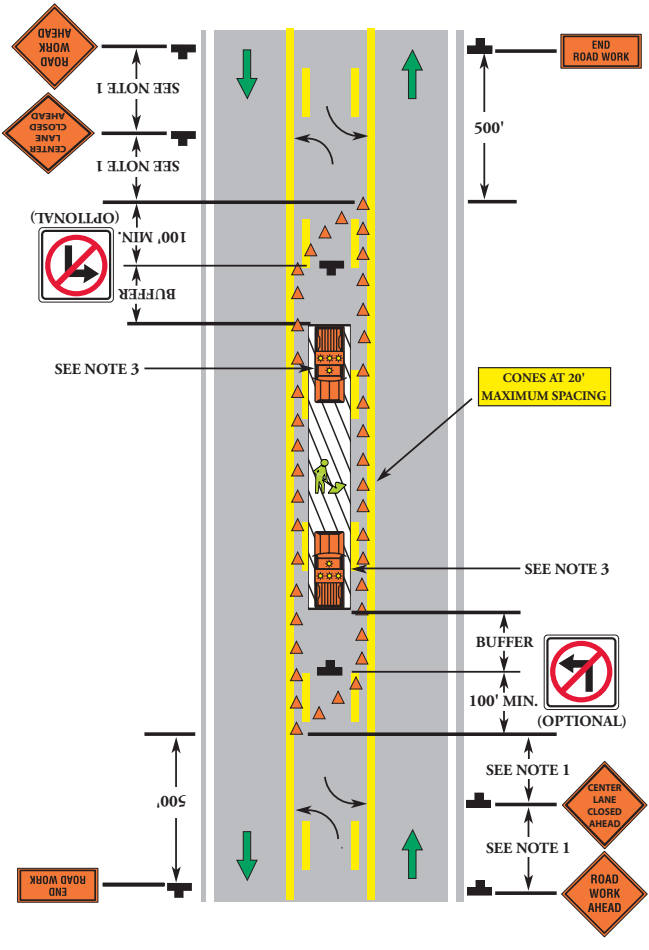
4. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew. When posted speed limit is 45 mph or greater, a TMA shall be used.

5. The flashing arrow board shall be a **Type C** only.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Center Turn Lane Closure on a Three-lane, Two-way Road

(Greater Than 60 Minutes in the Immediate Area)



Center Turn Lane Closure on a Three-lane, Two-way Road

Notes:

1. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

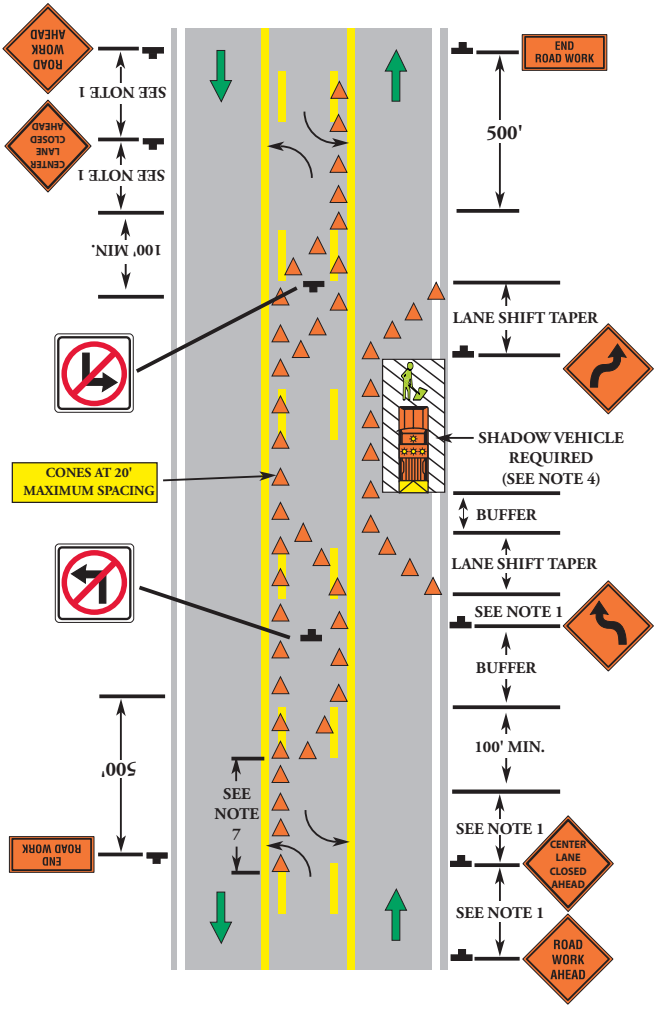
2. To prevent vehicles from turning into the work zone, cone spacing shall be a maximum of 20' on centers.

3. A shadow vehicle with amber high intensity rotating, oscillating, or flashing lights shall be parked 80'-120' in advance of the work crew and shall have a TMA if the posted speed limit is 45 mph or greater.

4. A graphic "NO LEFT TURN" sign should be used within the closed lane.

Lane Shift on a Three-lane, Two-way Road

(Greater Than 60 Minutes in the Immediate Area)



Lane Shift on a Three-lane, Two-way Road

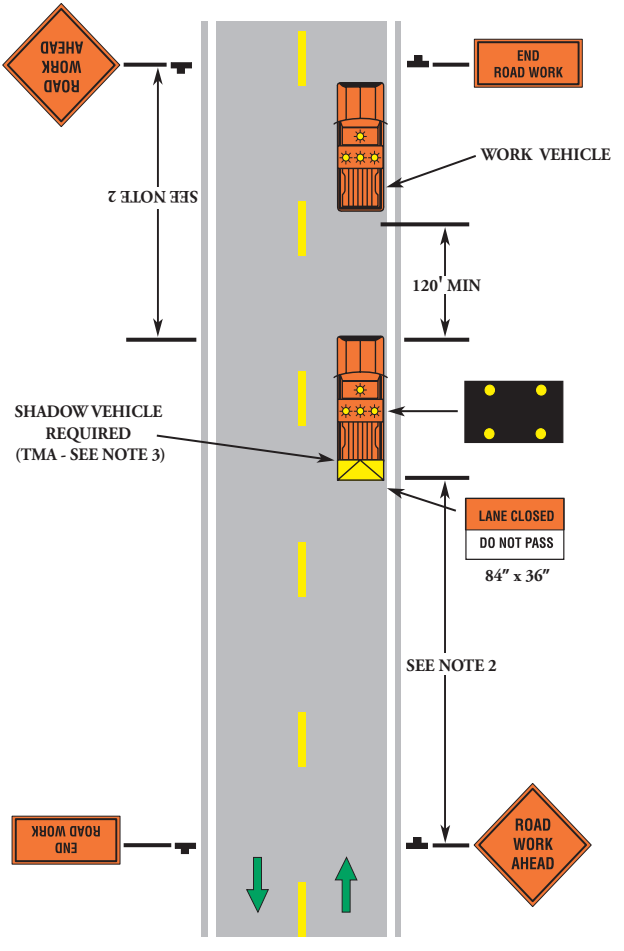
Notes:

1. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.
2. For the length of the lane shift taper, see Taper Length Chart on page 15.
3. For length of the buffer, see Buffer Space Length Chart on page 14.
4. A shadow vehicle with amber high intensity rotating, oscillating, strobe, or flashing lights shall be parked 80'-120' in advance of the work crew and shall have a TMA if the posted speed limit is 45 mph or greater.
5. A graphic "NO LEFT TURN" sign should be used within the closed lane.
6. The two graphic reverse curve/lane shift signs may be replace by a single double reverse curve sign (W24-1) if the distance between the single reverse curve signs is less than 600 feet.
7. 4 Additional channelizing devices for motorist guidance.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Two-lane Road - Mobile Operation

(15 Minutes or Less in the Immediate Area)



Two-lane Road - Mobile Operation

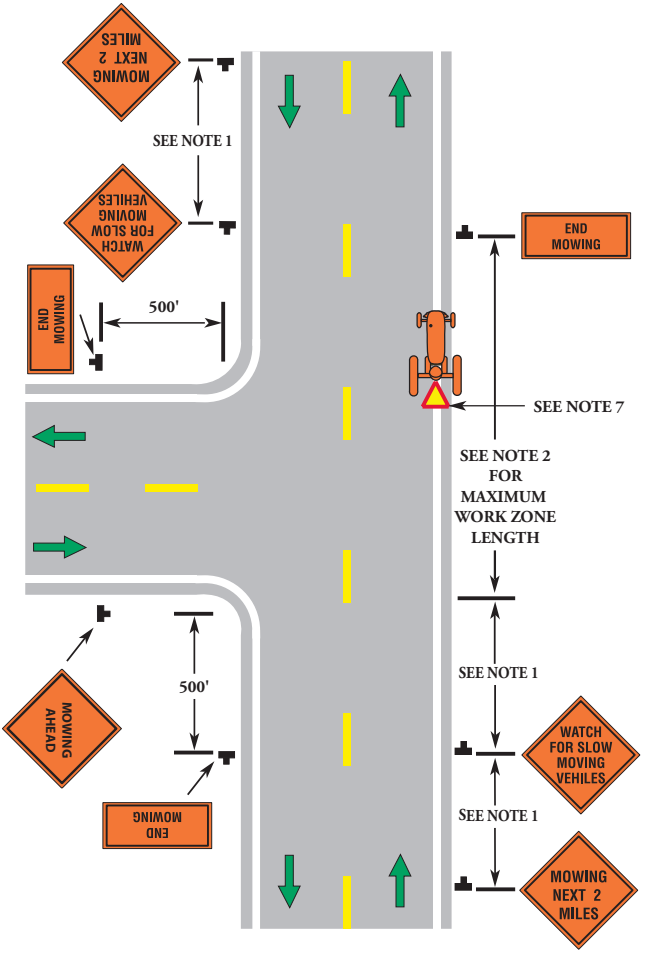
Notes:

1. Each vehicle involved in the mobile operation shall be equipped with at least one amber high intensity rotating, oscillating, or flashing light. **If an arrow board is used, it shall be used in the four corner caution mode.**

2. The minimum distance between the sign and advance warning vehicle should be 350'-500' where the posted speed is 45 mph or less, and 500'-800' where the posted speed is greater than 45 mph. The maximum distance between the sign and the shadow/TMA vehicle is 2 miles.

3. A TMA should be used on the shadow vehicle, located 120' in advance of the operation, other vehicles, or equipment.

Two-lane Road - Mowing With Encroachment



Two-lane Road - Mowing With Encroachment

Notes:

1. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. No more than 2 complete setups (2 miles each) should be exposed to motorist at any one time.

3. Each vehicle involved in the operation shall be equipped with at least one amber high intensity rotating, oscillating, or flashing light.

4. Additional traffic control devices may be required as directed by the VDOT Regional Traffic Engineer.

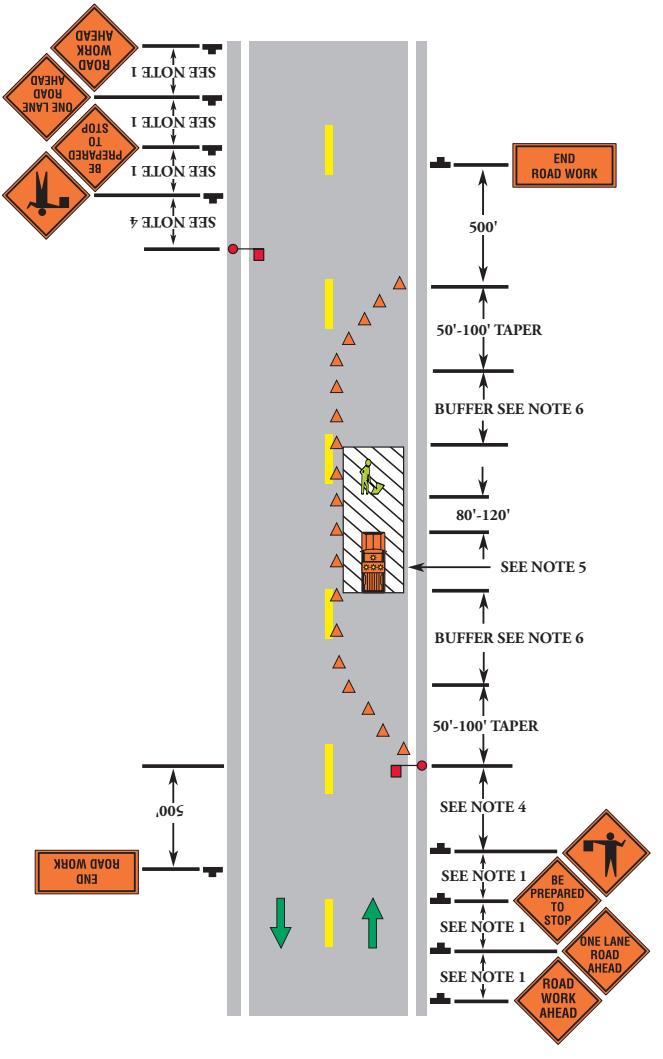
5. If the operation is completely off the travelway, the "WATCH FOR SLOW MOVING VEHICLES" sign may be omitted.

6. Connecting roads entering into the work area shall be signed as shown.

7. **All vehicles traveling at speeds below 25 mph shall display a slow moving vehicle emblem per OHSA regulation 1910.145(d)(10).**

Two-lane Road - Stationary Closure

(Two Flagger Operation)



Two-lane Road - Stationary Closure

Notes:

1. Sign spacing: posted speed greater than 45 mph 500′ – 800′; posted speed 45 mph or less 350′ – 500′; see spacing of signs for urban use on page 6.

2. The cone transition length should be 50′- 100′ in length.

3. **All flaggers shall be state certified and have their certification card in their possession when flagging.**

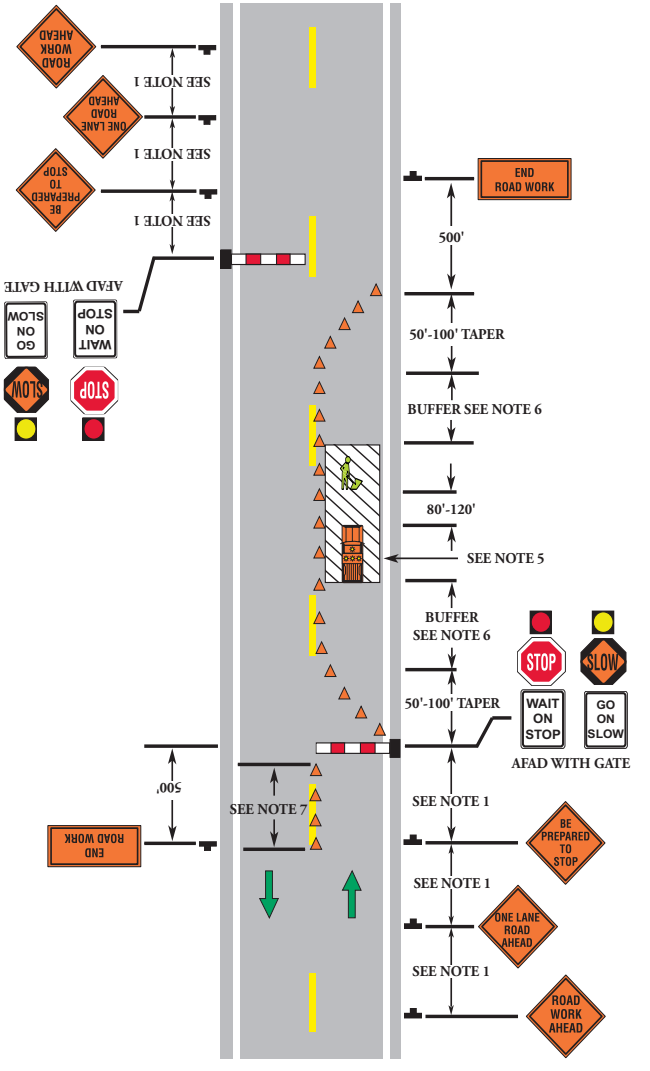
4. Flagging stations should be located with a desired clear site distance in advance of the flagger based on the maximum sign spacing listed in Note 1.

5. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80′-120′ in advance of the first work crew.

6. For length of the buffer, see Buffer Space Length Chart on page 14.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Stop/Slow Automated Flagger Assistance Device (AFAD)



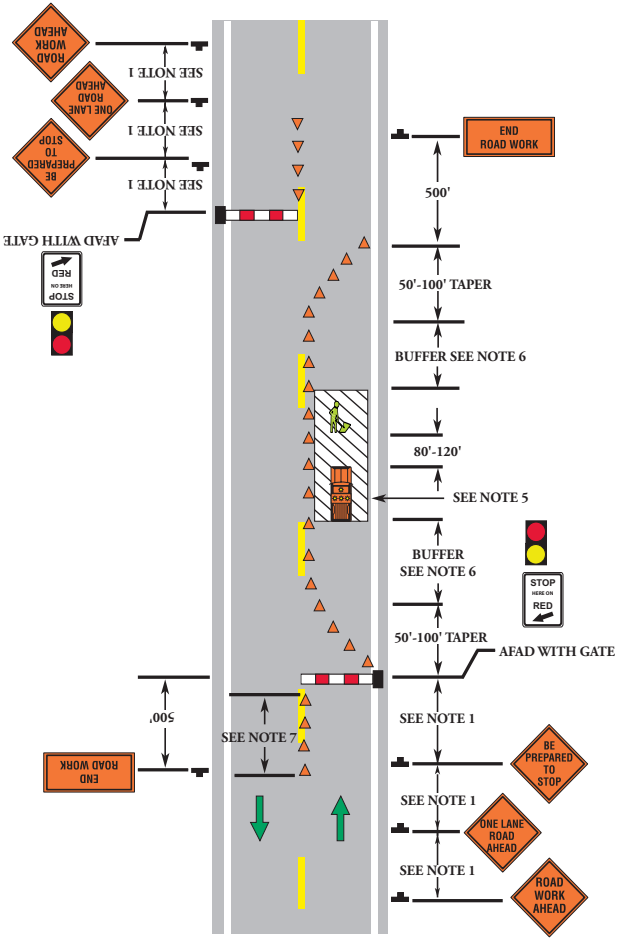
Stop/Slow Automated Flagger Assistance Device (AFAD)

Notes:

1. Sign spacing: posted speed greater than 45 mph 500′ – 800′; posted speed 45 mph or less 350′ – 500′; see spacing of signs for urban use on page 6.
2. The cone transition length should be 50′- 100′ in length.
3. **All AFADs shall be operated by state certified flaggers, with their certification card in their possession, and trained in the operation of the AFAD when flagging.**
4. AFAD stations should be located with a desired clear site distance in advance of the flagger based on the maximum sign spacing listed in Note 1.
5. A shadow vehicle with at least one amber high intensity rotating, oscillating, strobe, or flashing light shall be parked 80′-120′ in advance of the first work crew.
6. For length of the buffer, see Buffer Space Length Chart on page 14.
7. 4 Additional channelizing devices for motorist guidance.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Red/Yellow Lens Automated Flagger Assistance Device (AFAD)



Red/Yellow Lens Automated Flagger Assistance Device (AFAD)

Notes:

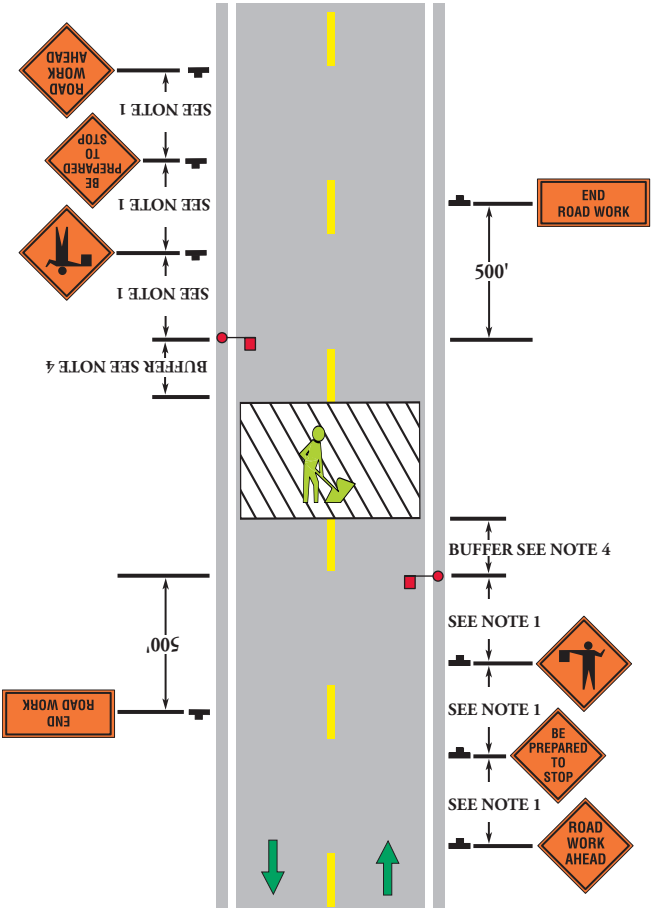
1. Sign spacing: posted speed greater than 45 mph 500′ – 800′; posted speed 45 mph or less 350′ – 500′; see spacing of signs for urban use on page 6.
2. The cone transition length should be 50′- 100′ in length.
3. **All AFADs shall be operated by state certified flaggers, with their certification card in their possession, and trained in the operation of the AFAD when flagging.**
4. AFAD stations should be located with a desired clear site distance in advance of the flagger based on the maximum sign spacing listed in Note 1.
5. A shadow vehicle with at least one amber high intensity rotating, oscillating, strobe, or flashing light shall be parked 80′-120′ in advance of the first work crew.
6. For length of the buffer, see Buffer Space Length Chart on page 14.
7. 4 Additional channelizing devices for motorist guidance.

Cone Spacing

Location	0-35 mph	36+ mph
Transition	20'	40'
Travelway	40'	80'

Two-Lane Roadway - Temporary Disruption

(Not to exceed 20 minutes during the daytime)



Two-Lane Roadway - Temporary Disruption

Notes:

1. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. This application is intended for a planned temporary closure not to exceed 20 minutes during the daytime.

3. **All flaggers shall be state certified and have their certification card in their possession when flagging.**

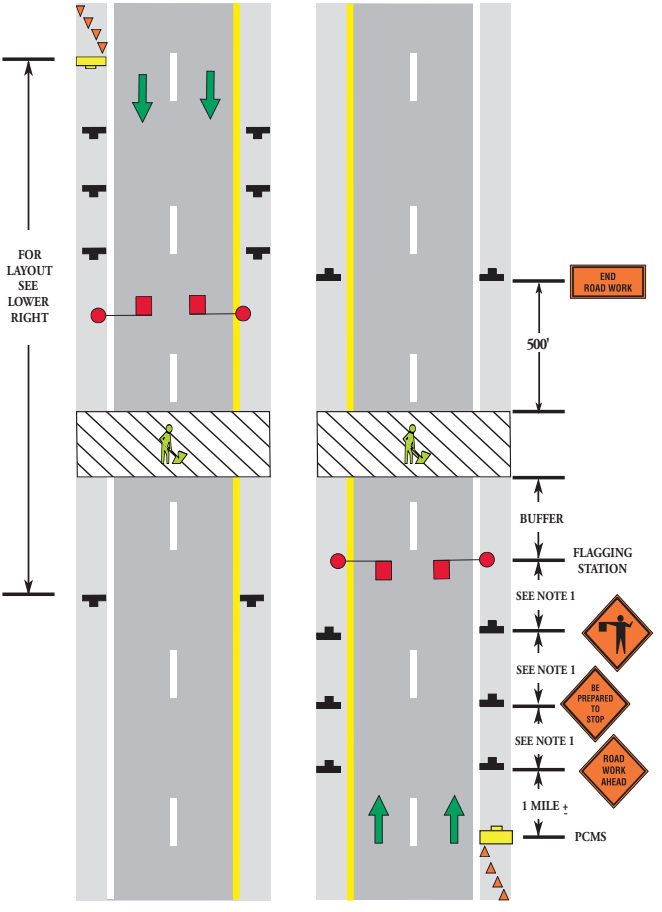
4. For length of buffer, see Buffer Space Chart on page 14.

5. For high volume roads, use of police for traffic stoppage is recommended.

6. Additional traffic control devices may be required.

Multi-Lane Roadway - Temporary Disruption

(Not to exceed 20 minutes during the daytime)



Multi-Lane Roadway - Temporary Disruption

Notes:

1. Sign and flagger station spacing: Limited Access highways, 1300′ – 1500′; posted speed greater than 45 mph 500′ – 800′; posted speed 45 mph or less 350′ – 500′; see spacing of signs for urban use on page 6.

2. This application is intended for a planned temporary closure not to exceed 20 minutes during the daytime.

3. **All flaggers shall be state certified and have their certification card in their possession when flagging.**

4. For length of buffer, see Buffer Space Chart on page 14.

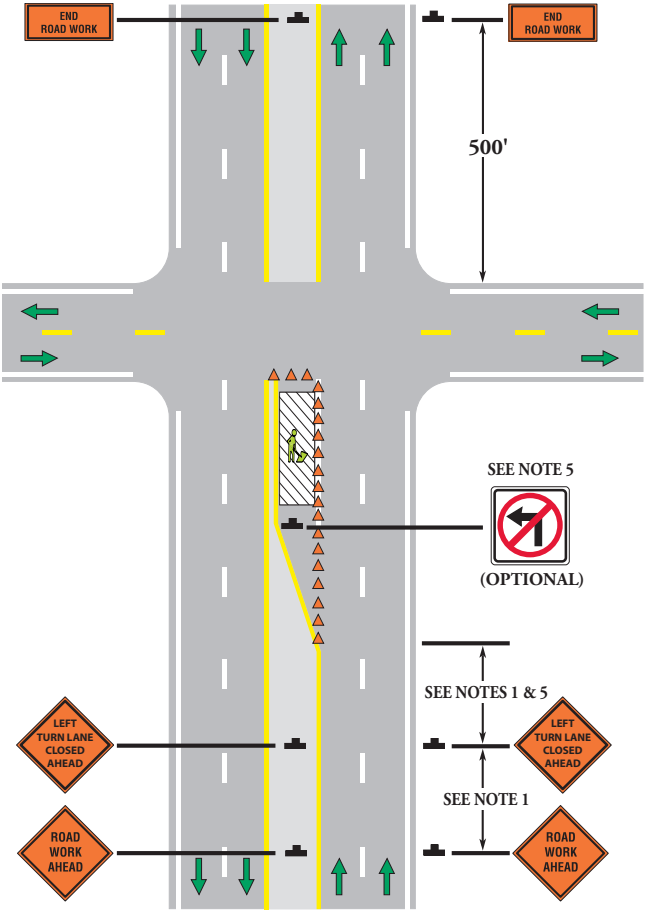
5. For high volume roads, use of police for traffic stoppage is recommended.

6. Additional traffic control devices may be required.

7. A Portable Changeable Message Sign (PCMS) with 4 drum channelizing devices placed in a taper in advance of the PCMS, should be used on Limited Access highways.

Turn Lane Stationary Closure

(Greater than 60 minutes)



Turn Lane Stationary Closure

Notes:

1. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. On divided roadways having a median wider than 8', left and right sign assemblies shall be required.

3. To prevent accidental intrusion into the work area, cone spacing shall not exceed 20' on centers.

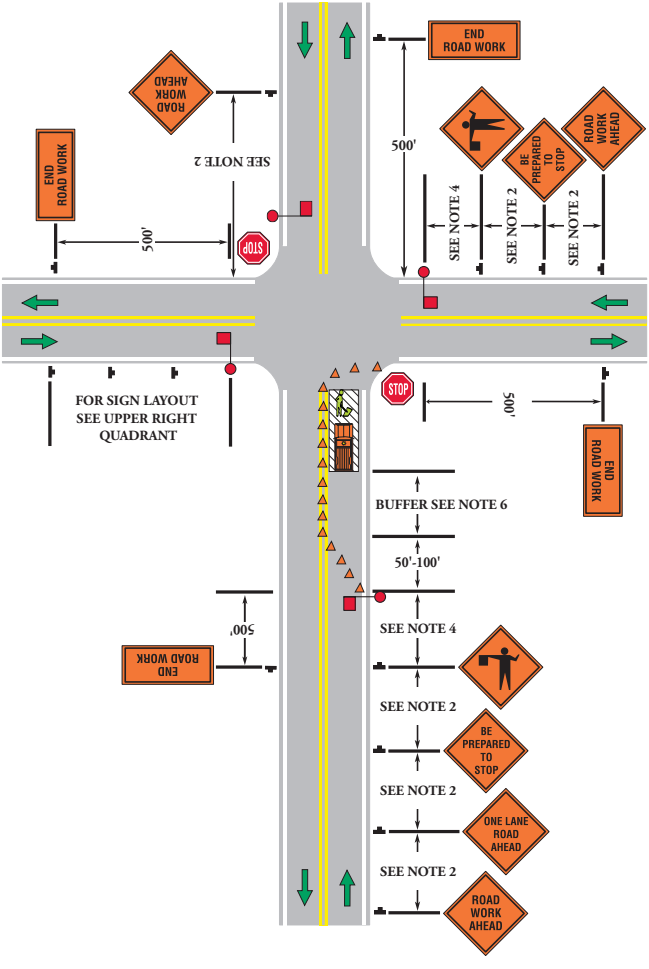
4. This layout may be used for either left or right turn lane closures.

5. For high turning volumes, additional signing may be required.

6. When closing one turn lane in a dual turn lane situation the left/right turn lane closed ahead and no left turn signs are not required.

Lane Closure in Advance of Intersection

(Stop Signs on North/South Approaches)



Lane Closure in Advance of Intersection

Notes:

1. Depending on traffic conditions, additional traffic control, such as flaggers and appropriate signage, may be needed on the cross road approaches.

2. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

3. **All flaggers shall be state certified and have their certification card in their possession when flagging.**

4. Flagging stations should be located with a desired clear site distance in advance of the flagger based on the maximum sign spacing listed in Note 2.

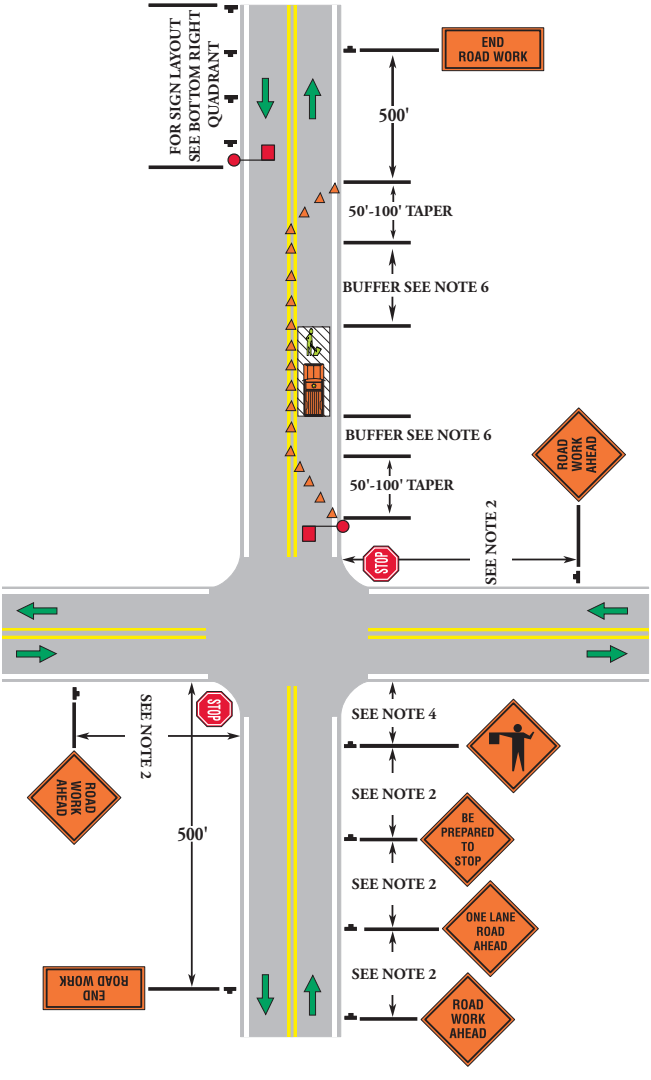
5. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew.

6. For length of the buffer, see Buffer Space Length Chart on page 14.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Lane Closure Beyond Intersection (North/South)

(Stop Signs on East/West Approaches)



Lane Closure
Beyond Intersection (North/South)

Notes:

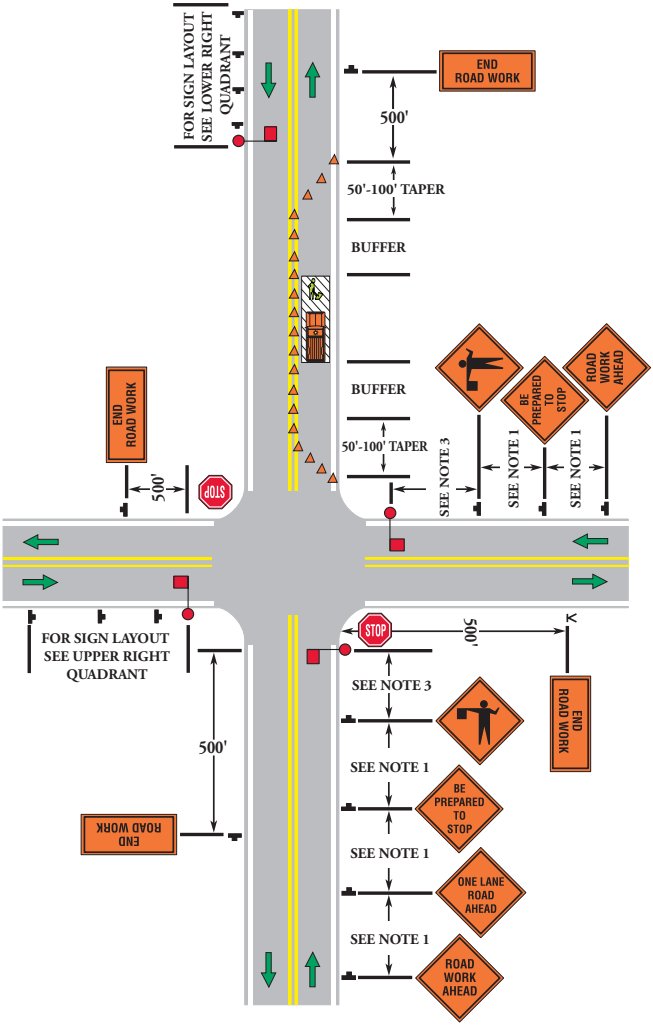
1. Depending on traffic conditions, additional traffic control, such as flaggers and appropriate signage, may be needed on the cross road approaches.
2. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.
3. **All flaggers shall be state certified and have their certification card in their possession when flagging.**
4. Flagging stations should be located with a desired clear site distance in advance of the flagger based on the maximum sign spacing listed in Note 2.
5. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew.
6. For length of the buffer, see Buffer Space Length Chart on page 14.

Cone Spacing

Location	0-35 mph	36+ mph
Transition	20'	40'
Travelway	40'	80'

Lane Closure Beyond Intersection (North/South)

(Stop Signs on North/South Approaches)



Lane Closure
Beyond Intersection (North/South)

Notes:

1. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. **All flaggers shall be state certified and have their certification card in their possession when flagging.**

3. Flagging stations should be located with a desired clear site distance in advance of the flagger based on the maximum sign spacing listed in Note 1.

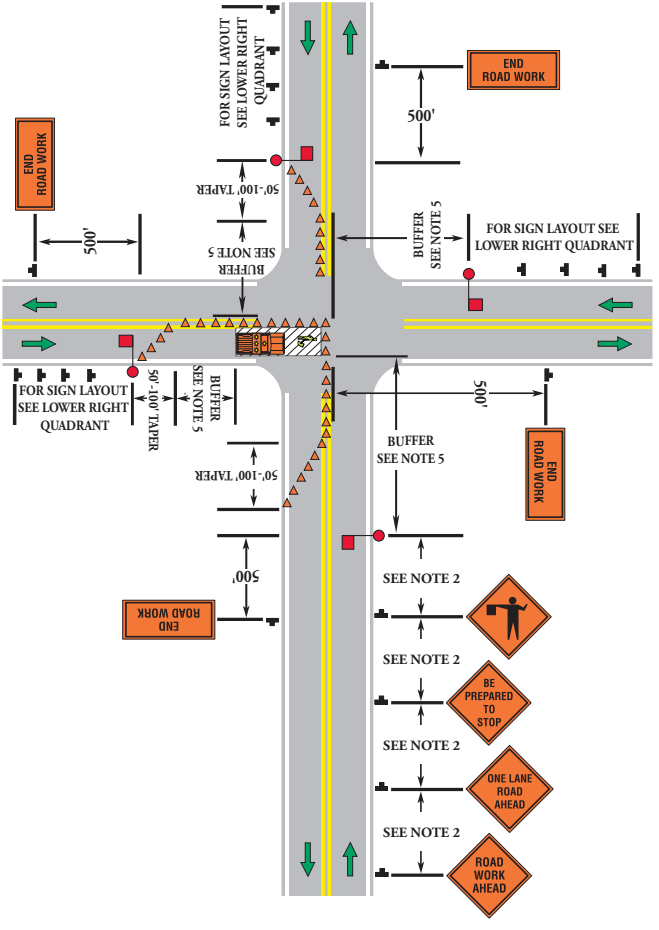
4. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew.

5. For length of the buffer, see Buffer Space Length Chart on page 14.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Closure in Center of Intersection

(Greater than 30 minutes in Duration)



Closure in Center of Intersection

Notes:

1. The control of traffic through the intersection in order of preference:
   A. Obtain the services of law enforcement personnel.
   B. Detour the effective routes to other roads as approved and directed by the VDOT Regional Traffic Engineer.
   C. Use state certified flaggers on each leg of the intersection as shown.

   Appropriate signing, as shown, should be used for law enforcement and flagging operations. See TTC-30 in the *Virginia Work Area Protection Manual*.

2. Sign spacing: posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

3. Cone spacing shall be on 20' spacing or less.

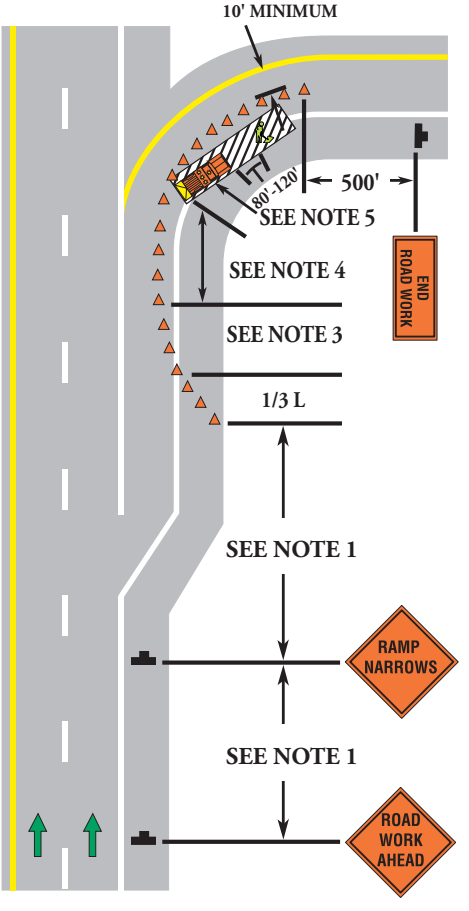
4. For emergency situations of 30 minutes or less duration, appropriate warning and hazard lights on the vehicle and visible for 360°, will be required in addition to channelizing devices around the vehicle.

5. For length of the buffer space, see Buffer Space Length Chart on page 14.

Cone Spacing		
Location	**0-35 mph**	**36+ mph**
Transition	**20'**	**40'**
Travelway	**40'**	**80'**

Partial Ramp Closure Operation

(Greater Than 60 Minutes in Duration)



Partial Ramp Closure Operation

Notes:

1. Sign spacing: limited access 1300' - 1500'; posted speed greater than 45 mph 500' – 800'; posted speed 45 mph or less 350' – 500'; see spacing of signs for urban use on page 6.

2. To prevent accidental intrusion into the work area, cone spacing shall not exceed 20' on centers.

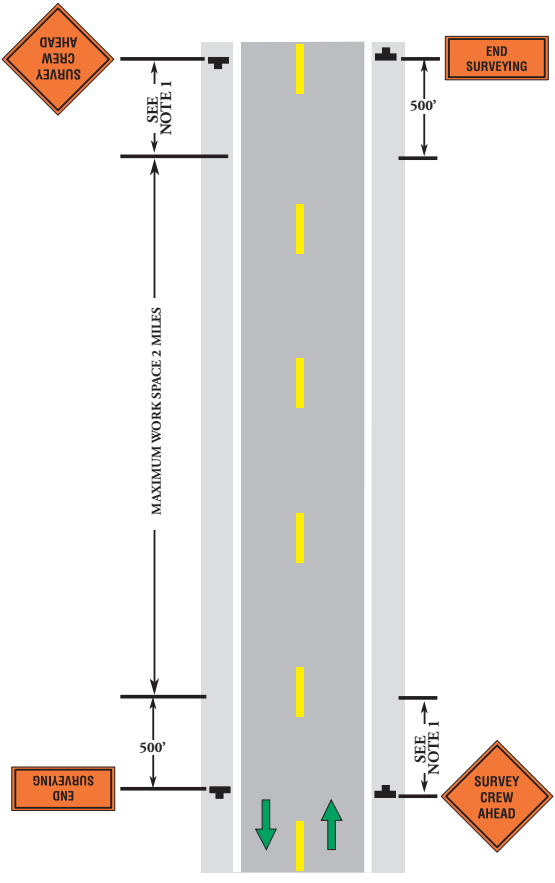
3. Cone Taper Length (L) = actual speed of motorists (S) x width of actual ramp closure (W). [L = S x W] (Example: 270' = 45 x 6)

4. For length of the buffer space, see Buffer Space Length Chart on page 14.

5. A shadow vehicle with at least one amber high intensity rotating, oscillating, or flashing light shall be parked 80'-120' in advance of the first work crew. When posted speed limit is 45 mph or greater, a TMA shall be used.

6. Truck off-tracking should be considered when determining whether the 10 foot minimum lane width is adequate.

Surveying Operations



Surveying Operations

Notes:

1. Sign spacing distance should be 350'-500' where the posted speed is 45 mph or less, and 500'-800' where the posted speed is greater than 45 mph.

2. Each vehicle involved in the surveying operations shall have at least one amber high intensity rotating, oscillating, or flashing light.

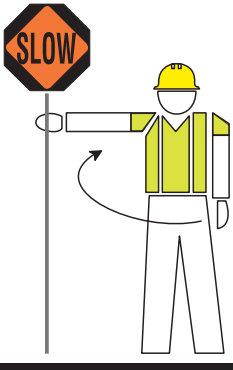
3. Maximum length of the work space is two miles.

4. Surveying operations shall be off the travelway. For encroachment into the travelway, see flagging or lane closure traffic control.

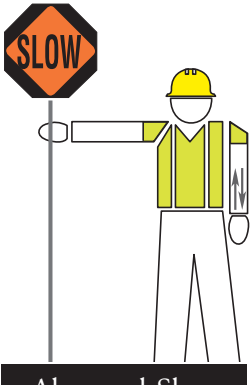
Flagging Procedures

Paddle

Stop Traffic



Traffic Proceed



Alert and Slow Traffic

Notes:

1. To maintain alertness, flaggers should be relieved every two hours for a minimum period of fifteen minutes.

Flagging Procedures

Flagger Qualifications

- Good physical condition, including sight, mobility and hearing
- Skill in communicating specific instructions clearly, firmly and courteously
- Flaggers shall be able to speak in English while performing their job duty as a flagger.
- Courteous but firm manner
- At least 18 years old

(See 6E.01 of the VA WAPM for additional qualifications)

Properly Trained Flaggers

- State certified with certification card on person
- Properly using hand signals with the STOP/SLOW paddle
- Demonstrating clear messages to motorists as shown above
- Coordinated with other flaggers
- Alert and attentive

Properly Equipped Flaggers

- Approved STOP/SLOW paddles:
  - 24" octagonal sign
  - SLOW side fluorescent orange prismatic lens sheeting
  - STOP side red fluorescent lens sheeting
  - Legible and clean
- Five foot minimum height from bottom of sign paddle to roadway
- Approved highly-visibility safety apparel:
  - Retroreflective meeting ANSI/ISEA 107-2010 Class 3 risk exposure for daytime and ANSI/ISEA-2010 Class 3 risk exposure which shall include Type E trousers for nighttime.
- Wearing steel toed safety shoes and hardhats meeting OSHA standards
- Wearing headphones is prohibited

Flagging Procedures (continued)

Proper Flagging Stations

- Good approach sight distance based to the chart below
- Highly visible to traffic
- Positioned away from the work space according to chart below
- Beginning operation from the roadway shoulder
- Never standing in the moving traffic lane
- Standing and flagging alone
- Illuminated at night by a light source producing a minimum of 5 foot candles (50 lux)

Proper Advance Warning Signs

- Always use correct warning signs, in proper order
- Allow reaction distance from signs to work area
- Always remove flagging symbol sign when not at the flagging station

Flagger Station Distance in Advance of the Work Space

The distance from the flagger station to the work space should be as shown in the table below plus the 50 to 100 foot one-lane, two-way taper length.

Posted Speed (MPH)	Distance (Feet)
20 and below	115 – 120
25	155 – 165
30	200 – 210
35	250 – 260
40	305 – 325
45	360 – 380
50	425 – 445
55	500 – 530

Liability

Steps to Minimize Liability

- Have an approved traffic control plan
- Personnel with appropriate work zone traffic control training shall be present during installation, maintenance, and removal of the traffic control devices
- Train all personnel in proper work zone safety techniques
- Follow the latest edition of the *Virginia Work Area Protection Manual* and revisions
- Minimize traffic disruptions
- Inspect work zone sites daily for conformance
- Promptly repair or replace damaged devices
- Promptly remove unneeded devices
- Properly install and remove temporary traffic control devices from the road way
- View the work zone from the road user's perspective (cars, trucks, motorcycles, bicyclists, and pedestrians)
- Keep comprehensive documentation
    - o Written checklist form
    - o Daily diary
    - o Photographs
    - o Video recordings

Daily Checklist

Daily Top Ten Checklist For Temporary Traffic Control		
1	✓	All devices meet specifications and quality standards.
2	✓	All signs properly installed and legible; covered or removed when not needed
3	✓	Arrow displays and PCMS's properly aligned and maintained.
4	✓	Proper taper and buffer lengths established.
5	✓	Channelizing devices are clean, aligned, and properly spaced.
6	✓	Flaggers certified, properly equipped, in the correct location and using hand signals.
7	✓	Temporary barriers and attenuators properly installed and maintained in serviceable condition.
8	✓	Inapplicable traffic control devices removed when not required.
9	✓	Pavement markings in place at end of the work shift.
10	✓	Day and night drive-through inspections conducted and logged or recorded.

Name_____

Notes

Intersection Sight Distance(ISD)- Feet	
Posted Speed (mph)	**Minimum ISD**
20	195
25	240
30	290
35	335
40	385
45	430
50	480
55	530
60	575
65	625
70	670

For a review of all current work zone safety requirements, the *Virginia Work Area Protection Manual* may be accessed at: www.VirginiaDOT.org. Access the Business Center on the VDOT Home Page and click on "Manuals" to open the web page containing the link to the latest edition of the *Virginia Work Area Protection Manual*.

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Acknowledgements

These guidelines were developed by the Virginia Department of Transportation to meet VDOT's requirements for safety in temporary traffic control zones.

For additional information related to these work zone safety guidelines, the *Virginia Work Area Protection Manual* or work zone safety in Virginia, please contact:

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Traffic Engineering Division -
Work Zone Safety Section
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1-800-FOR-ROAD