

PAVEMENT MARKINGS

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7-1.00 INTRODUCTION

7-1.01 Purpose

Pavement markings provide guidance and information to road users. It is MnDOT's mission to provide appropriate pavement markings on all highways 365 days per year.

This chapter gives specific guidelines for the use of pavement markings on the trunk highway system. The Minnesota Manual on Uniform Traffic Control Devices ([MN MUTCD](#)) sets forth general standards for all roads in the state of Minnesota. This chapter outlines preferred practices for Minnesota trunk highways but does not duplicate or violate the standards established in the MN MUTCD. Since the standards for the application of pavement markings set forth in the MN MUTCD must be followed, engineers, technicians, and maintenance personnel responsible for their design, selection, placement, and documentation should have access to and be familiar with the MN MUTCD.

7-1.02 Scope

This chapter covers general procedures for the selection, placement, and installation of pavement markings. Information presented in this chapter includes: (1) types and use of materials, (2) general principles to be followed, (3) links to design details including standards and specifications, and (4) specific use and placement of pavement markings. Not all situations can be addressed; therefore, the pavement marking applications discussed must be considered and applied as directed by engineering judgment.

The major supporting documents for this chapter are the [MN MUTCD](#), the pavement marking typical details, and the [MnDOT Standard Specifications for Construction](#). Individuals responsible for selecting, designing, and installing pavement markings should have access to and be familiar with these reference materials. Technical support is available from the [MnDOT Office of Traffic Engineering \(OTE\)](#).

7-1.03 Chapter Organization

The following section is a glossary of selected terms used in this chapter. The remaining sections of this chapter discuss legal authority, pavement marking materials, pavement marking application guidelines, roundabout markings, preferential lane markings, and reference materials. Work zone traffic control pavement marking practices are found in Chapter 8 of this manual.

7-2.00 GLOSSARY

This glossary defines pavement marking terms that are not covered in the MN MUTCD. For other applicable terms, please see the [MN MUTCD](#), Part 3.

Appropriate Pavement Marking

One that meets or exceeds the standards defined in the MN MUTCD including any minimum levels of retroreflectivity when weather permits. During winter operations, pavement markings should provide a presence after pavement is clear of snow and ice.

Crosswalk Block

White longitudinal lines placed at crosswalks that are parallel to the flow of traffic.

Contrast Marking

A marking with a black border used to enhance contrast with the pavement.

Durable Markings

Marking materials and practices designed to provide a year-round presence and retroreflectivity for at least two years.

Hazardous Waste Disposal

With respect to removal of pavement markings, waste debris created may be toxic (see *Toxics in Specified Products*, below) and/or flammable and require handling and disposal procedures prescribed by waste management laws, rules, and regulations.

Non-Hazardous Waste Disposal

With respect to the removal of pavement markings, non-hazardous waste debris may be disposed of using less stringent criteria. This would make it acceptable at some in-state waste facilities as designated by [MnDOT's Office of Environmental Stewardship](#).

Pavement Markings

All lines, symbols, words, colors, or other devices (except signs and power-operated traffic control devices) set into the surface of, applied upon, or attached to the roadway.

Rumble Stripes

Rumble strips cut into the pavement where the edge line and/or centerline are to be placed. After the rumble strips are ground in, a white or yellow line is marked over the rumble strips.

Sharks Teeth

Triangular shaped markings placed as a yield line.

Toxics in Specified Products

[2014 Minnesota Statutes, Chapter 115A, Section 115A.9651](#) states that "After July 1, 1998, no person may distribute a listed product for sale or use in this state." Subdivision 2(e) states "Listed Metal means lead, cadmium, mercury, or hexavalent chromium." These toxins may be found in older pavement markings, particularly lead and chromium in yellow markings. Non-toxic pavement markings must be specified in contracts and purchases.

Waste Debris

With respect to pavement marking materials, any remnants generated by the removal of pavement markings, including pavement material.

Wet Recoverable

Materials or installation processes that enhance performance of pavement markings during wet weather conditions but still lose retroreflective properties when covered with water. Examples of these include larger glass beads, profiled markings, and rumble stripes.

Wet Reflective

Materials that enhance performance of pavement markings during wet weather conditions and retain their retroreflective properties when covered by water.

7-3.00 LEGALITY**7-3.01 Legal Authority**

[Minn. Stat. Sec. 169.06, Subd. 1-4](#) and [Minn Stat. Sec. 169.07](#) establish the legal authority for MnDOT and local units of government to: (1) place and maintain markings, (2) require obedience to official markings, (3) prohibit the display of unauthorized markings, and (4) prohibit interference with official markings. Markings shall be placed only by the authority of the public body having jurisdiction over the highway, road, or street for the purpose of regulating, warning, or guiding traffic. Pavement and curb markings are all normally within highway, road, or street rights-of-way and, therefore, should never be installed except under public authority.

[Minn.Stat. Sec. 169.18, Subd. 5\(3\)](#) prohibits driving left of the roadway center to pass if a distinctive centerline (~~double solid yellow~~) is marked with a line that prohibits that maneuver, as declared in the [MN MUTCD](#), Part 3.

7-3.02 Responsibility for Placement and Removal

Permanent pavement markings are the responsibility of the governing road authority. These markings may be placed by other agencies with permission. The installation or removal of markings may be performed by maintenance personnel or contractors.

7-3.03 Legal Effect

It is important that correct markings are used since markings have specific meanings defined in law and in the MN MUTCD. The use of inappropriate or conflicting markings could lead to legal claims.

7-4.00 PAVEMENT MARKING MATERIALS

7-4.01 Materials Selection

The basic requirements for pavement markings are: (1) specified colors are identifiable day and night and (2) minimum visibility standards (including retroreflectivity) are maintained throughout the material's lifetime. Factors considered in selecting markings are durability, workability, drying and non-track time, accommodation of heavy traffic volumes, replacement of material, safety, and environmental concerns.

7-4.01.01 Material Life Expectancy

Experience has shown that traffic volumes, pavement maintenance, and snow and ice operations have the greatest impact on the performance of pavement marking materials. Table 7-1, below, outlines the life expectancy of three surface applied materials based on traffic volumes and minimum retroreflective performance values.

| Life Expectancy of Surface Applied Pavement Markings | | |
|---|------------------------------------|---------------------|
| Material | Average Daily Traffic (ADT) | |
| | < 1500 | > 1500 |
| Latex Paint | > 1 year | 1 year |
| Epoxy (Plural Component Liquid) | > 5 years | 3-5 years |
| Preformed Polymer Tape or Thermoplastic | > 5 years | > 5 years |

Table 7-1 Life Expectancy of Surface Applied Pavement Markings

Research has shown that recessing pavement marking materials below the pavement surface can significantly increase the life expectancy of the marking. Examples of recessing techniques would be grooving, inlaying, installing in a sinusoidal rumble strip, slightly raising the traveled lanes (while leaving the marking area recessed), etc. Table 7-2, below, outlines the life expectancy of various materials that have been recessed based on traffic volumes.

| Life Expectancy of Recessed Pavement Markings | | |
|--|------------------------------------|---------------------|
| Material | Average Daily Traffic (ADT) | |
| | < 1500 | > 1500 |
| Latex Paint | > 3 years | 3 years |
| Epoxy (Plural Component Liquid) | > 6 years | 5-7 years |
| Preformed Polymer Tape or Thermoplastic | > 7 years | > 7 years |

Table 7-2 Life Expectancy of Recessed Pavement Markings

7-4.01.02 Retroreflectivity

Pavement markings that must be visible at night shall be reflectorized unless ambient illumination assures adequate visibility. Most pavement markings are reflectorized with the exception of curb and parking lines.

Retroreflectorization, defined as the return of light from a vehicle head lamp to the driver's eye, is accomplished by retroreflective elements (glass, ceramic, etc.) embedded into the marking material. Road grime, salt, dirt, damp or wet conditions, and snow plow damage reduce the retroreflectivity of a marking. Snow plowing, particularly by the under-body plow blade type, can destroy retroreflectivity by shaving or removing the glass beads.

When pavement markings have reached minimum performance levels for retroreflectivity, they should be scheduled for replacement. Measurements of the retroreflectivity of in-place pavement markings can be collected by handheld or mobile retroreflectometers. The protocol for handheld retroreflectometer data collection can be found on the Pavement Markings and Delineation website at: <http://www.dot.state.mn.us/trafficeng/pavement/manual.html>.

The Data Logging System (DLS) and Mobile Retroreflectometer Measurements (MRM) special provisions were created to gather installation data and initial retroreflectivity measurements of the markings on construction projects to ensure that specifications are being met. The data will be collected for pavement marking management.

7-4.01.03 Wet Reflectivity/Recoverability

Wet night visibility is an increasingly important pavement marking issue. Wet reflective and wet recoverable products and processes have been shown to improve visibility of markings in adverse conditions. MnDOT considers wet reflective and wet recoverable products to be comparable in wet weather conditions. MnDOT recommends that pavement markings installed on surfaces with a life expectancy of more than three years be wet reflective/recoverable.

All wet reflective/recoverable materials shall be recessed to ensure continued wet weather performance after snow plowing operations. The materials should be installed as recommended by the manufacturer.

7-4.02 Installation Guidelines

Pavement markings shall be installed in accordance with [MnDOT Standard Specifications for Construction](#) and per the manufacturer's recommendations.

7-4.03 Statewide Provisions

To meet the goal of providing an appropriate marking 365 days per year, the Technical Memorandum "[MnDOT Provisions for Pavement Marking Operations](#)" (Tech Memo 14-11-T-02), which contains guidance for the application of pavement marking materials, has been developed and will be maintained.

All marking materials shall be on [MnDOT's Approved/Qualified Products List](#) and shall be installed according to the manufacturer's specifications. This may include removal of existing pavement markings and other surface treatments as recommended by the manufacturer.

7-4.04 Temporary Markings

Temporary markings are used in construction areas and at locations where a temporary alignment must be properly marked until the necessary repairs or improvements can be made.

The types of temporary pavement markings which are used in Minnesota and their respective characteristics are described in Chapter 8 of this manual. The [MN MUTCD](#), Part 6 should be consulted for interim pavement marking requirements.

7-4.05 Removal of Markings

Markings that are no longer applicable or that may cause confusion for the road user shall be removed or obliterated as to be unidentifiable as soon as practical.

Overly aggressive removal techniques may leave pavement scars that can confuse drivers. Any excessive scarring should be repaired to avoid confusion. Lines and scars from line removal may look different at night. Nighttime inspections are desirable to ensure that pavement markings are visible and understandable under night conditions.

Methods that have typically been used to remove pavement markings include sandblasting, grinding, and high pressure water jets. Whatever method is used, it must effectively remove the marking while at the same time doing the least damage to the pavement. For larger projects, truck-mounted, hydraulically controlled, dual-scarifying drums with built-in vacuum systems should be considered. With this type of system, a trailing sweeper/vacuum unit recovers the coarser paint/surface waste mixture.

Markings may be temporarily masked until they can be removed, obliterated, or uncovered. Markings on bituminous may be masked with black tape. Markings on concrete may be temporarily covered with paint that closely matches the pavement surface.

7-5.00 GENERAL PAVEMENT MARKING APPLICATION GUIDELINES

7-5.01 Purpose

The pavement marking applications that are discussed in this section are those which are not specifically addressed in the MN MUTCD, or those that provide additional guidance to that given in the MN MUTCD. Pavement marking typical details for most situations are published by the Office of Traffic Engineering (OTE) and found on the [Pavement Markings and Delineation](#) website.

7-5.02 Marking Widths and Patterns

Widths and patterns of longitudinal lines are shown below (see also [MN MUTCD](#), Part 3).

A normal width line is defined as 4 inches.

Other widths may be used per designer preference. For example, the use of 6-inch edge lines on rural two-lane roads.

A wide line is defined as 8 inches.

Broken Line Markings (commonly referred to as “skips”).

The Minnesota cycle length for broken line pavement markings is 50 feet. The cycle consists of a 10-foot stripe and a 40-foot gap. For MnDOT striping operations, all new surfaces/overlays shall be striped with the 50-foot cycle. All striping done on existing surfaces shall match the cycle currently in place.

Dotted Line

There are a variety of patterns used in Minnesota for dotted lines. The Minnesota cycle length for a dotted line pavement marking is 15 feet. The cycle consists of a 3-foot stripe and a 12-foot gap. The pattern for dotted lines used as intersection extension lines (commonly referred to as ‘cat tracks’) has a cycle length of 8 feet. The cycle consists of a 2-foot stripe and a 6-foot gap.

See Section [7-6.00](#) for patterns to be used in roundabouts.

7-5.03 No-Passing Zone Markings

7-5.03.01 Warrants - Minimum Passing Sight Distance

A no-passing zone is warranted when the minimum passing sight distance is less than the distances shown in [Table 7-3](#). No-passing zone surveys shall be run at an eye height of 3.5 feet to an object height of 3.5 feet at the sight distance required based upon the 85th percentile speed or the posted or statutory speed limit. The beginning of a no-passing zone shall be the point at which the sight distance first becomes less than that specified in [Table 7-3](#). The end of the no passing zone shall be that point at which the sight distance becomes greater than the minimum specified in [Table 7-3](#). See [MN MUTCD](#) Table 3B.1 for latest version.

| Minimum Passing Sight Distances for No-Passing Zone Markings | |
|---|---------------------------------------|
| 85th Percentile or Posted or Statutory Speed Limit | Minimum Passing Sight Distance |
| MPH | Feet |
| 25 | 450 |
| 30 | 500 |
| 35 | 550 |
| 40 | 600 |
| 45 | 700 |
| 50 | 800 |
| 55 | 900 |
| 60 | 1000 |
| 65 | 1100 |
| 70 | 1200 |

Table 7-3 Minimum Passing Sight Distances for No-Passing Zone Markings

7-5.03.02 Minimum Length of No-Passing Zone

A no-passing line should not be less than 500 feet in length unless it is in advance of a stop condition as specified in Table 7-4 below or as specified in a particular figure.

| Minimum Length of a No-Passing Zone in Advance of a Stop Condition | | |
|---|-----------------------|--------------|
| 85th Percentile or Posted or Statutory Speed Limit MPH | Minimum Length | |
| | Feet | Yards |
| 0-30 | 300 | 100 |
| 40-50 | 400 | 133 |
| 55 or greater | 500 | 167 |

Table 7-4 Minimum Length of No-Passing Zone in Advance of a Stop Condition

7-5.03.03 Minimum Distance Between No-Passing Zones

If the distance between two no-passing zones is less than that specified in Table 7-5 below, the no-passing lines should be connected to provide a continuous restriction through both zones. If a re-survey of an existing no-passing zone is done and it changes in length, the NO PASSING ZONE pennant does not have to be relocated if the new terminus is within 100 feet of the sign.

| Minimum Distance or Gap Between No-Passing Zones | | |
|---|-----------------------|--------------|
| 85th Percentile or Posted or Statutory Speed Limit MPH | Minimum Length | |
| | Feet | Yards |
| 20-39 | 500 | 167 |
| 40-54 | 650 | 217 |
| 55 or greater | 800 | 267 |

Table 7-5 Minimum Distance or Gap Between No-Passing Zones

7-5.03.04 No-Passing Zone Survey Procedures

Work Zone Traffic Control

The first step in any surveying operation is work zone traffic control. Typically, work zone traffic control for executing a no-passing zone survey is considered a mobile operation. For the two-vehicle method described below, this implies that workers are not typically stopped on the road for more than 15 minutes and traffic control devices are vehicle mounted. [MN MUTCD](#), Section 6K, (the Field Manual), Layout **11 5** is a typical minimum treatment. [MN MUTCD](#), Section 6K (the Field Manual), Layout **8 2** is a higher level of treatment that could be used if the road has challenging geometry. Ideally, surveys should be scheduled for the lowest volume time periods. Higher Average Daily Traffic (ADT) volumes, narrow shoulders, or intense geometric changes may require additional traffic control measures that could include advance road signs, shadow vehicles, and/or lane closures in order to protect survey workers and the motoring public. These impacts should be assessed and appropriate work zone treatments scheduled to coincide with the no-passing zone survey.

Two-Vehicle Method

There are several methods for locating the beginning and end points of no-passing zones. A discussion of various methods can be found in the ITE Traffic Control Devices Handbook, Chapter 9, pg. 290 (2013). An efficient and accurate method frequently used is the two-vehicle method whereby two vehicles strategically move through the section of road to be surveyed marking the beginning and end points of the no-passing zone.

Using this method, one vehicle moves the required minimum passing sight distance ([Table 7-3](#)) ahead of the other vehicle. Maintaining this distance, both vehicles drive through the section of road to be measured. When the driver of the rear vehicle loses sight of a target mounted on the front vehicle, a mark is painted on the roadway that indicates the beginning of the no-passing zone. Continuing forward, when the target on the front vehicle reappears, a mark is painted on the roadway indicating the end of the no-passing zone. Given the slow vehicle pace necessary to conduct this type of study, care must be taken when locating no-passing zones to see that traffic does not become confused or congested. Both vehicles should pull over onto the shoulder when the rear driver notices cars being held back.

Equipment Needed

If possible, two intermediate sedan-sized vehicles should be used. The trailing vehicle should be at least an intermediate sized sedan with a driver's eye height near the 3.5-foot mark.

The vehicles should be equipped with the following:

- Two-way radios (for driver communication to verify distances).
- Calibrated distance measuring instruments (DMIs). Note that DMI's are calibrated at correct tire pressures - both vehicle tire pressures should be verified.
- Flashing amber lights.
- A target for eye height mounted on the lead vehicle.

The target is typically mounted on the rear of the vehicle on the driver's side, and should be mounted so the top of the target is at 3.5 feet. The target should be a bright color different than the vehicle so that a sharp cut off can be observed from 1000 feet. A 4-inch 12-volt LED light from an arrow board can also be a good target. Do not use white lights. Minnesota law prohibits bright white lights projecting from the rear of a vehicle while traveling.

- Height-of-eye paddles to assist in unusual geometry.

Setting the Minimum Sight Distance Interval

The following section details the process for determining minimum sight distance intervals.

1. Both cars should park abreast on the roadway or shoulder with both DMIs set at 0.000.
2. The lead vehicle then moves forward to the minimum passing sight distance for the speed indicated ([Table 7-3](#)), stops, and resets the DMI to 0.000. The vehicles are now deployed with the appropriate minimum sight distance between them.
3. Both vehicles then move forward making sure that they maintain the correct distance apart. One way this can be accomplished is by the lead vehicle observer calling off feet via the two-way radio often enough to keep identical readings on the DMIs. To practice this procedure, readings should be called off every 100 feet with the vehicles traveling at approximately 5 mph. With added experience this speed may be increased. If identical readings cannot be maintained, the trailing vehicle should have a lower reading. This will result in the vehicles being farther apart than required. The vehicles should not be backed up to adjust the spacing unless the DMIs being used are capable of operating backwards.
4. Curves - most vertical curves can be surveyed from the shoulder. Horizontal curves should be sighted from near the centerline.

Marking the Beginning and End of a No-Passing Zone

1. While taking measurements, the driver of the trailing vehicle should stop both vehicles just before the lead vehicle goes out of sight. The trailing vehicle can then move up to obtain identical DMI readings.
2. From this point, each vehicle will move forward 50 feet, stop, then move another 50 feet until the target on the lead vehicle goes out of sight over the crest of a hill or is obscured by obstructions along the roadside on horizontal curves. With practice, a team may be able to move continuously and stop only when the lead vehicle goes out of sight.
3. When the lead vehicle's target disappears, both vehicle operators should mark the pavement with spray paint or by some other method. The trailing vehicle operator should mark to the right of the centerline and the leading vehicle to the left. The trailing vehicle marks represent the beginning and end of the no-passing zone for vehicles traveling in the direction of the study. The lead vehicle marks will represent the no-passing zone for the opposite direction of travel. For spotting symbols see [Figure 7-1](#).
4. The two vehicles should then proceed forward with identical DMI readings until the driver of the trailing vehicle sees the top of the lead vehicle. Both vehicles are stopped and the trailing vehicle is moved forward to obtain identical DMI readings. Then both vehicles should move forward 50 feet, and stop to determine if the target has re-appeared. This "stepping" is repeated until the target re-appears.
5. Both drivers should then stop and mark the roadway. The lead driver marks on the left of the centerline and the trailing driver marks on the right of the centerline ([Figure 7-2](#)).

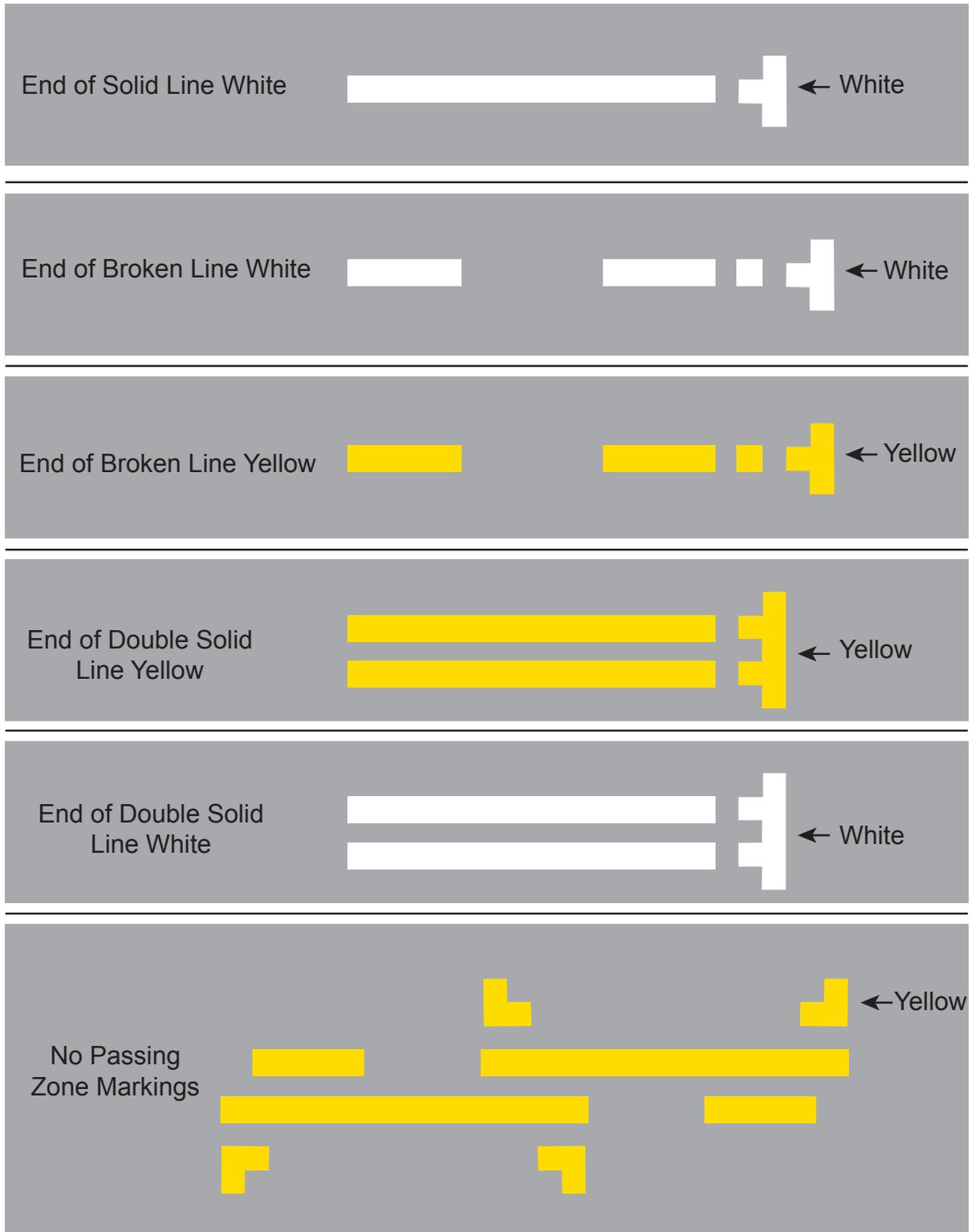


Figure 7-1 Spotting Symbols for Pavement Striping

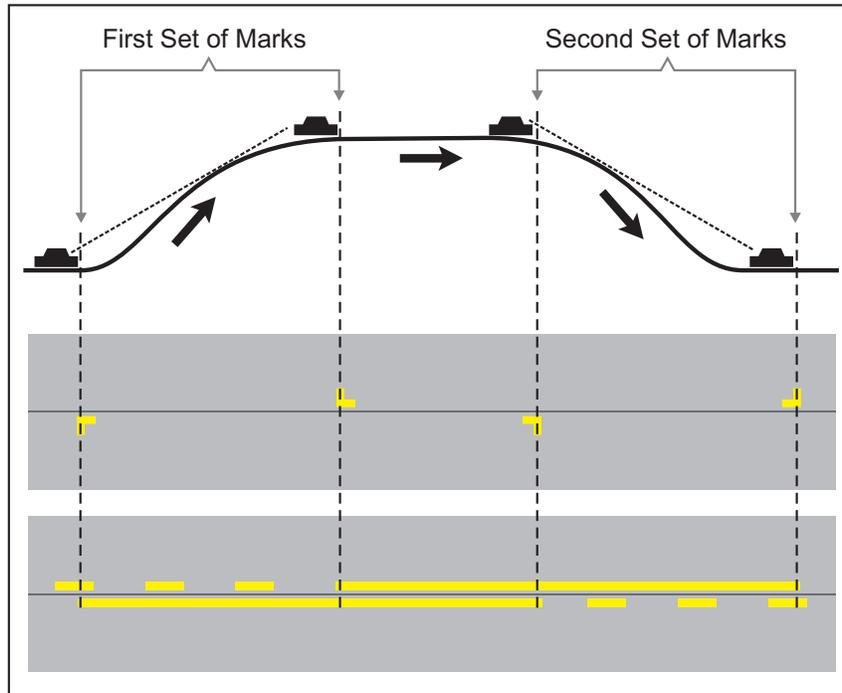


Figure 7-2 Establishing Marks for Identifying No-Passing Zone Locations

Obstructions and Depressions Causing “Lost” Vehicles

It is possible for vehicles positioned in between the study vehicles to become lost in depressions even though vehicles are spaced the minimum sight distance apart and the drivers may see each other. Reverse horizontal curves can create similar situations (Figure 7-3).

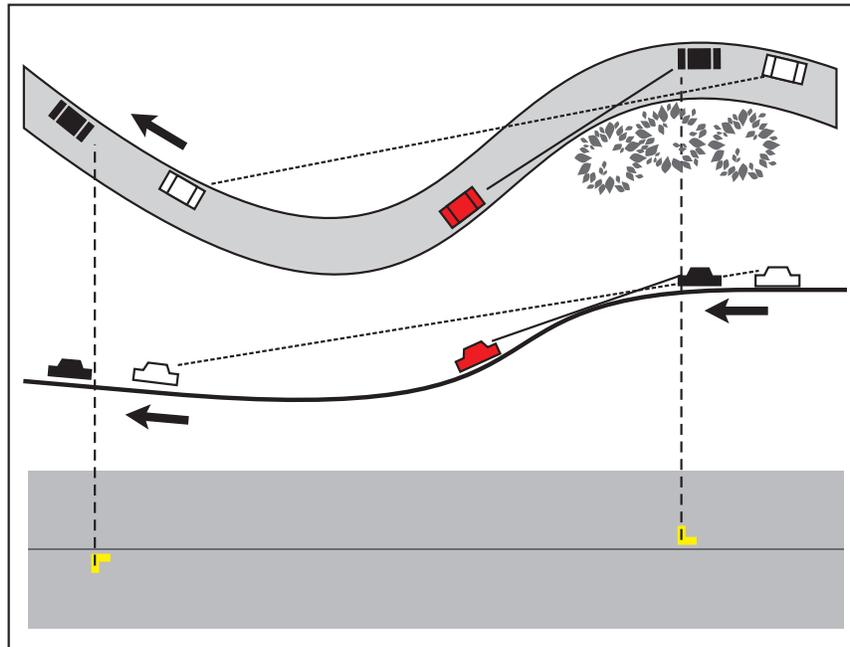


Figure 7-3 How Obstructions and Depressions Cause Vehicle to Become “Lost”

Procedure suggested for “Lost” Vehicles in Roadway Depressions

The following procedure is suggested for handling lost vehicle situations in roadway depressions.

1. The driver of the lead vehicle estimates where the low point of a depression is and stops there.
2. The trailing vehicle then moves forward until the target on the lead vehicle is in sight. If it is noted by the trailing driver that other on-coming vehicles continue to become lost, the trailing vehicle must move forward to a point where the driver does not lose an on-coming car in the depressions.
3. At this point, a spot should be marked to the right of the centerline by the trailing vehicle's driver.
4. With the trailing vehicle stopped, the lead vehicle then moves forward so it has a DMI reading identical to the trailing vehicle and marks a spot to the left of the centerline. The two vehicles are now synchronized and may proceed with the study.
5. If traffic volumes are high enough, the trailing vehicle can use oncoming cars to spot depressions sighting both headlights instead of the target on the lead vehicle. The trailing driver would then radio this reading to the lead driver to re-synchronize the vehicles.

Procedure suggested for “Lost” Vehicles in Horizontal Curves

The following procedure is suggested for handling lost vehicle situations in horizontal curves.

1. Ideally, sight lines should be made from the wheel path nearest the centerline or on the centerline. Drivers may have to exit their vehicles and use the height-of-eye paddles ([Figure 7-4](#)).
2. Multiple horizontal curves in a row or compound curves will probably have to be driven in both directions to verify accurate placement.
3. The minimum passing sight distance used during the study should be changed to accommodate changes in the speed limit. This may require changing passing sight distances while in a no-passing zone. If there is any doubt, the longer of the two distances should be used. It is advisable to drive these situations in both directions to confirm placement.

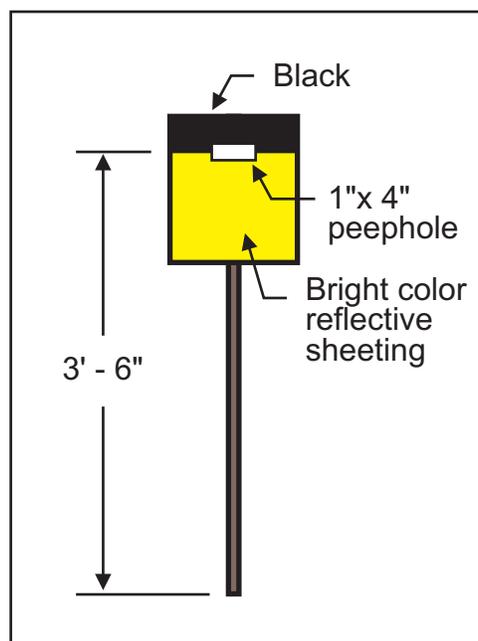


Figure 7-4 Height-of-Eye Paddle

Connecting No-Passing Zones

Range finders will help in determining if no-passing zones should be connected. If at the end of a potential zone, the trailing operator sees a stop sign ahead, the operator can target the stop sign and get a reading. If that reading is less than the distance in [Table 7-4 Minimum Length of No-Passing Zone in Advance of a Stop Condition](#), plus the gap distance shown in [Table 7-5 Minimum Distance or Gap Between No-Passing Zones](#), then a mark should not be made at the end of the zone until reaching the intersection. Similar range finding techniques can be used to assist in placement of zones in advance of bridges, RR crossings, and medians. The use of temporary pavement tape for spotting marks can also be a time saver in challenging alignment where many gaps need to be connected. The tape can be easily pulled off the pavement without scarring or causing black paint erasure marks.

Final No-Passing Zone Adjustments

Before final no-passing zones are marked on the pavement, minor adjustments may be made to survey data so that the marking of sight restrictions of short duration are either extended to 500 feet (0.095 mile) or disregarded altogether. If extended, the addition shall be made to the beginning of the zone. Before a sight restriction of less than 500 feet is either installed or disregarded, close field examination shall be made, checking to see if the target is completely out of sight for approximately 2 seconds at the prevailing speed. If the target vehicle does not go completely out of sight, the no-passing zone may be disregarded.

Sound judgment must be exercised by the no-passing zone crew leader, taking into consideration distance traveled and time elapsed during the sight restriction and weighing these factors against the time which both drivers have to observe each other prior to reaching the sight obstruction. If doubt exists, the no-passing zone should be marked to a minimum of 500 feet.

A No Passing Zone Study spreadsheet that may be used to log the placement and type of no passing zones can be found on the [Traffic Engineering Plans and Special Provisions](#) website.

7-5.03.05 Removal of Sight Obstructions

When minor maintenance activity can be performed to remove sight obstructions, a request explaining the obstruction shall be sent to the appropriate maintenance area for action. Requests for removal(s) of sight obstructions should normally be limited to work needed to avoid extending a no-passing zone.

7-5.03.05 Standard Spotting Procedure

A standard practice of the department is to “spot” or mark guidelines to ensure proper placement of pavement markings. A traffic technician, survey crew, or contractor does the spotting with spray paint. Spotting symbols (shown in [Figure 7-1](#)), are used when spotting for striping. The color of the symbol should match the color of the stripe to be painted.

7-5.04 Centerline Markings

Stopping centerline markings at intersections is based on engineering judgment. Centerlines should be stopped at intersections that include crosswalks.

7-5.05 Lane Line and Channelizing Line Markings

7-5.05.01 General

The Minnesota cycle length for broken line pavement markings is 50 feet. The cycle consists of a 10-foot stripe and a 40-foot gap (see [MN MUTCD 3A.6](#)). For MnDOT striping operations, all new surfaces/overlays shall be striped with the 50-foot cycle. All striping done on existing surfaces shall match the cycle currently in place.

The Minnesota cycle length for a dotted line pavement marking is 15 feet. The cycle consists of a 3-foot stripe and a 12-foot gap (see [MN MUTCD 3B.4](#)).

7-5.05.02 *Interchange Exit and Entrance Ramps* (See also [MN MUTCD](#) 3B.4)

Typical pavement markings for interchange ramps are shown in the pavement marking typical details. It should be noted that wide line width gore markings are used at all entrance and exit ramps.

7-5.05.03 *Auxiliary Lanes and Lane Drops* (See also [MN MUTCD](#) 3B.4)

Wide width dotted lane lines are used to designate auxiliary lanes and lane drops.

7-5.05.04 *Turn Lanes*

A solid white lane line is used to separate adjacent lanes from dedicated turn lanes. Lane use arrows should be used, unless a dotted extension of the lane line through the taper is used. For turn lanes located within a curved alignment, a dotted extension of the lane line through the taper may be used to delineate the through movement.

7-5.05.05 *Bypass Lanes at Intersections*

Bypass lanes at intersections should be marked with wide dotted lane line markings. A no-passing zone section should continue 500 feet on either side of intersections with bypass lanes. For rural intersections, no-passing zone striping at intersections with bypass lanes is at the discretion of the District Traffic Engineer.

7-5.05.06 *Truck Climbing Lanes*

Truck climbing lanes should be delineated by normal width broken lines.

7-5.05.07 *Truck Stopping Lane*

Pavement markings for truck stopping lanes are shown in the pavement marking typical details.

7-5.05.08 *Free Right Conditions*

Pavement Markings for free right conditions are shown in the pavement marking typical details.

7-5.05.09 *Bicycle Lanes*

See the [MN MUTCD](#), Chapter 9 - Traffic Controls for Bicycle Facilities and the MnDOT Bikeways Facility Design Manual found on the [Bicycling Design and Engineering](#) website.

7-5.06 **Edge Line Markings**

Edge line markings are used extensively by MnDOT. Six inch edge lines are installed where other safety countermeasures are not already in place, as recommended by Technical Memorandum "[Provisions for Pavement Marking Operations.](#)" dated October 30, 2014. Edge line markings should not be continued through intersections or major driveways. Major driveways are defined as access points that are controlled with a traffic control device. Edge line markings may be excluded, based on engineering judgment, for reasons such as the traveled way edges are already delineated by curbs, parking, or other markings. If the shoulder width is such that it could be used as a driving lane, edge line markings should be used.

7-5.07 **Extensions through Intersections** (See also [MN MUTCD](#) 3B.8)

Minnesota's typical pattern for line extensions through intersections is a 2 foot normal width line with a 6 foot gap.

7-5.08 Lane Reduction Markings

As stated in the [MN MUTCD](#), Part 3B.20, except on low-speed urban roadways where curbs clearly define the roadway edge in the lane-reduction transition, or where a through lane becomes a parking lane, lane-reduction transition arrow markings should be used to guide traffic through transition areas where the number of through lanes is reduced.

7-5.09 Raised Pavement Markers (RPMs)

Raised pavement markers are not used in permanent situations in Minnesota due to snow and ice operations and safety concerns. Temporary raised pavement markers are used in work zones, as described in Chapter 8 of this manual.

7-5.10 Transverse Pavement Markings

7-5.10.01 Stop Lines

Use stop lines to emphasize stopping location. Stop lines shall extend across all approach lanes. The typical stop bar width is 24 inches.

As stated in the [MN MUTCD](#) Part 3B.16, stop lines should be used to indicate the point behind which vehicles are required to stop in compliance with a traffic control signal. However, crosswalk markings of a longitudinal width of 24 inches or greater may provide adequate indication to drivers of the required stopping location in lieu of stop lines.

7-5.10.02 Yield Lines (See also [MN MUTCD](#) 3B.16)

The typical pattern for yield lines is a set of triangles with a 24 inch base and a 36 inch height, each 12 inches apart (see typical detail [Character areas, stop line, yield & crosshatch Layouts 37-39b](#)). MnDOT typical applications for yield lines include:

- J-turns paired with acceleration lanes (see typical detail [RCUTS \(J-Turn\) Layouts 86-88](#)).
- Optional yield lines at roundabout entrances. These may be placed at entrances where the yield location is ambiguous (see typical detail [Roundabouts Layouts 52-57](#)).

7-5.10.03 Crosswalk Markings (See also [MN MUTCD](#) 3B.18)

Marked crosswalks should not be used indiscriminately; they have been shown to increase pedestrian crashes in certain applications. Skid resistant materials may be used to minimize slipping risks for pedestrians, bicyclists and motorcyclists. See Chapter 13, Non-Motorized Facilities, of this manual for additional information.

MnDOT uses the crosswalk block pattern for marked crosswalks. See pavement marking typical details for the dimensions of the crosswalk blocks to be used. Crosswalk blocks shall be a minimum of 6 feet long and at least as long as the truncated domes; however, if this is a fanned truncated dome installation, the blocks shall be at least as long as the approaching sidewalk or path.

7-5.10.04 Word, Symbol, and Arrow Markings (See also [MN MUTCD](#) 3B.20)

Word, symbol, and arrow markings may be used to supplement signs and/or to provide additional guidance as necessary. A pavement message consisting of words is generally placed at or shortly beyond the sign giving the same message and may be repeated wherever approach speeds are high or unusual alignment exists. Where through lanes approaching an intersection become mandatory turn lanes, ONLY word markings should be used in addition to the required lane-use arrow markings and signs. A solid yellow no-passing line shall be used with the STOP AHEAD or SIGNAL AHEAD pavement message.

The dimensions for word, symbol, and arrow markings can be found in the [MnDOT Standard Signs Manual](#). Guidance for use and placement of word, symbol and arrow markings can be found in the pavement marking typical details.

7-5.10.05 Speed Measurement Markings (Airplane Markings) (See also [MN MUTCD 3B.21](#))

To determine appropriate pavement markings for State Patrol airplanes, each District Traffic Engineer should confer annually with the Patrol Captain and Chief Pilot to review existing zones. This review should identify any zones which can be eliminated because they are not being used.

Speed measurement markings consist of white stripes, with dimensions of 4 feet by 2 feet if in the traffic lane or on the centerline. Use white stripes 6 feet by 2 feet for markings on the shoulder. The marking should extend 2 feet into the driving lane. A zone should consist of a set of 5 markers and be placed on a straight roadway if possible. Zones should be separated by 1/2 to 1 mile.

7-5.10.06 Curb Markings (See also [MN MUTCD 3B.23](#))

Permission to restrict parking on trunk highways must be obtained from the appropriate district traffic engineer. If curb markings are used to prohibit parking, then parking should be prohibited at all times. Other restrictions should be shown by standard parking signs. Local highway agencies may prescribe special colors for curb markings to supplement standard signs for parking regulation. Curb markings are maintained by the local authority.

7-5.10.07 Chevron and Diagonal Crosshatch Markings (See also [MN MUTCD 3B.24](#))

Chevron and diagonal crosshatch markings may be used to discourage travel in certain paved areas. In areas with speeds 40 mph or greater, chevron or diagonal crosshatch markings should be 24 inches in width. For areas with speeds less than 40 mph, the width may be reduced to 12 inches. Spacing, angles, and other placement guidance is shown in the pavement marking typical details.

7-5.10.08 Railroad Crossing with Stopping Lane

All approaches to railroad grade crossings with a stopping lane in rural areas, except minor spurs, shall be marked as shown in the typical details. The local road authority is responsible for marking all railroad crossings on their roadways.

7-6.00 ROUNDABOUT MARKINGS (See also [MN MUTCD Chapter 3C](#))

The overall concept for roundabout marking is similar to general intersection marking. Typical pavement marking for roundabout intersections consists of delineating the entries, exits, crosswalks, bike lane accommodations (only on approaches and exits), and marking the circulatory roadway on multi-lane roundabout intersections. Typical designs for roundabout intersections are shown in the pavement marking typical details.

Applicable local standards may also govern the design and placement of pavement markings as long as they do not conflict with the [MN MUTCD](#) and [MnDOT Policies](#). On connecting highways, coordinate pavement marking with the district traffic office and the local agency to maintain consistency on the facility. Contact the Office of Traffic Engineering ([OTE](#)) for additional guidance.

Correct placement of pavement markings and signs is critical within roundabouts. The designer of the pavement marking plan should be available, if possible, to assist in spotting the markings in roundabouts.

1. Materials and Installation

Roundabout markings will generally deteriorate at an accelerated rate. It is recommended that a durable pavement marking material be used. The pavement marking material selection should be clearly spelled out in the specifications and mentioned at the pre-construction conference. Preformed thermoplastic ESR is recommended for arrows, words, crosswalks and lines 8 inches or wider.

2. Approach and Entry Pavement Markings

Approach and entry pavement markings consist of lane line, channelization marking, dotted edge line extension marking, optional yield line, and symbol markings.

Lane lines on approaches should be 4 inches wide. When an approach lane is a turn only lane, the channelizing line should be 8 inches wide and solid. When the left approach lane is a dropped lane or exclusive turn lane, the approach lane line marking should be a dotted line.

When two or more lanes approach a roundabout, lane use arrows should be marked in each lane to denote proper lane usage. These markings should conform to the standards given in [MN MUTCD](#), Part 3. Fishhook arrows should not be used. Place the arrows at the point where the channelizing or lane line begins. When the approaching roadway is two lanes, another set of arrows should be placed next to the lane designation signs.

The pavement messages “YIELD” and “YIELD AHEAD”, and yield line markings (sharks teeth) are optional. If used, these markings should conform to the standards given in the [MN MUTCD](#), Part 3.

The dotted edge line extension used to demarcate the entry approach from the circulatory roadway is 12 inches wide with a 3 foot line and a 3 foot gap and located along the edge line alignment between the splitter island and succeeding existing edge line. Set the dotted edge line extension slightly back from the circulating roadway to prevent circulating traffic from scuffing the markings. Do not place pavement marking to demarcate the exit from the circulatory roadway.

Splitter islands will be marked in accordance with standard MnDOT guidelines for “Approach Markings for Obstructions” in [MN MUTCD](#), Part 3. The edge line marking on the circle end of the splitter island will be white. The typical details show the breakpoint between white and yellow markings around the splitter island.

Crosswalk markings should be placed such that vehicles approaching the roundabout are not likely to stop on the crosswalk. A distance of 20 to 25 feet back from the yield point is typically appropriate.

3. Circulatory Roadway Markings

Lane lines within a multilane roundabout should be 4 inches wide with a 6 foot line and 3 foot gap (strong skip) marking cycle. Lane lines and left edge lines within the circulatory roadway can have a spiral effect to guide the motorist through the roundabout to the appropriate exit eliminating the need to change lanes. The strong skip patterned lane lines should continue through the intended exit and terminate at the crosswalk of that exit leg. If a crosswalk is not within the exit leg, terminate the strong skip patterned lane line approximately 25 feet beyond the edge of the circulatory roadway.

When two lanes are allowed to proceed around the circle, lane use arrows should be marked in each lane within the roundabout, adjacent to each splitter island. Arrows placed within the roadway should conform to the standards in the [MN MUTCD](#), Part 3.

Consult the District Traffic Engineer for optional marking recommendations.

7-7.00 PREFERENTIAL LANE MARKINGS

1. Bus and Car Pool

See the typical details for an example of the application of HOV pavement markings at a freeway on-ramp. The use of these markings shall be documented by a Traffic Control Order and approved by the State Traffic Engineer.

2. Managed Lanes

Typical pavement markings for Managed Lanes, such as MnPASS lanes, will be provided in a technical memorandum.

7-8.00 REFERENCES

1. Minnesota Department of Transportation, Minnesota, Manual on Uniform Traffic Control Devices ([MN MUTCD](#)), current edition.
2. American Association of State Highway Officials ([AASHTO](#)): A Policy on Geometric Design of Rural Highways, current edition.

3. State of Minnesota, [Minnesota Statutes](#).
4. Minnesota Department of Transportation, [Standard Signs Summary](#), current edition.
5. Minnesota Department of Transportation, [Road Design Manual](#), current edition.
6. Minnesota Department of Transportation, [Pavement Marking Typical Detail Sheets](#).
7. Minnesota Department of Transportation, [Bikeways Facility Design Manual](#), current edition.