MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 14-11-T-02
October 30, 2014

To: Electronic Distribution Recipients

From: Jon M. Chiglo, P.E.
Division Director, Engineering Services

Subject: MnDOT Provisions for Pavement Marking Operations

Expiration
This technical memorandum will remain in effect until October 22, 2019, unless superseded before that date or incorporated into MnDOT manuals. This technical memorandum supersedes the provisions contained in Technical Memorandum 13-13-T-03, dated July 1, 2013 and Technical Memorandum 08-10-T-02, dated May 20, 2008.

Implementation
This technical memorandum shall be implemented immediately.

Introduction
The FHWA is continuing their efforts for developing minimum retroreflectivity criteria for pavement markings. When this process is completed, striping operations across the state will be responsible for assuring that pavement markings meet or exceed these minimum level criteria. Because of Minnesota's climatic extremes, a systematic approach to pavement markings (District and Statewide striping plans) has been developed and implemented in order to attain MnDOT's mission.

Over the past several years, MnDOT has put emphasis on the efforts to increase the performance of pavement markings throughout the State. These efforts have focused on improving equipment, streamlining maintenance operations, evaluating new materials, retrofitting materials on existing surfaces, and investigating performance based specifications to better deliver MnDOT's goal to:

Provide an appropriate pavement marking on all highways, 365 days per year.

Purpose
The purpose of this technical memorandum is to provide a consistent statewide approach for pavement marking operations on state trunk highways. This includes guidance on material usage for final pavement markings including both longitudinal lines and special markings (i.e. crosswalks, messages, etc.).

The guidance contained in this technical memorandum applies to the pavement marking operations on all pavements that fall under the jurisdiction of the Minnesota Department of Transportation.

Definitions
An appropriate pavement marking is one that meets or exceeds the standards defined in the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD). During winter weather events, pavement markings should provide presence after pavement is clear of snow and ice.

Performance
Research has shown that the threshold between an acceptable and an unacceptable pavement marking based on nighttime driver visibility needs is between 80 and 120 MCD/m^2/lux. MnDOT has adopted the minimum performance of 100 MCD/m^2/lux for a white line and 80 MCD/m^2/lux for a yellow line. These minimum performance values are used to schedule maintenance or replacement of all pavement marking installations and used to determine when pavement marking materials can be left beyond expected service life. If retroreflectivity data is not available, Districts may use expected life of pavement markings

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from tables below and a visual nighttime inspection to determine whether maintenance or replacement is necessary.

Pavement markings are an important road asset that needs to be managed effectively and performance measures for pavement markings need to be developed to assess the health of the system. The Office of Traffic, Safety, and Technology, through the Traffic Engineering Organization, will develop these performance measures for pavement markings.

Pavement Marking Life Expectancy
Experience has shown that traffic volumes and resulting snow and ice operations have the greatest impact on the longevity of pavement markings. The following chart outlines the life expectancy of various surface applied materials based on traffic volumes and the minimum retroreflective performance values listed above.

Expected Life of Surface Applied Markings

Material	**ADT**	
	<1,500	>1,500
Latex Paint	>1 yr.	1 yr.
Epoxy (Plural Component Liquid)	>5 yr.	3-5 yr.
Preformed Polymer Tape or Thermoplastic	>5 yr	>5 yr

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. The following chart outlines the life expectancy of various materials that have been recessed based on traffic volumes.

Expected Life of Recessed Markings

Material	**ADT**	
	<1,500	>1,500
Latex Paint	>3 yr.	3 yr.
Epoxy (Plural Component Liquid)	>6 yr.	5-7 yr.
Preformed Polymer Tape or Thermoplastic	>7 yr	>7 yr

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 the visibility of markings in these adverse conditions. MnDOT considers wet reflective and wet recoverable products to be comparable in wet weather conditions, therefore this guidance will not distinguish between them.

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

Wet Reflective Materials are those materials that enhance performance of pavement marking during wet weather conditions and retain their retroreflective properties when covered by water. Examples of these materials are those that contain specialized elements that are retroreflective when covered by water.

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

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Statewide Guidance
To meet the goal of providing an appropriate marking 365 days per year, flowcharts (attached) with recommendations for the application of pavement marking materials have been developed. The materials shown in the flowcharts are the minimum types recommended. Districts may choose to use materials with a longer life expectancy for specific projects or broader applications. All pavement marking materials used shall be on MnDOT's Qualified Products List (QPL). New materials to be investigated shall follow the provisional approval process of the QPL.

When markings have reached the minimum performance levels and are scheduled to be replaced by Maintenance, it is recommended that the materials used are based on remaining life of the pavement surface. The following table lists the recommendations for refreshing markings.

REFRESHING MARKINGS (MAINTENANCE)

Remaining Pavement Surface Life[1] (years)	Surface Applied	Recessed
0-3	Latex	Latex
>3	Epoxy[3,4]	Latex or Epoxy[2]

[1]Anticipated life of existing pavement is based on planned projects and anticipated life of surface is based on preventive maintenance plans. For the purpose of this tech memo, 3 years was chosen based on suggested optimum time until initial preservation project.
[2]Avoid placing Epoxy over Latex unless Latex presence is minimal. Epoxy should be placed on Epoxy if the remaining surface life is anticipated to be 6+ years.
[3]If pavement joint treatment is being used, latex can be used for lines at joints regardless of Remaining Pavement Surface Life.
[4]If the surface condition of the road would require Epoxy to be replaced within 2 years, Latex may be used.

Each year in January, the Office of Maintenance will ask the Districts to submit their annual maintenance striping request. The Districts will fulfill this request by submitting the information requested on the Request for Striping form that can be found at http://www.dot.state.mn.us/trafficeng/pavement/manual.html .

Aside from the material recommendations, it is also recommended that 6" edgelines are installed on rural two-lane two-way roads where there are no additional safety countermeasures for lane departures (such as rumble strips or stripes). Studies have shown a considerable reduction in crashes when wider edgelines are installed. A 2012 study done by the Texas Transportation Institute demonstrated a reduction in total crashes of 15-30% and a reduction of 15-38% in fatal plus injury crashes. An FHWA report released in late 2013 that detailed studies done in Kansas, Michigan and Illinois noted reductions of similar magnitude. The safety benefit determined by these studies makes this an important tool to add to our safety countermeasures.

Alternative Practices and Installations
Statewide goals and plans cannot include all conditions and circumstances. To allow the Pavement Marking Engineer to monitor alternative pavement marking practices, if a District chooses to have an alternative practice or installation that differs from the guidance in this technical memorandum, the District should provide notification to the Pavement Marking Engineer with details and reason(s) for the change. Notification is only requested for large scale differences or district-wide practices, and need not include short segments or intersections. The Pavement Marking Engineer will track alternate practices and installations for the purpose of using the results in future decisions on pavement marking practices and operations.

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Questions
Any questions regarding the technical provisions of this Technical Memorandum can be addressed to either of the following:

- **Ken Johnson**, Work Zone, Pavement Marking and Traffic Devices Engineer, at **(651) 234-7386**
- **Michelle Moser**, Pavement Marking and Traffic Device Engineer at **(651) 234-7380**

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at http://techmemos.dot.state.mn.us/techmemo.aspx.

To add, remove, or change your name on the Technical Memoranda mailing list, please visit the web page http://techmemos.dot.state.mn.us/subscribe.aspx

Attachments:
A: Longitudinal Striping
B: Pavement Messages

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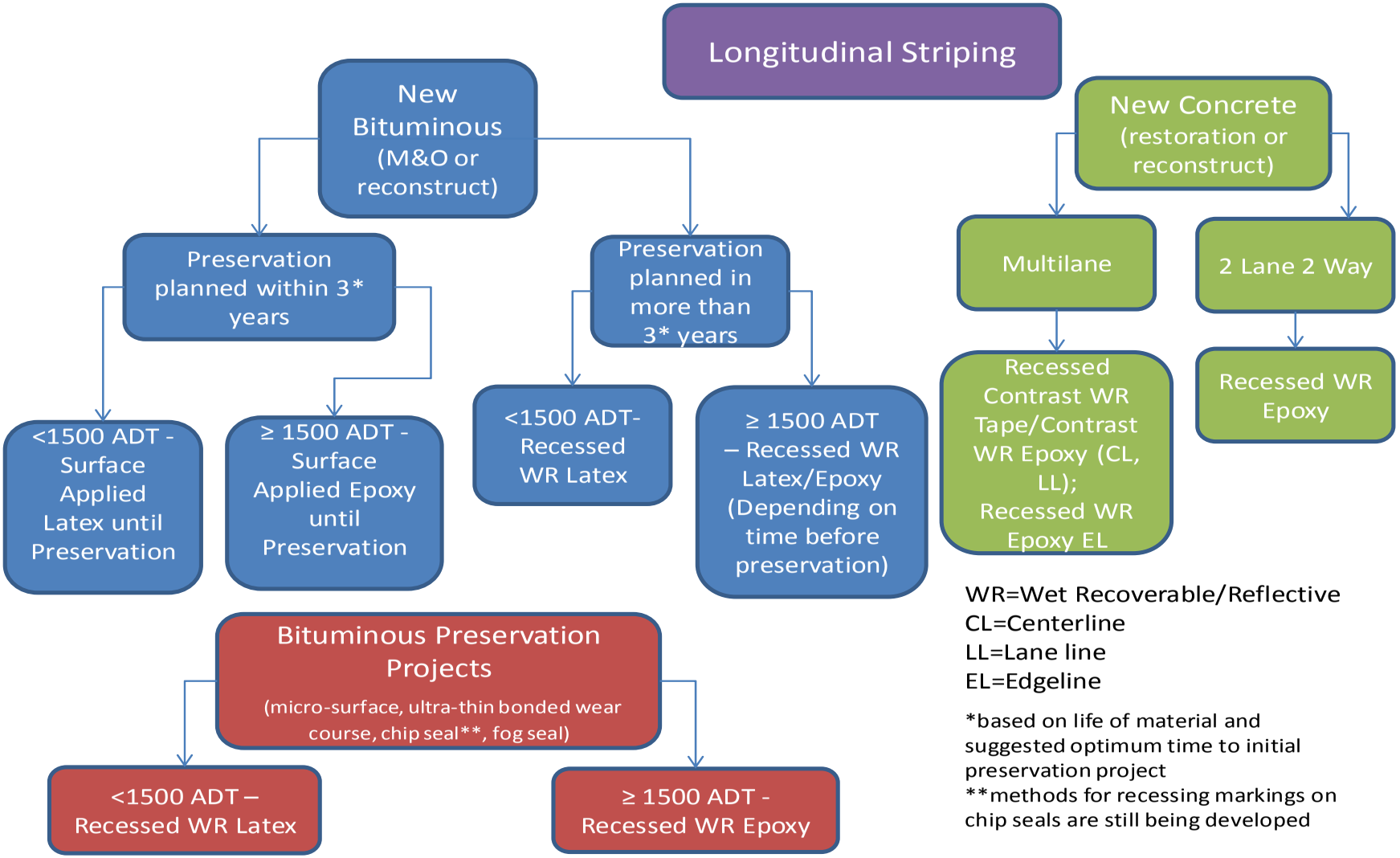
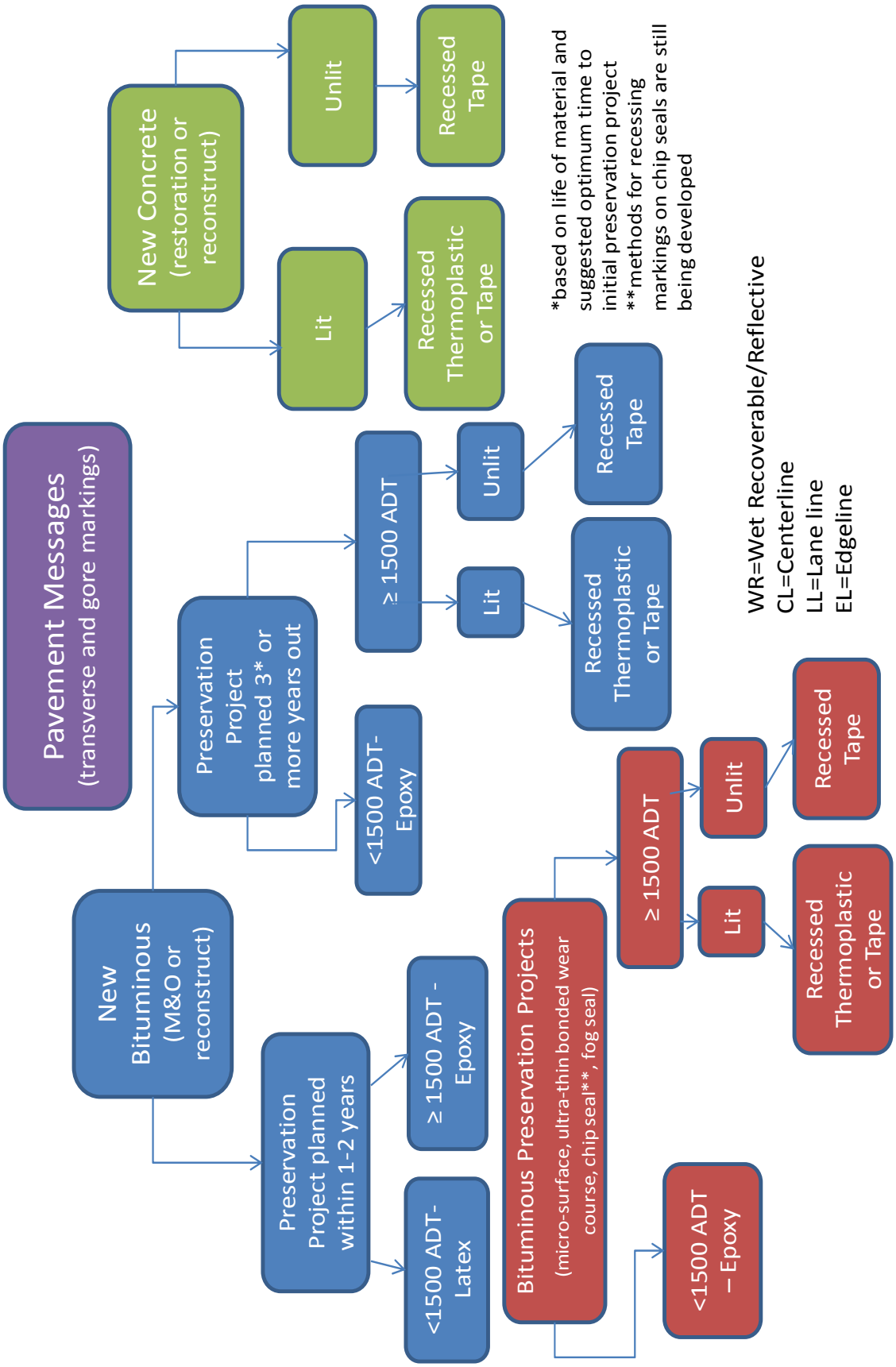


WR=Wet Recoverable/Reflective
CL=Centerline
LL=Lane line
EL=Edgeline

*based on life of material and suggested optimum time to initial preservation project
**methods for recessing markings on chip seals are still being developed


Pavement Messages
(transverse and gore markings)
New Concrete
(restoration or reconstruct)
Unlit
Recessed Tape
Lit
Recessed Thermoplastic or Tape
New Bituminous
(M&O or reconstruct)
Preservation Project planned 3* or more years out
≥ 1500 ADT
Unlit
Recessed Tape
Lit
Recessed Thermoplastic or Tape
<1500 ADT-Epoxy
Preservation Project planned within 1-2 years
≥ 1500 ADT - Epoxy
<1500 ADT-Latex
Bituminous Preservation Projects
(micro-surface, ultra-thin bonded wear course, chip seal**, fog seal)
≥ 1500 ADT
Unlit
Recessed Tape
Lit
Recessed Thermoplastic or Tape
<1500 ADT – Epoxy
*based on life of material and suggested optimum time to initial preservation project
**methods for recessing markings on chip seals are still being developed
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