Date: October 20, 2015


The 2015 version of the “Traffic Engineering Manual” (TEM) is a significant rewrite of the previous TEM published in October of 2009. Users should now refer to the October 2015 TEM for MnDOT standards and practices as they relate to traffic engineering.

Printed versions of the TEM are no longer available. Users may print as much or as little of the electronic version as needed.

Electronic notifications will continue to be sent out to all users who are registered to receive notifications of future updates and revisions on the Office of Traffic, Safety, and Technology’s publication website (http://www.dot.state.mn.us/trafficeng/publ/updates.html).

Electronic notifications that are returned to the sender will result in the subscriber’s name being removed from the notification list. It is the responsibility of the subscriber to submit a new request for notification should their email address change.

Contact Diane Colton, Office of Traffic, Safety, and Technology at diane.colton@state.mn.us or 651/234-7379 with general questions concerning the TEM.

Your comments and suggestions are always appreciated.

Sincerely,

Susan M. Groth, PE, PTOE
State Traffic Engineer

An Equal Opportunity Employer
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<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>A Injury</td>
<td>Incapacitating Injury</td>
</tr>
<tr>
<td>AASHTO</td>
<td>Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ADM</td>
<td>Archived Data Management</td>
</tr>
<tr>
<td>ADA</td>
<td>Americans with Disabilities Act</td>
</tr>
<tr>
<td>ADT</td>
<td>Average Daily Traffic</td>
</tr>
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<td>AFMS</td>
<td>Automated Facilities Management System</td>
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<td>AMBER</td>
<td>America’s Missing: Broadcast Emergency Response</td>
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<td>Approved Products List</td>
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<td>Accessible Pedestrian Signal</td>
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<td>APTS</td>
<td>Advanced Public Transportation System</td>
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<td>Annual Transportation Improvement Plan</td>
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<td>Advanced Traveler Information System</td>
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<td>Advanced Traffic Management System</td>
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<td>DDS</td>
<td>Data Distribution Server</td>
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<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
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<tr>
<td>DOT</td>
<td>Department of Transportation</td>
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<td>DPS</td>
<td>Department of Public Safety</td>
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<tr>
<td>DTN</td>
<td>Data Transmission Network</td>
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<tr>
<td>DVR</td>
<td>Digital Video Recording</td>
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<tr>
<td>DVS</td>
<td>Department of Public Safety, Driver Vehicle Services Division</td>
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<tr>
<td>EAS</td>
<td>Emergency Alert System</td>
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<tr>
<td>EOC</td>
<td>Emergency Operations Center</td>
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<tr>
<td>EM</td>
<td>Emergency Management</td>
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<tr>
<td>EMS</td>
<td>Emergency Medical Services</td>
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<tr>
<td>EVP</td>
<td>Emergency Vehicle Preemption</td>
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<tr>
<td>FAA</td>
<td>Federal Aviation Administration</td>
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<tr>
<td>FAR</td>
<td>Fatal (K) and incapacitating injury (A) crash rate</td>
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<tr>
<td>FAST</td>
<td>Free and Secure Trade</td>
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<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>FIRST</td>
<td>Freeway Incident Response Safety Team</td>
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<tr>
<td>FMCSA</td>
<td>Federal Motor Carrier Safety Administration</td>
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<tr>
<td>FYA</td>
<td>Flashing Yellow Arrow</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>HAR</td>
<td>Highway Advisory Radio</td>
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<tr>
<td>HAZMAT</td>
<td>Hazardous Materials</td>
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<td>HOT</td>
<td>High-Occupancy Toll</td>
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<td>HOV</td>
<td>High-Occupancy Vehicle</td>
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<tr>
<td>HRI</td>
<td>Highway-Rail intersection</td>
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<tr>
<td>HSIP</td>
<td>Highway Safety Improvement Program</td>
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<tr>
<td>HSM</td>
<td>Highway Safety Manual</td>
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<tr>
<td>ICE</td>
<td>Intersection Control Evaluation</td>
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<tr>
<td>ICM</td>
<td>Integrated Corridor Management</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<tr>
<td>IFTA</td>
<td>International Fuel Tax Agreement</td>
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<td>IRP</td>
<td>International Registration Plan</td>
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<td>ISP</td>
<td>Information Service Provider</td>
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<tr>
<td>ITE</td>
<td>Institute of Transportation Engineers</td>
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<td>ITS</td>
<td>Intelligent Transportation Systems</td>
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<td>IVR</td>
<td>Interactive Voice Response</td>
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<td>IWZ</td>
<td>Intelligent Work Zone</td>
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<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<td>LPFM</td>
<td>Low Power FM Radio</td>
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<td>LRRB</td>
<td>Local Road Research Board</td>
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<td>LTAP</td>
<td>Local Technical Assistance Program</td>
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<tr>
<td>MCM</td>
<td>Maintenance and Construction Management</td>
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<tr>
<td>MCMIS</td>
<td>Motor Carrier Management Information System</td>
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<tr>
<td>MDSS</td>
<td>Maintenance Decision Support System</td>
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<tr>
<td>MDT</td>
<td>Mobile Data Terminal</td>
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<tr>
<td>MESU</td>
<td>Metro Electrical Service Unit</td>
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<tr>
<td>MN</td>
<td>Minnesota Manual on Uniform Traffic Control Devices</td>
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<tr>
<td>MUTCD</td>
<td>Minnesota Crash Mapping Analysis Tool</td>
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<tr>
<td>MnDOT</td>
<td>Minnesota Department of Transportation</td>
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<td>MPCA</td>
<td>Minnesota Pollution Control Agency</td>
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<td>MSP</td>
<td>Minnesota State Patrol</td>
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<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
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<tr>
<td>NCHRP</td>
<td>National Cooperative Highway Research Program</td>
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<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
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<td>NFPA</td>
<td>National Fire Protection Association</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>OS/OW</td>
<td>Oversize/Overweight</td>
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<tr>
<td>OTST</td>
<td>Office of Traffic, Safety, and Technology (MnDOT)</td>
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<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
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<tr>
<td>PRISM</td>
<td>Performance and Registration information Systems Management</td>
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**LIST OF ACRONYMS, cont.**

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<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>PSAP</td>
<td>Public Safety Answering Point</td>
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<tr>
<td>RASAWI</td>
<td>Rest Area Sponsorship, Advertising, and Wireless Internet</td>
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<tr>
<td>RCA</td>
<td>Resource Consumption Application</td>
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<td>RDS</td>
<td>Radio Data Service</td>
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<td>RESU</td>
<td>Regional Electrical Service Unit</td>
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<tr>
<td>RFID</td>
<td>Radio-Frequency Identification</td>
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<tr>
<td>RSA</td>
<td>Roadway Safety Audit</td>
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<td>RTMC</td>
<td>Regional Transportation Management Center</td>
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<tr>
<td>RWIS</td>
<td>Road Weather Information System</td>
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<tr>
<td>SAFER</td>
<td>Safety and Fitness Electronic Records</td>
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<tr>
<td>SALT</td>
<td>State Aid for Local Transportation</td>
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<tr>
<td>SEOC</td>
<td>State Emergency Operations Center</td>
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<tr>
<td>SHSP</td>
<td>Strategic Highway Safety Plan</td>
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<tr>
<td>SOV</td>
<td>Single Occupancy Vehicle</td>
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<tr>
<td>STIP</td>
<td>State Transportation Improvement Plan</td>
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<tr>
<td>TE</td>
<td>Traffic Engineering</td>
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<tr>
<td>TMC</td>
<td>Transportation/Traffic Management Center</td>
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<tr>
<td>TOCC</td>
<td>Transportation Operation and Communications Center</td>
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<td>TRB</td>
<td>Transportation Research Board</td>
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<tr>
<td>TSP</td>
<td>Transit Signal Priority</td>
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<tr>
<td>TZD</td>
<td>Toward Zero Deaths</td>
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<tr>
<td>UPA</td>
<td>Urban Partnership Agreement</td>
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<tr>
<td>VMT</td>
<td>Vehicle Miles Traveled</td>
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<td>VSL</td>
<td>Variable Speed Limit</td>
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<td>VWS</td>
<td>Virtual Weigh Station</td>
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<tr>
<td>WAN</td>
<td>Wide Area Network</td>
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<td>WIM</td>
<td>Weigh-in-Motion</td>
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# GENERAL INFORMATION

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TRAFFIC ENGINEERING ORGANIZATION- See Chapter 15
1-1.00 INTRODUCTION

1-1.01 Purpose of the Traffic Engineering Manual
The Traffic Engineering Manual (TEM) is issued and updated by the Minnesota Department of Transportation (MnDOT) Office of Traffic, Safety, and Technology (OTST). The purpose of the TEM is to establish uniform guidelines and procedures, primarily for use by MnDOT personnel. Counties, cities, and local units of government will also find this manual useful when striving for uniformity in traffic engineering throughout the state of Minnesota. Uniform application of guidelines and procedures aids the road user in recognizing and understanding the various traffic control devices used throughout the United States.

The guidelines and criteria in this manual are largely adapted from the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) which is the statewide standard for the planning, design, and application of traffic control devices on all roads open to public travel. This manual presents engineering information typically required in the design and application of traffic control devices for trunk highways. The information must be combined with engineering judgment and balanced with social, economic, environmental, and political factors in order to yield appropriate traffic engineering solutions. This manual is not intended as a legal standard.

1-1.02 Scope of the Manual

1-1.02.01 Relationship to the Minnesota Manual on Uniform Traffic Control Devices.
The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) is established through Minn. Stat. Sec. 169.06. The MN MUTCD is based on the Federal Highway Administration’s (FHWA) “Manual of Uniform Traffic Control Devices” established under Title 23, United States Code, Section 109(d) and Title 23, Code of Federal Regulations (CFR) Part 655.603. Each state is required to adopt this manual or create a manual that is accepted by the FHWA as being in substantial conformance with the federal manual.

The MN MUTCD sets forth the basic principles, and presents state and federal laws which govern the design and usage of traffic control devices on all streets and highways in Minnesota. The TEM complements, but does not duplicate, the MN MUTCD. The TEM merely references the appropriate section of the MN MUTCD. Where the MN MUTCD does not specify warrants or applications, the TEM clarifies the accepted MnDOT practice. The TEM also details MnDOT traffic engineering guidelines and procedures not included in the MN MUTCD.

1-1.02.02 Relationship to MnDOT Policies
The TEM does not include MnDOT business policies per se, although sections of the Manual reflect existing MnDOT policies related to traffic engineering. Formal MnDOT policies can be found at www.dot.state.mn.us/policy.

1-1.02.03 Relationship to Other MnDOT Manuals
The TEM is one of many manuals which describe guidelines, procedures, specifications, and references for the activities of MnDOT. The TEM is intended primarily for use by MnDOT’s traffic engineering personnel working in the Central Office and the District Offices. It is not a textbook or a design and construction manual, and is not all-inclusive. It establishes guidelines and standards for traffic engineers to use in fulfilling their daily duties. Accordingly, where appropriate, references are made to other MnDOT manuals which may be useful to the traffic engineering function.
1-1.02.04 Complementary References

Traffic engineers at MnDOT should have ready access to the latest editions of the following documents to complement the material presented in the TEM. Additional references, which may also be useful, are listed in each of the individual chapters of this Manual.


2. Traffic Control Devices Handbook - Institute of Transportation Engineers (ITE). This Handbook is meant as a guidance to assist in determining the appropriate traffic control device(s) for a specific condition based on judgment and/or study. http://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=IR-112A


1-1.03 Organization of the Manual

There are 14 chapters organized around the basic functions performed by traffic engineers within MnDOT.

Chapter 1 General Information
Chapter 2 Traffic Laws
Chapter 3 Freeway Corridor Traffic Management
Chapter 4 Traffic Research
Chapter 5 Intelligent Transportation Systems
Chapter 6 Traffic Signs
Chapter 7 Pavement Markings
Chapter 8 Temporary Traffic Control
1-1.04 Revisions
Material in the TEM is continuously subject to revision as guidelines and procedures evolve and other information becomes available. Changes to the TEM may be preceded by MnDOT Technical Memorandums which will describe the guideline or procedure that is to be modified, added, or deleted. MnDOT’s active and historical Technical Memoranda can be found at: http://techmemos.dot.state.mn.us/.

An electronic notification will be sent to those individuals who have subscribed to an electronic notification list for updates, changes, revisions, or training planned specific to the Traffic Engineering Manual. The online subscription form can be found at: http://www.dot.state.mn.us/trafficeng/publ/updates.html.

1-2.00 OFFICE OF TRAFFIC, SAFETY, AND TECHNOLOGY FUNCTIONS

1-2.01 MnDOT Organization
MnDOT is organized as shown in the MnDOT Organizational Chart. The Office of Traffic, Safety, and Technology (OTST) is part of the Operations Division and is led by the State Traffic Engineer. Each MnDOT transportation district office has a Traffic Engineering Section led by a District Traffic Engineer. These offices work cooperatively to provide engineering and operational services to transportation users.

1-2.02 OTST Organization
The primary duties of OTST include setting standards, policies, and guidelines and providing training, technical support, and traffic related research.

The OTST is divided into three sections - OTST Organizational Chart.

1. Intelligent Transportation Systems (ITS)
   a. Administrative Support and Training
   b. Traffic Signals and Lighting
   c. ITS Program Management and Research
   d. Electrical Services

2. Traffic Engineering (TE)
   a. Signing
   b. Pavement Markings, Work Zones, and Product Evaluation
   c. Tort Claims, Traffic Standards, and Pedestrian and Bicycle Safety
   d. Traffic Safety

3. Minnesota Toward Zero Deaths (TZD)
1-2.03 OTST Functions and Responsibilities

The OTST provides leadership, expertise, and education in traffic design, operations, and safety programs, and in the development, use, and maintenance of traffic control devices in order to create a safe and efficient highway system. All the OTST units act as liaisons between MnDOT Districts, MnDOT functional offices, and the Federal Highway Administration. The OTST units also provide traffic engineering technical expertise to MnDOT Districts, MnDOT functional offices, local units of government, and external safety partners. The units and their functions are as follows:

Intelligent Transportation Systems (ITS)

1. Administrative Support and Training
   a. Provide a full range of administrative services to all OTST staff and the Traffic Engineering Organization.
   b. Administer the TEO Education/Training Committee.

2. Traffic Signals and Lighting
   a. Provide technical expertise and training for traffic signal and roadway lighting design, operation, construction, and the contract process.
   b. Develop and maintain standards, guidelines, concepts, and applications for lights and signals.
   c. Provide quality assurance for plan preparation and specifications.
   d. Research new traffic equipment and software technology for lighting and signal systems and design.
   e. Ensure that signal and lighting projects conform to MnDOT policy, the TEM, the MN MUTCD, and other applicable standards.
   f. Administer the TEO Signals and Lighting Committees.

3. ITS Program Management and Research
   a. Provide technical expertise regarding ITS.
   b. Manage, plan, and administer funding for ITS research, development, and operational test projects.
   c. Administer the TEO Intelligent Transportation Systems Committee.
   d. Develop and maintain ITS standards, guidelines, concepts, and applications.
   e. Assist OTST sections and the Department in developing traffic and safety research program need statements and implement appropriate research projects.

4. Electrical Services
   a. Provide electrical maintenance for traffic signals (statewide), lighting (greater MN), and ITS devices (greater MN).
   b. Provide dispatch for locating MnDOT underground facilities as part of the Gopher State One Call system.
   c. Perform locates of MnDOT underground facilities within the Metro District.
Traffic Engineering (TE)

1. **Signs**
   

b. Develop and maintain standards, guidelines, concepts, and applications for signs.

c. Evaluate materials, equipment, and methods to be incorporated into signing projects.

d. Support statewide sign design and sign management software.

e. Analyze the relationships between geometrics, driver expectancy, traffic flow, standardization, and operations to ensure the proper sign message and placement.

f. Develop and implement statewide signing training.

g. Ensure that signing projects conform to the MN MUTCD, the TEM, and other applicable standards.

h. Administer the Traffic Engineering Organization (TEO) Signing Committee.

i. Administer the External Sign Variance Committee.

2. **Pavement Markings, Work Zones and Product Evaluation**

   a. Provide leadership and technical expertise for temporary traffic controls, pavement markings, crashworthiness of traffic control devices, and provide quality assurance for plan preparation, specifications, and estimates.

   b. Develop and maintain standards, specifications, special provisions, typical plans, guidelines, concepts, applications, and training for temporary traffic controls and pavement markings.

   c. Conduct research regarding temporary traffic control and pavement marking methods, products, and procedures.

   d. Maintain and ensure Department adherence to the Minnesota Work Zone Safety and Mobility Policy.

   e. Perform temporary traffic control reviews and feedback sessions with the Districts.

   f. Conduct annual crash studies of work zones.

   g. Ensure that pavement marking installations conform to the MN MUTCD, the TEM, and other MnDOT guidelines.

   h. Manage a statewide pavement marking database and performance measures, and support the central striping business.

   i. Establish and maintain models for pavement marking life cycles.

   j. Evaluate materials, equipment, and methods to be incorporated into pavement marking projects.

   k. Manage MnDOT’s [Approved Products List (APL) for Traffic Control Devices](#).
1. Coordinate traffic control device evaluations.

m. Coordinate new products with traffic engineering research efforts, evaluation, and approvals.

n. Administer the Statewide Work Zone Safety Committee and TEO Temporary Traffic Control Committee.

o. Administer the TEO Pavement Marking Committee.

3. Tort Claims, Standards, and Pedestrian and Bicycle Safety
   
a. Provide technical expertise to the Districts for reducing risk and liability on MnDOT projects.

b. Provide technical expertise for bike and pedestrian safety features and provide quality assurance for plan preparation.

c. Develop and maintain standards, guidelines, concepts, and applications for bike and pedestrian safety features such as crosswalks and bike lanes.

d. Direct and coordinate state and MnDOT traffic engineering policy.

e. Coordinate and administer the Minnesota Committee on Uniform Traffic Control Devices.

f. Prepare, coordinate, and administer traffic engineering standards and technical memoranda.

g. Arrange for publication and distribution of various traffic engineering manuals and provide expertise on their interpretation.

h. Represent MnDOT interests in the defense against tort claims and lawsuits.

i. Evaluate tort claims, negotiate and approve settlements, and develop MnDOT policies and practices regarding tort liability settlement decisions.

j. Ensure that standards are available to MnDOT personnel so road design projects conform to MnDOT policy, the MN MUTCD, the TEM, and other applicable standards as they pertain to bike and pedestrian safety.

4. Traffic Safety
   
a. Provide leadership and technical expertise on traffic safety issues.

b. Develop safety plans, provide crash data, evaluate effectiveness, highlight research reports, and identify implementation opportunities to support the Toward Zero Deaths (TZD) program.

c. Administer the Highway Safety Improvement Program.


e. Manage the Transportation Information System (TIS) crash data, and conduct training on use of the data for the Districts and local agencies.
f. Conduct Road Safety Audits as required.

g. Develop and implement Minnesota’s Strategic Highway Safety Plan, working closely with the Department of Public Safety, Minnesota State Patrol, and other safety partners.

h. Propose needed Traffic Safety Research projects and act as the technical liaison to these projects.

i. Interact with other states and research groups in order to exchange information and assist in practical safety research.

j. Administer the TEO Safety Committee.

Minnesota Toward Zero Deaths Program (TZD)

Minnesota TZD is the state’s cornerstone traffic safety program, employing an interdisciplinary approach to reducing traffic crashes, injuries, and deaths on Minnesota roads. The TZD program works in partnership with other state agencies, local units of government, non-profit safety groups, community and corridor groups to improve traffic safety across all Minnesota roadways. TZD provides technical assistance, materials, and guidance to local groups that are committed to reducing crashes and the fatalities and severe injuries that result from them. The Director of MnDOT’s Office of Traffic, Safety, and Technology serves as co-chair of the TZD program along with the Director of the Office of Traffic Safety, Department of Public Safety.

TZD has identified several major focus areas to reduce traffic injuries and fatalities as outlined in the Strategic Highway Safety Plan (SHSP). A combination of strategies from different focus areas is often most effective for solving a particular problem:

1. Education - changing driver behavior.
2. Emergency Medical and Trauma Services - fast and efficient emergency response
3. Enforcement - ensuring compliance with traffic laws.
4. Engineering - careful evaluation of road characteristics

1-2.04 Delegation of Authority

In addition to the responsibilities of the State Traffic Engineer, which are carried out by the various units of the OTST, the State Traffic Engineer is delegated very specific authority and responsibility from the Commissioner of MnDOT for providing traffic control devices on the trunk highway system. In addition, some authority is further delegated to the District Traffic Engineers. The general levels of authority and responsibility are described in the following sections:

1. Orders approved by the District Traffic Engineer
   a. For standard traffic signs and markings which are in accordance with the MN MUTCD, the District Traffic Engineer may issue a District Traffic Work Order, Form 29187 (Form 1.A).
   b. Files are kept in the District Traffic Office.

2. Speed limit authorization by the Office of Traffic, Safety, and Technology.
   a. The State Traffic Engineer or Assistant State Traffic Engineer authorizes speed limits in accordance with Minn. Stat. Sec. 169.14 based on the engineering and traffic investigation prepared by the district traffic office.
1-3.00 DISTRICT TRAFFIC ENGINEERING FUNCTIONS

1-3.01 General Functions of the District Traffic Engineering Staff
The functions of the District are primarily to implement guidelines, standards, policies and preferred practices, advise local governmental agencies as requested, manage day-to-day field operations, develop traffic plans, provide feedback to MnDOT Central Office on policies and practices, perform field investigations, collect data, supervise signing and striping operations, and conduct studies.

Within the MnDOT organization, many important traffic engineering functions are carried out by the District Traffic Engineer (DTE) and staff. While each District has a slightly different organization, the functions performed by the DTE’s and their staffs are essentially the same. [Links to MnDOT District Websites]

1-3.02 Specific Functions
Specific functions performed by District Traffic Engineering Staff:

1. Design Coordination
   a. Review preliminary and final road design plans from a traffic engineering perspective.
   b. Obtain and administer all work authorities needed by and/or assigned to the traffic office.
   c. Review comprehensive plans, plats, and proposed development documents.
   d. Obtain local approvals of traffic engineering projects where needed.
   e. Review proposed design standards and provide feedback.
   f. Update P6 schedules for traffic activities.
   g. Discuss staging strategies and traffic control options for completion of Traffic Management Plan.

2. Safety Design
   a. Develop a District Safety Improvement Program, including contract and maintenance work.
   b. Investigate safety issues and develop safety project proposals.
   c. Review entrance permits.
   d. Make recommendations to designers.
   e. Prepare design study reports for safety projects when requested.
   f. Prepare portions of large study reports relating to crashes, traffic volume, roadway operations, etc.
   g. Assist in the development of guardrail improvement programs.
   h. Review and assist local safety programs.
   i. Provide capacity analysis of roadways, intersections, etc.
   j. Provide District support of traffic-oriented research programs.
k. Provide before and after evaluations of projects.

l. Manage the District Transportation Information System (TIS) crash files.

3. Signal Design
   a. Prepare traffic signal design plans.
   b. Prepare traffic signal special provisions.
   c. Develop, administer, and process signal agreements with local governmental agencies in conjunction with the Office of Project Management and Technical Support.
   d. Prepare and approve Intersection Control Evaluation (ICE) letters and reports, which replace the signal justification report.
   e. Assist in the determination and preparation of signal installation and operation programs.
   f. Investigate and recommend signal system concepts on trunk highways and local roads.

4. Lighting Design
   a. Develop, administer, and process lighting agreements and exhibits with local agencies and utility companies in conjunction with the Office of Project Management and Technical Support.
   b. Prepare and process exhibits for lighting systems.
   c. Prepare lighting design plans.
   d. Prepare lighting special provisions.
   e. Prepare lighting study reports.
   f. Review lighting permits submitted by local municipalities and utility companies.
   g. Determine the source of power obtained from the utility company.

5. Signal and Lighting Construction
   a. Supervise contracts and provide inspection for assigned signal and lighting projects as directed by the District Engineer.
   b. Assist in the inspection of signal and lighting contracts assigned to others.
   c. Originate traffic engineering requests for state furnished equipment.
   d. Update the Automated Facilities Management System (AFMS).
   e. Provide Turn-On Reports for signal and lighting installations.

6. Signal and Lighting Operations
   a. Investigate and respond to questions regarding signal and lighting operations.
   b. Supervise lighting procedures.
c. Time all MnDOT signals, and develop and maintain a systematic review of the operation of all signal systems, including railroad emergency preemption.

d. Meet annually with RR signal personnel diagnostic team to review RR and signal preemption timing.

e. Coordinate activities with the appropriate Electrical Services Unit (ESU).

f. Provide inventory of signal and lighting equipment in the field for maintenance by the appropriate ESU.

g. Assist in minor troubleshooting of signals as requested by the appropriate ESU.

h. Provide liaison with electric utility companies for repairs when MnDOT provides lane closures.

i. Locate underground facilities in response to requests from Gopher State One Call.

j. Prepare a signal and light agreement checklist for agreement preparation.

k. Perform general maintenance to signal and lighting systems such as changing filters, dusting, updating plans, maintaining log books, and checking operations and hardware.

7. Signing Design and Operations

   a. Investigate and reply to complaints relative to signing.

   b. Investigate and prepare District Traffic Work Orders for needed signs.

   c. Administer special signing projects such as signing for resorts, campgrounds, corporate limits, specific service signs, etc.

   d. Prepare layouts for routine sign maintenance programs.

   e. Assist in the formulation of signing standards and policies.

   f. Design and/or review designs of layouts and plans.

8. Construction Coordination

   a. Prepare Traffic Control Orders which cover traffic control devices used for maintenance operations.

   b. Coordinate MnDOT sign crew activities in the field.

   c. In conjunction with the Project Engineer, determine construction staging required and prepare the Traffic Control Plan for a construction project.

   d. Ensure the development of and assist in the preparation of Transportation Management Plans.

   e. Conduct or assist in periodic reviews of construction projects to assure the adequacy of the temporary traffic control plan.

   f. Obtain and keep a record of crashes within work zones.
g. Assist in the preparation of time and traffic provisions.

h. Assist in the layout and installation of contract signing.

i. Assist in the preparation of public information for construction projects.

9. Speed Zoning and Special Studies
   a. Prepare speed limit studies and manage the District speed limit authorization process.
   b. Investigate complaints and systematically review all speed zoning on the trunk highway system.
   c. Collect data for determining speed trends and influences.
   d. Conduct investigations and provide reports for school safety programs.
   e. Conduct investigations and provide reports for railroad crossing programs.

10. Special Studies
    a. Conduct sight distance studies.
    b. Gather turning movement counts.
    c. Perform no-passing zone studies and maintain database.
    d. Administer the annual ADT tube counting program.
    e. Perform and/or coordinate modeling for capacity and level-of-service analysis.
    f. Perform signal warrant analysis.

11. Pavement Marking Operations
    a. Maintain appropriate pavement markings on all highways and interstates.
    b. Oversee construction and maintenance activities related to pavement markings.
    c. Collect and report handheld retroreflectometer readings to the pavement marking unit to be added to the inventory data base.
    d. Provide daily work planning and supervision for pavement markings.

12. Oversee the design, construction, maintenance, and operation of District ITS systems which may include cameras, electronic signs, vehicle detection, and communications networks.

13. Assist in the issuance of permits for parades and events.

14. Respond to numerous public and legislative concerns and requests.

15. Facilitate District tort claim responses.
CHAPTER 2 - TRAFFIC LAWS

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2-1.00 INTRODUCTION

2-1.01 Purpose

The purpose of this chapter is to identify and describe Minnesota state laws and Minnesota Department of Transportation (MnDOT) regulations which regulate traffic on Minnesota highways and therefore, govern the actions and responsibilities of traffic engineers in the State. Under Minnesota law, the regulation of traffic may be accomplished by statute, MnDOT regulation, local order, ordinance, or resolution approved by MnDOT. While this chapter identifies traffic laws and regulations and presents their application as related to the safe and expeditious movement of traffic, it does not purport to be a legal document, nor shall it be interpreted as such. Readers are referred to the latest official publication of Minnesota Statutes for more complete legal information.

2-1.01.01 Laws

Both laws and regulations are principles governing actions or procedures. A law has been made obligatory and enforceable by a supreme authority or sanction. In Minnesota, “official” state laws are statutes passed by the State Legislature and approved by the Governor. They are commonly referred to as Minnesota Statutes or Minnesota Statutes Annotated.

2-1.01.02 Regulations

A regulation is a rule which may be enforced. Regulations can be established or approved only by the proper authority as provided in the law. In Minnesota, the Transportation Commissioner may establish or approve regulations affecting traffic movement on trunk highways. Failure to conform to a regulation is a violation of law.

2-1.01.03 Common Traffic Laws and Regulations

The most common laws and regulations pertaining to MnDOT are those regarding:

- Signs, signals and pavement markings,
- Speed restrictions,
- No passing restrictions,
- Parking prohibitions,
- Through highways,
- Load limits,
- Lane use restrictions and controls,
- Advertising restrictions,
- Restrictions of certain classes of traffic, including pedestrians, bicycles, and animals,
- Right-of-way,
- Rules of the road, and
- Construction.

2-1.02 Scope

The primary purpose of the Traffic Engineering Manual (TEM) is to provide information needed by traffic engineering personnel to carry out their daily duties. Laws affecting these activities will be discussed in this chapter of the TEM. Chapters 160-173 of Minnesota Statutes include most of the state laws affecting roads and highways in Minnesota. Chapter 169, Traffic Regulations, is important to traffic engineers and will be the primary focus of this chapter.
### 2-1.03 Chapter Organization

The following section includes a selected glossary of legal definitions. The remaining sections of the chapter will describe specific laws and regulations of concern to traffic engineers. In each of these sections the applicable law(s) and regulations will be identified, an interpretation of the law will be provided, and the law’s legal implications will be discussed. Where appropriate, references to other sections of the TEM and other traffic engineering publications will be provided. The applicable law(s) are not quoted verbatim in the interest of brevity. Readers should consult the latest official publication of the [Minnesota Statutes](https://www.revisor.mn.gov/statutes/) for current and complete legal information.

#### 2-2.00 GLOSSARY

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*See Chapter 6 of this manual for further definitions of Expressway and Conventional Road Multilane for signing purposes.*
### Official Traffic-Control Devices
- Private Road or Driveway: [Minn. Stat. Sec. 169.011, Subd. 57](#)
- Railroad Sign or Signal: [Minn. Stat. Sec. 169.011, Subd. 59](#)
- Residence District: [Minn. Stat. Sec. 169.011, Subd. 63](#)
- Residential Roadway: [Minn. Stat. Sec. 169.011, Subd. 64](#)
- Road Authority: [Minn. Stat. Sec. 160.02, Subd. 25](#)
- Roadway: [Minn. Stat. Sec. 169.011, Subd. 68](#)
- Rural Residential District: [Minn. Stat. Sec. 169.011, Subd. 69a](#)
- School Bus: [Minn. Stat. Sec. 169.011, Subd. 71](#)
- School Zone: [Minn. Stat. Sec. 169.011, Subd. 7](#)
- Seasonal Load Restrictions: [Minn. Stat. Sec. 169.87](#) and [Minn. Stat. Sec. 169.86 Subd 1a](#)
- Sidewalk: [Minn. Stat. Sec. 169.011, Subd. 75](#)
- Specific Service: [Minn. Stat. Sec. 160.292, Subd. 21](#)
- Specific Service Sign: [Minn. Stat. Sec. 160.292, Subd. 22](#)
- Speed Limits: [Minn. Stat. Sec. 169.14](#)
- Street or Highway: [Minn. Stat. Sec. 169.011, Subd. 81](#)
- Through Highway: [Minn. Stat. Sec. 169.011, Subd. 82](#)
- Tourist-Oriented Business: [Minn. Stat. Sec. 160.292, Subd. 25](#)
- Town Roads: [Minn. Stat. Sec. 160.02, Subd. 28](#)
- Traffic: [Minn. Stat. Sec. 169.011, Subd. 84](#)
- Traffic Control Signal: [Minn. Stat. Sec. 169.011, Subd. 85](#)
- Trunk Highways: [Minn. Stat. Sec. 160.02, Subd. 29](#)
- Urban District: [Minn. Stat. Sec. 169.011, Subd. 90](#)
- Work Zone: [Minn. Stat. Sec. 169.011, Subd. 95](#)

## 2-3.00 LEGAL RESPONSIBILITIES

### 2-3.01 General Powers of the Commissioner

The general powers of the Commissioner are described in [Minn. Stat. Sec. 161.20](#). Minn. Stat. Sec. 161.20 Subd 1 states that “the Commissioner shall carry out the provisions of Article 14, Section 2, of the Constitution of the State of Minnesota.” To do so, the Commissioner has the power to acquire property, construct and maintain highways, let contracts, make agreements with local communities, expend funds, and promulgate regulations. The powers of the Commissioner are more specifically defined in many other sections of Minnesota Statutes, primarily in Chapters 160-173.

The Department of Transportation is supervised and controlled by the Commissioner who is appointed by the governor. The Commissioner delegates specific authority and responsibilities to the various offices within MnDOT.
2-3.02 Legal Responsibilities of a Local Authority

2-3.02.01 Local Authority - Minn. Stat. Sec. 169.04

Minn. Stat. Sec. 169.04, Local Authority, has two important implications for MnDOT engineers. First, with respect to streets and highways under their jurisdiction, and with the consent of the Commissioner when needed, local authorities have virtually complete authority (with notable exceptions such as Speed Zoning and Experimental Devices) over all streets and highways under their jurisdiction (county state-aid highways, county highways, municipal state-aid streets, and town roads). The local authority may enact any ordinance or regulation authorized by statutes affecting traffic operation on these facilities. For legal definitions of the types of local roads see Minn. Stat. Sec. 160.02. For local authority requirements concerning traffic-control devices and requirements to conform to the Minnesota Manual on Uniform Traffic Devices (MN MUTCD) see Minn. Stat. Sec. 169.06, Subd. 2 and 3.

Second, local authorities may undertake actions affecting state trunk highways only with the consent of MnDOT. The District Engineer is responsible for the review of all ordinances, regulations, or proposed actions affecting trunk highways.

2-3.03 MnDOT Approvals

2-3.03.01 Approval by the District

Proposed ordinances, regulations, or restrictions affecting state trunk highways shall be investigated and approved by MnDOT before implementation. A formal resolution requesting an investigation shall be submitted to a MnDOT District by the local authority along with a draft of the proposed ordinance, regulation, or restriction. Proposals which would inhibit capacity or movement of trunk highway traffic, such as improper parking procedures, turn restrictions, truck routing, or similar items, must be investigated by MnDOT. If the proposed change is covered by the MN MUTCD, this Traffic Engineering Manual, or MnDOT Technical Memoranda, the District may approve the action without a review by the State Traffic Engineer of MnDOT's Office of Traffic Engineering (OTE). A District Traffic Work Order may be used for this purpose.

2-3.03.02 Approval by the State Traffic Engineer, Office of Traffic, Safety and Technology

The need for statewide uniformity and the legally sensitive nature of some work orders requires a centralized review. In these cases, the District conducts an investigation of the proposed action and transmits the proposal to the State Traffic Engineer, OTE with recommendations for action. At all times the District should make an effort, through close contact with local officials, to ensure that the applicable legal requirements are fulfilled. The State Traffic Engineer, OTE shall review and sign any order affecting:

1. Speed restrictions (see Section 2-5.00 SPEED RESTRICTIONS).
2. Designations of through highways (see Section 2-7.00 THROUGH HIGHWAYS AND CONTROLLED ACCESS HIGHWAYS).
3. Experimental traffic control devices.

2-4.00 SIGNS, SIGNALS, AND MARKINGS

This section will discuss the legal rights and responsibilities of MnDOT regarding the placement and maintenance of signs, signals, and markings on streets and highways in Minnesota. Chapters 6, 7, 8, and 9 of this manual describe standards and procedures for their design and implementation. Areas that will be covered in this section include:

1. The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD),
2. Placement and maintenance of signs, signals, and markings,
3. Unauthorized sign, signals and markings,
4. Prohibited lights or signals, and
5. Vandalism.

2-4.01 Minnesota Manual on Uniform Traffic Control Devices

*Minn. Stat. Sec. 169.06, Subd. 1* states that the Commissioner shall adopt a manual and specifications for a uniform system of traffic-control devices for use on highways in Minnesota. This manual, the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) has been adopted by the Commissioner. Unless a variation is approved by the FHWA, all traffic control devices shall conform to specifications in the MN MUTCD.

2-4.01.01 Variations from the MN MUTCD

The FHWA may authorize variations from the MN MUTCD only for purposes of investigation and research. *Minn. Stat. Sec. 169.06, Subd. 2* states, “The commissioner may authorize variations from the manual and specifications for the purpose of investigation and research into the use and development of traffic-control devices. When such authorized variation pertains to the regulation of traffic, notice of the intended regulatory purpose shall be published in a qualified newspaper of general circulation in the area where the research is being conducted.” Procedures to request approval to use experimental traffic control devices can be found in Chapter 1 of the MN MUTCD.

2-4.02 Placement and Maintenance Signs, Signals, Markings

2-4.02.01 Trunk Highways - *Minn. Stat. Sec. 169.06, Subd. 2*

Under *Minn. Stat. Sec. 169.06, Subd. 2*, it is the sole responsibility of MnDOT to place and maintain all necessary traffic control devices on trunk highways although permission to do so may be granted to other authorities by MnDOT. All such devices shall conform to the MN MUTCD and to MnDOT specifications unless a variance for experimental devices has been granted by the FHWA (see 2-4.01.01 above).

2-4.02.02 Local Streets and Roads - *Minn. Stat. Sec. 169.06, Subd. 3*

Under *Minn. Stat. Sec. 169.06, Subd. 3*, local authorities have both the right and the responsibility to place and maintain traffic control devices on streets and highways under their jurisdiction. All traffic control devices shall conform to the MN MUTCD and to state specifications. Legal liability for the existence and condition of these facilities rests with the local authority, not with MnDOT.

2-4.03 Unauthorized Sign, Signal, or Marking

2-4.03.01 Unauthorized Devices - *Minn. Stat. Sec. 169.07*

*Minn. Stat. Sec. 169.07* gives MnDOT and local road authorities the authority and responsibility to identify and remove any sign, signal, marking or other device on trunk highways or other roads which is a traffic hazard or deters the effectiveness of official traffic control devices. Such devices may be removed by MnDOT without notice to the owner. “Every such prohibited sign, signal, or marking is hereby declared to be a public nuisance, and the authority having jurisdiction over the highways is hereby empowered to remove the same, or cause it to be removed, without notice.”

This authority does not extend to informational signs on private property which do not resemble and cannot be mistaken as official traffic control devices.
2-4.04  Prohibited Light or Signal

2-4.04.01 Red Lights, Signs, and Signals - Minn. Stat. Sec. 169.073

Minn. Stat. Sec. 169.073 prohibits private individuals and companies from placing red lights, signals, or signs within view of highways or active railroads in such a way that affects the effectiveness or efficiency of official traffic control devices. MnDOT may order the removal or replacement of such lights by giving official written notice to the owner that the light is a traffic hazard. Notices shall be issued officially as provided in Minn. Stat. Sec. 216.17. The aggrieved party has the right of appeal as required in Minn. Stat. Sec. 216.25.

2-4.05  Railroad Stop Crossings

2-4.05.01 Responsibility for Railroad Crossing Signs - Minn. Stat. Sec. 219.20

With respect to the provisions of Minn. Stat. Sec. 219.20, MnDOT does not have the authority to install, replace, or remove signs on railroad property, including at railroad crossings. These signs and signals are the responsibility of the railroad company. MnDOT may declare a crossing “dangerous” and order the installation of stop signs at the crossing. Procedures for determining the need for traffic control devices at railroad crossings are discussed in Chapter 14 of this manual.

“After an investigation following a petition from a governmental agency or subdivision (responsible for a road that crosses a railroad track) or on the Commissioner’s own motion that stop signs or yield signs should be installed at a crossing, the Commissioner shall designate the crossing as a stop crossing or yield crossing and shall notify the railway company operating the railroad at the crossing of this designation. Within 30 days after notification, the railway company shall erect the uniform stop crossing signs or yield crossing signs in accordance with the Commissioner’s order.”

2-4.06  Vandalism

2-4.07.01 Prosecution - Minn. Stat. Sec. 169.08

Minn. Stat. Sec. 169.08 states that it is against the law to possess, alter, deface, or remove any official traffic-control device or any railroad sign or signal.

2-5.00  SPEED RESTRICTIONS

2-5.01  Duty to Drive with Due Care

Minn. Stat. Sec. 169.14, Subd. 1 states that “No person shall drive a vehicle on a highway at a speed greater than is reasonable and prudent under the conditions.” Every driver is responsible for maintaining awareness of driving hazards and for restricting speeds to what would be reasonable under prevailing conditions. Regardless of the posted speed limit, this basic concept governs the enforcement of speed laws.

2-5.02  Authority to Establish Speed Limits

MnDOT has the authority and responsibility to establish speed limits on trunk highways and to authorize speed limits on any street or highway in the State (Minn. Stat. Sec. 169.14, Subd. 4,5). The purpose of this section is to discuss the laws and regulations permitting the restriction of speed on Minnesota streets and highways.

2-5.03  Speed Limits

2-5.03.01 Minn. Stat. Sec. 169.14 - Speed Limits.

Minnesota law sets speed limits on public roads, identifies penalties, and authorizes MnDOT, and in some cases local governments, to change the limit. The statutory speed limits are: 30 m.p.h. for roads in an “urban
“district,” which is any segment of a city street or town road that is built up with structures spaced less than 100 feet apart for a minimum distance of a quarter-mile; 65 or 70 m.p.h. for interstates (depending on whether it is, respectively, within or outside an urbanized area of at least 50,000); 65 m.p.h. on divided highways with controlled access; 10 m.p.h. for alleys, mobile home parks, and campgrounds; and a default of 55 m.p.h. on other roads. Some other limits apply for specific vehicles. A 40-m.p.h. minimum speed limit applies on interstates. Minn. Stat. Sec. 169.14, Subd. 2 defines the various statutory speed limits available. For more information see “Minnesota Speed Limits”, Minnesota House Research document, updated September 2015.

2-5.03.02 Establishment of Zones by Commissioner - Minn. Stat. Sec. 169.14, Subd. 4

The determination and implementation of speed limits on trunk highways is solely the responsibility of MnDOT. Procedural elements of speed zone determination including the “engineering and traffic investigation” are discussed in Chapter 14 of this manual. Information on Data Collection may be found in Chapter 5 of this manual.

2-5.03.03 Speed Zoning within Local Areas - Minn. Stat. Sec. 169.14, Subd. 5

On all streets and highways other than trunk highways, the local authority must request investigation and authorization by MnDOT. Following MnDOT authorization, the local authority is responsible for placing and maintaining the speed limit signs on roadways under its jurisdiction.

2-5.03.04 District Investigation

The District Traffic Engineer is responsible for the surveys and data collection needed to determine speed limits on all streets and highways. The results of the District Traffic Engineer’s investigation and his/her recommendations shall be transmitted to OTE for official approval and authorization before any speed limit may be revised. The procedures on establishing appropriate speed limits are described in Chapter 14 of this manual.

2-5.03.05 Sign Placement - see Chapter 6 of this manual.

2-5.03.06 School Speed Limits - Minn. Stat. Sec. 169.14, Subd. 5a

Minn. Stat. Sec. 169.14, Subd. 5a, grants local authorities the power to establish school speed limits within a school zone of a public or nonpublic school upon the basis of an engineering and traffic investigation as prescribed by the Commissioner of Transportation. MnDOT consent is required only if a trunk highway would be affected by the proposed action. Except on trunk highways, the placement and maintenance of any such traffic control devices is the responsibility of the local authority.

School zone speed limits shall be in effect when children are present, going to or leaving school during normal school hours, and must be identified accordingly. It is important to consider other safety alternatives which can complement school speed zone implementation. Examples of these alternatives are sidewalk construction, parking restrictions, crossing guards, stop signs and signals, and pedestrian rerouting.

The required procedures for conducting an investigation to determine a school speed limit are outlined in MnDOT’s “A Guide to Establishing Speed Limits in School Zones” (MN MUTCD Section 7E.1). The local authority shall complete an engineering and traffic investigation as prescribed by MnDOT before a school speed zone can be established. This investigation shall include:

1. A school route plan,
2. A school zone hazard evaluation, and
3. A tabular listing of all hazards with recommended corrective actions.
2-5.03.07 Segments in Urban Districts - Minn. Stat. Sec. 169.14, Subd. 5b

Authority - Minn. Stat. Sec. 169.14, Subd. 5b, grants local authorities the power to reduce a previously established speed limit greater than 30 mph on a segment of a city street, municipal state-aid street, or town road in an area that meets the “urban district” as defined in Minn. Stat. Sec. 169.011, Subd. 90. The speed established will be as specified in Minn. Stat. Sec. 169.14, Subd 2.

Responsibility - A copy of the resolution must be sent to the Commissioner at least 10 days prior to sign installation.

2-5.03.08 Speed Limit in Work Zone When Workers Present - Minn. Stat. Sec. 169.14, Subd. 5d

This law requires that the speed limit on a road having an established speed limit of 50 miles per hour or greater is adjusted to 45 miles per hour in a work zone when (1) at least one lane or portion of a lane of traffic is closed in either direction, and (2) workers are present. This requirement does not apply to a segment of road in which:

- Positive barriers are placed between workers and the traveled portion of the highway.
- The work zone is in place for less than 24 hours.
- A different speed limit for the work zone is determined by the road authority following an engineering and traffic investigation and based on accepted engineering practice.
- A different speed limit for the work zone is established by the road authority per the paragraph below.

In addition to the requirement as stated above, the statute allows the Commissioner, on trunk highways and temporary trunk highways, and local authorities, on streets and highways under their jurisdiction, to authorize the use of reduced maximum speed limits in work zones with workers present. The Commissioner or local road authority is not required to conduct an engineering and traffic investigation before authorizing this reduced speed limit. The work zone speed limit must not reduce the speed limit on the affected street or highway by more than:

- 20 mph on a street or highway having an established speed limit of 55 mph or greater.
- 15 mph on a street or highway having an established speed limit of 50 mph or less.

The law also requires that signs must be erected identifying the speed limit and indicating the beginning and end of the speed limit zone. The signs must also be removed or covered when they are not required.

Procedures on establishing speed limits in work zones are described in Chapter 8 of this manual.

2-5.03.09 Minimum Speed Limits - Minn. Stat. Sec. 169.14, Subd. 8

MnDOT has the authority to establish minimum, as well as maximum, speed limits on trunk highways. The determination of minimum speed limits is usually based on engineering judgment, taking into consideration the fact that safety decreases as speed differences increase. As a general rule, speed differences greater than 15-20 miles per hour are not desirable. The application of minimum speed limits is generally limited to higher speed freeway sections. An engineering and traffic investigation must precede the determination of minimum speed limits. Such regulations become effective when minimum speed signs are erected on the affected trunk highway.

2-5.03.10 Speed Limits on Local Roads Having an Established Bicycle Lane - Minn. Stat. Sec. 160.263, Subd. 4

The law allows a 25 mph or higher speed limit to be established on any roads governed by local authorities that contains a marked bike lane. An engineering and traffic investigation is not required to post speed limits on a road containing a bicycle lane. A bicycle lane needs to have the appropriate signs and markings in place prior to changing the speed limit utilizing this statute. The MN MUTCD, Section 1A-13 covers important definitions relating to bicycles.
2-5.03.11  Speed Limits in Manufactured Home Parks and Recreational Camping Areas - Minn. Stat. Sec. 327.27, Subd. 2 and 2a.

2-6.00  NO PASSING ZONES AND LANE DESIGNATIONS

2-6.01  No Passing Zones
Minn. Stat. Sec. 169.18, Subd. 5(b) provides the legal basis for establishing “no passing zones.” It is MnDOT practice to indicate such no passing zones on rural (two- and three-lane roadways) by “No Passing Zone” pennant signs and distinctive pavement markings. Since drivers have become very dependent upon these devices, proper maintenance of these signs and markings is very important. The District Engineer is responsible for the application and proper maintenance of no passing zone signs and markings in accordance with the procedures set forth in Chapters 6 and Chapter 7 of this manual.

2-6.02  Lane Designations
Under Minn. Stat. Sec. 168.18, Subd. 7(c), MnDOT may erect signs on trunk highways (or authorize the erection of such signs on local highways) directing traffic to use specific lanes. Special lanes may be designated when certain vehicles (for example, trucks) cannot maintain the speed required to keep the speed differential within 15-20 mph and there is adequate space available. In addition, special bus and car pool lanes, known as restricted lanes, are designated on certain freeway entrance ramps within the eight county metro region.

2-7.00  THROUGH HIGHWAYS AND CONTROLLED ACCESS HIGHWAYS

2-7.01  Through Highways
The general rule in determining through highways (Minn. Stat. Sec. 169.30) is that intersection controls should be designed to favor the predominant traffic flow. Normally, it is desirable to erect STOP signs at all public entrances to trunk highways except where another means of control is provided. However, where trunk highway traffic is minor in comparison to traffic on the intersecting road, the intersecting road could have priority. MnDOT places and maintains the necessary STOP signs on all public streets and roads intersecting a trunk highway. STOP signs are usually not placed at private or commercial entrances, except as determined by the District Traffic Engineer. See Chapter 6 of this manual for practice on installation and maintenance of advance warning signs on local road approaches to trunk highway intersections.

Local authorities may designate through highways and stop or yield intersections involving trunk highways only with MnDOT’s prior consent.

2-7.02  Controlled Access Highways
Minn. Stat. Sec.169.305 grants authority to MnDOT and local authorities to prohibit “incompatible” traffic on controlled access highways under their respective jurisdictions. The restriction of non-motorized traffic, including pedestrians and bicyclists, and of motorized bicycles is specifically included within this authority. Such prohibitions and restrictions are effective only when appropriate signs are erected on the affected highway. It is important to note that MnDOT may restrict traffic classes but is not required to do so by law.

2-8.00  PARKING REGULATIONS

2-8.01  General Regulations
Minn. Stat. Sec. 169.34 Prohibitions; Stopping, Parking contains general regulations regarding stopping or parking on public streets and highways.

2-8.01.01  Restrictions on Trunk Highways
Beyond the parking regulations established by law in Minn. Stat. Sec. 169.34, MnDOT may restrict or prohibit parking on trunk highways whenever it is dangerous to highway users or would interfere with the free
movement of traffic. Any parking restrictions on trunk highways within municipalities should be established with the concurrence of the local authority.

2-8.01.02 Local Authority

Local authorities may also restrict parking by ordinance or resolution. Any proposed local restrictions on trunk highways shall normally be approved by the District Engineer.

2-8.02 Limited Time Parking

Limited time parking is a local concern which is controlled by local authorities. It is MnDOT’s practice to give considerable latitude to local communities in setting parking time limits.

2-8.03 Parking Meter Zones

Local authorities may establish parking meter zones as they deem necessary within local communities, and should use standard pavement markings to designate parking spaces. Standards for parking space dimensions and markings are described in Chapter 7 of this manual and Chapter 3 of the MN MUTCD.

2-8.04 Disabled Parking

2-8.04.01 Applicable Laws

Minn. Stat. Sec. 169.345, Parking Privilege for Physically Disabled, and Minn. Stat. Sec. 169.346, Disability Parking Areas; Criteria, Enforcement establish criteria and requirements to provide the disabled with adequate parking facilities.

2-8.04.02 Signing and Marking for Disabled Parking Spaces

The MN MUTCD and Minnesota Standard Signs Manual provide sign designs and details. Full size drawings for the “Disabled Parking” sign (R7-8m) and for the disabled pavement marking symbol are available from the Office of Traffic Engineering (OTE).

2-8.04.03 Source of Information

The Minnesota State Council on Disability (http://www.disability.state.mn.us/) is a good source of information on legal issues concerning disabled parking.

2-8.05 Angle or Parallel Parking

2-8.05.01 Applicable Law Minn. Stat. Sec. 169.35, Subd. 1 is as follows:

“Except where angle parking is permitted by local ordinance, each vehicle stopped or parked upon a two-way roadway where there is an adjacent curb shall be so stopped or parked with the right-hand wheels of the vehicle parallel with and within 12 inches of the right-hand curb, provided, that such exception shall only apply to a State trunk highway after approval by the Commissioner.”

2-8.05.02 MnDOT Guidance

All requests for parking along trunk highways should be reviewed on a case-by-case basis. Consideration should be given to traffic volumes, speeds, roadway width, and bicycle and pedestrian needs in determining the type of parking allowed (parallel, front-in angle, back-in angle, other).

Where traffic is low volume (<10,000 ADT multilane; <5,000 ADT one lane) and low speed (≤ 20mph) there may not be much difference in safety between parallel and angled parking. However, with slightly higher volume (< 15,000 ADT) and slightly higher speed (≤30mph) parallel parking may be the safer choice.
Low volume roads are preferred for both parallel and angled parking due to reduced conflicts and reduced impacts to traffic flow. Low volume roads provide larger gaps allowing drivers more time to park, exit their vehicle, and later maneuver back into traffic safely.

On street parking may not be compatible where there is higher priority for serving traffic flow needs.

Back-in angle parking gives exiting vehicles superior sight lines allowing increased visibility to vehicles, pedestrians, bicyclists, and other modes of transportation. The maneuvers for back-in angle parking are similar to parallel parking.

Potential issues with back-in angle parking include:

- Head-in violators,
- driver unfamiliarity, and
- exhaust from idling vehicles.

MnDOT discourages front-in angle parking in most cases due to increased crash rates compared to other types of parking.

2-8.06 Parking on One-Way Streets

Under Minn. Stat. Sec. 169.35, Subd. 3, local authorities may permit parking near the left curb of local one-way streets by ordinances. Prior consent of MnDOT is required to permit such parking on trunk highways.

2-9.00 LOAD RESTRICTIONS

2-9.01 General Load Restrictions

Load restriction laws in Minnesota restrict: (1) width, (2) height, (3) length, and (4) mass of loads which may be carried on streets and highways in Minnesota. These laws are included in Minn. Stat. Sec. 169.80-169.88. They are very specific and include many exceptions and conditions, the user should refer directly to the Minnesota Statutes.

2-9.02 Seasonal Restrictions

Under Minn. Stat. Sec. 169.87, Subd. 1, MnDOT, with respect to trunk highways, and local authorities, with respect to highways under their jurisdiction, may prohibit or restrict the operation or mass of vehicles on any highway which would be seriously damaged or destroyed by such use. The basis for this determination should include deterioration, rain, snow, or other climactic conditions. Signs stating the prohibition or restrictions must be erected on the affected highways to promulgate these regulations.

2-9.03 Truck Routes

Based on Minn. Stat. Sec. 169.87, Subd. 1e, when a local authority petitions MnDOT to establish a truck route for travel into, through, or out of the territory under its jurisdiction, MnDOT shall investigate the matter. If the request is approved, MnDOT may designate certain highways under MnDOT’s jurisdiction as “truck routes” and may restrict truck travel to those routes when signs are erected. However, except under conditions stated in Minn. Stat. Sec. 169.87, MnDOT is not authorized to prohibit truck travel on trunk highways. The designation of a truck route is based on the design of the roadway, the type and mass of trucks using the facility, the load carried, and weather conditions.

2-9.04 Load Permits

Under the provisions of Minn. Stat. Sec. 169.86, Special Permits, MnDOT may issue several types of permits related to load restrictions. For example, “single trip” permits can be issued for specific trips; “job” permits can be issued for a specific activity for a specific length of time; an “annual” permit can be issued for a period not to exceed 365 days; and a “special interest” permit can be issued for a certain project for specific length of time.
These special permits are issued, where the applicant shows good cause, for the vehicle to travel over a certain route where the vehicle and/or load exceed the normal legal operating size or mass limits. MnDOT may only issue permits for use on trunk highways. Load permits are issued by the District Offices, and through the Office of Freight and Commercial Vehicle Operations, Transportation Permit Section.

2-10.00 ADVERTISING DEVICES

2-10.01 Minnesota Outdoor Advertising Control Act

2-10.01.01 Advertising Restrictions

\textit{Minnesota Stat. Sec. 173.01 “Declaration of Policy”} forms the basis for the control of advertising along interstate and primary highways in Minnesota. \textit{Chapter 173} of Minnesota statutes provides for: (1) the designation, acquisition, and control of “scenic areas” along interstate and primary highways, and (2) the general control of outdoor advertising along interstate and primary highways. Special advertising controls are provided in \textit{Articles 173.01-173.17} and may be exercised in scenic areas. In addition, the law specifically prohibits advertising devices:

1. In or within 500 feet of national parks, state parks, local parks, historic sites, and public picnic or rest areas.
2. Within 100 feet of a church or school.
3. Which purports to be or resembles an official traffic-control device, sign, or signal, or railroad sign or signal; or which hides from view or interferes in any material degree with the effectiveness of any traffic-control device, sign, or signal, or railroad sign or signal, or which obstructs or interferes with the driver’s view of approaching, merging, or intersecting traffic for a distance not to exceed 500 feet.
4. Which prominently displays the word “stop” or “danger”.
5. Which contains statements, words, or pictures of an obscene, indecent, or immoral character, or such as would offend public morals or decency.
6. On any right-of-way of the interstate system of highways, except as otherwise provided by law or allowed by the Commissioner.
7. On private land without the consent of the owner or occupant thereof.
8. On trees, shrubs, or which are painted or drawn upon rocks or natural features, or on public utility poles.
9. Which has distracting flashing or moving lights so designed or lighted as to be a traffic hazard. See \textit{MnDOT Technical Memorandum} No. 13-07-ENV-01 dated May 8, 2013. The guideline is intended for evaluating and providing a uniform policy regarding all off-premise outdoor advertising devices that utilize lighting for illumination and displaying messages or pictorial images.
10. To which access can be obtained only from an interstate main-traveled way but excluding frontage roads adjacent thereto.
11. Which are structurally unsafe, are in disrepair, or are abandoned.

2-10.01.02 Design of Advertising Devices

Advertising devices near highways must, in general, be structurally safe and of a design which does not resemble a traffic control device or create a traffic hazard. Specific rules and regulations affecting Outdoor
Advertising are provided in Minnesota Rules, 8810.0200 - 8810.1400 and in Minn. Stat. Sec. Chapter 173, Signs and billboards Along Highways.

2-10.01.03 Advertising Permits

All advertising devices adjacent to interstate or primary highways outside business districts require a permit from MnDOT. Advertising permits are issued by the District in each appropriate District office. Questions regarding advertising devices should be directed to the District Sign Technician or District Permits Office. Local zoning authorities issue permits for advertising devices in business districts.

2-10.02 Resort and Camping Information Signs (County Slat Sign Program)

The intent of the Resort and Camping Signing Program (County Slat Sign Program) is to govern the installation of resort information “slat” type signs on county state-aid highways, county highways, and town roads within one-half mile of areas that have advertising restrictions. The intent of these signs is to give motorists confirmatory guidance or reassurance that they are on the right road once they have turned off a trunk highway. Standard guide signs must guide them to this point.

Minn. Stat. Sec. 160.283 Subd 3 defines the term “resort” as follows. For the purposes of sections 160.283 to 160.285 the term “resort” shall be as defined in section 157.15 or a golf course, restaurant, or motel as defined in section 157.15 or recreational camping area as defined in section 327.14, subdivision 8.

A complete description of the Resort and Camping Signing Program as well as required procedures and specifications for implementing same can be found in the MN MUTCD, Chapter 2M.11 and Chapter 6 of this manual.

2-10.03 Specific Service Signs

The intent of the Specific Services Sign Program (Minn. Stat. Sec. 160.292) is to govern the installation, design, and criteria for specific service signs (Minn. Stat. Sec. 160.292, Subd. 21). The intent of these signs is to direct the traveling public on non-freeway trunk highways in rural areas to rural agricultural or tourist-oriented businesses, places of worship, motels, restaurants, resorts, recreational camping areas, or gasoline service stations or other retail motor fuel businesses where outdoor advertising restrictions have prevented owners of these facilities from directing the public to their establishments.

A complete description, required procedures, and specifications for implementing the specific services sign program are given in MN MUTCD, Chapter 2K and Chapter 6 of this manual.

2-10.04 LOGO Sign Franchise Program

The LOGO Sign Franchise Program (Minn. Stat. Sec. 160.80) allows MnDOT to establish a sign franchise program. The intended purpose is to provide, on the right-of-way of interstate and certain specified controlled-access trunk highways, specific information on gas, food, camping, lodging, attractions, and 24-hour pharmacies for the benefit of the motoring public.

Pertinent information on this Program is given in MN MUTCD, Chapter 2J and Chapter 6 of this manual.

2-10.05 Directional Signs (Advertising Devices) - Minn. Stat. Sec. 173.081

Minn. Stat. Sec. 173.081 provides for the establishment of advertising “directional” signing standards for qualifying public or private attractions, which are nationally or regionally known and of outstanding interest to the traveling public. See Minn. Stat. Sec. 173.02, Subd 6(a) for definition of “Official signs and notices”, and Minn. Stat. Sec. 173.02, Subd 6(d) for definition of “Directional signs”.

“Directional” signing in this advertising context should not be confused with guide signing of a traffic control nature as developed in the Minnesota Manual on Uniform Traffic Control Devices.

“Selection Methods and Criteria for Outdoor Advertising Directional Signs” was developed by the Office of Environmental Stewardship (in cooperation with FHWA) and is available therefrom. Signs are erected off MnDOT right-of-way.
Applicants for advertising directional signing should contact the District Permits Office: www.dot.state.mn.us/roadsides/billboards.

2-11.00 PERMITS

2-11.01 General
Beyond the load restriction permits described in Section 2-9.04, traffic engineers in Minnesota should be aware that under special circumstances, permits may be issued for studded tires, parades, and entrances.

2-11.02 Studded Tire Permits
Under most circumstances, the use of studded tires is not permitted on streets or highways in Minnesota (Minn. Stat. Sec. 169.72, Subd. 1.) Special permits may be issued to certain traction engines, tractors, and other farm machinery. These permits are issued by the District Offices and through the Office of Contract Administration and Maintenance, Emergency Operations Unit, Transportation Permits.

2-11.03 Parade Permits
Local authorities, with the consent of MnDOT, may regulate or prohibit all assemblages on the streets and highways under their jurisdiction (Minn. Stat. Sec. 169.04.) MnDOT procedures are described in the criteria listed in Chapter 14 of this manual.

2-11.04 Entrance Permits
“The owner or occupant of property abutting upon a public highway, having a right of direct private access thereto, may provide such other or additional means of ingress from and egress to the highway as will facilitate the efficient use of the property for a particular lawful purpose, subject to reasonable regulation by and permit from the road authority as is necessary to prevent interference with the construction, maintenance and safe use of the highway and its appurtenances and the public use thereof.” See Minn. Stat. Sec. 160.18, Subd. 3.

2-11.04.01 Driveway Permits and Design
No driveway shall be constructed to or from a trunk highway until permits have been obtained from the District Traffic Engineer and the local governing authority. Rules and regulations for the design of driveways along the trunk highway system are provided in Minnesota Rules 8810.4100-8810.5600.

2-11.05 Special Event Permits and Agreements
MnDOT occasionally receives requests from organizations wishing to sponsor special events that require special traffic control measures and/or special use of the highway right-of-way. These special events include activities such as snowmobile races, golf tournaments, farm festivals, and music festivals.

The organization may be granted a special events permit or a formal agreement may be executed wherein certain conditions must be met. Items to be considered include:

1. Insofar as applicable to the event, all Minnesota laws pertaining to the use of highway right-of-way shall be obeyed.

2. Additional traffic control devices and/or law enforcement officers shall be provided by the organization (MnDOT may furnish services and bill the sponsor) as deemed necessary by MnDOT to adequately control traffic generated by the event, or as related to the event itself.

3. MnDOT may require a special event traffic control plan for events that substantially impact the flow of traffic in and around the special event. This plan is to be provided by the requester.
4. The organization shall agree to assume entire responsibility and liability for all damages or injury to all persons, whether employees or otherwise, and to all property, arising out of, resulting from, or in any manner connected with the operation of the special event. The organization shall agree to indemnify MnDOT, its agents and employees from all such claims including, without limiting the generality of the foregoing claims for which MnDOT may be claimed to be liable and legal fees and disbursements paid or incurred to enforce the provisions of this paragraph, and the sponsor shall further agree to obtain, maintain, and pay for such general liability coverage as will ensure the provisions of this paragraph.

5. The sponsor shall be responsible for any damage done to the highway property as a result of the special event, damages payable upon receipt of invoice.

Since many special events will be unique, MnDOT’s Tort Claims Engineer should be consulted as deemed necessary.

2-12.00 OTHER LEGAL CONSIDERATIONS

2-12.01 Particular Use of Right-of-Way - Minn. Stat. Sec. 160.27

2-12.01.01 Permitted Devices

As stated in Minn. Stat. Sec. 160.27, Subd. 1, 2, and 4, the only items other than official traffic control devices which may be placed within street or highway right-of-way include: (1) public notices, (2) benches and bus shelters, and (3) customs inspection facilities. These items shall be authorized by written permit by the appropriate road authority. In the case of trunk highways, it is the responsibility of the Transportation District Engineer to issue such permits. Before issuing such permits an investigation should be conducted to insure compliance with the appropriate safety criteria.

2-12.01.02 Prohibited Devices

Minn. Stat. Sec. 160.2715, provides a detailed list of actions which are not permitted within highway rights-of-way. Most important to traffic engineers, this law states that it is unlawful to “improperly place or fail to place warning signs and detour signs as provided by law.”

2-12.01.03 Violations

Violations of Minn. Stat. Sec. 160.2715 are misdemeanors.

2-12.02 Plat Review - Minn. Stat. Sec. 505.03

Under the provisions of Minn. Stat. Sec. 505.03, Subd. 2, any proposed plat which includes lands adjacent to an existing or proposed trunk highway shall be submitted to MnDOT for review. Districts/Divisions may be asked by MnDOT to review these plats. Procedures for reviewing proposed plats are outlined in Chapter 14 of this manual. MnDOT has 30 days to complete the plat review and to submit written comments and recommendations to the local authority. The law does not require the local authority to receive these comments; it only requires that final action be delayed until comments are received or the 30-day waiting period has passed.

2-12.03 Technical Assistance - Minn. Stat. Sec. 161.39

Under the provisions of Minn. Stat. Sec. 161.39, Subd. 1, 2, 3, 4, 5a and 6, MnDOT, when staff and work load conditions permit, may provide technical assistance to both local communities and other state agencies upon request. This assistance may include: technical and engineering advice, assistance, and supervision; surveys; plans; studies; investigations; and pavement markings. The local authority or State agency shall pay MnDOT for any technical services provided to them by MnDOT representatives.
2-12.04 Bridge Width and Clearance Requirements

2-12.04.01 Bridge and Culverts - Minn. Stat. Sec. 165.04

Minn. Stat. Sec. 165.04 requires that all bridges and culverts on any trunk highway, county state-aid highway, or municipal state-aid street hereafter established, constructed, or improved shall be at least 24 feet wide between curbs, and approaches thereto shall be at least 28 feet wide, shoulder to shoulder.

On other roads, all bridges, culverts, and approaches hereafter established, constructed, or improved shall be at least 20 feet wide.

There are notable exceptions to these requirements and the law should be reviewed carefully relative to bridge width requirements.

2-12.04.02 Railroad Bridge - Minn. Stat. Sec. 165.05

Minn. Stat. Sec. 165.05 requires that any railroad bridge hereafter constructed over a public highway, including city streets, shall be constructed so as to leave a clear opening for the highway at least 4 feet wider than the surfaced portion of the highway, but in no event less than 28 feet wide, except as may be modified and approved by MnDOT.

Minn. Stat. Sec. 165.05 further requires that at least 16 feet vertical clearance shall be provided from the surface of the highway to the bottom of the bridge.

On non-trunk highways, the vertical clearance shall not be less than 14 feet. Lesser clearances may be approved by MnDOT.

2-13.00 REFERENCES

1. A Guide to Establishing Speed Limits in School Zones, Minnesota Department of Transportation 2012 (contained in the Minnesota Manual on Uniform Traffic Control Devices, Department of Transportation).


CHAPTER 3 - FREEWAY CORRIDOR TRAFFIC MANAGEMENT

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3-1.00 INTRODUCTION

MnDOT is responsible for the planning, design, integration, operation, and maintenance of freeway corridor traffic management systems. These responsibilities, within the metropolitan area, are assigned to the Regional Transportation Management Center.

3-1.01 Purpose

The purpose of freeway traffic management systems is to optimize traffic flow in the metro area freeway corridors, with specific objectives including the following:

1. Minimize the magnitude and duration of congestion.
2. Maximize the traffic flow through freeway bottlenecks.
3. Reduce the crash rate and improve safety.
4. Minimize the impact of incidents.
5. Provide freeway operations support of special events, construction, and maintenance activities.
6. Promote travel demand management via High Occupancy Vehicle (HOV) facilities and other demand management initiatives.
7. Provide aid to stranded motorists.
8. Provide traveler information.

3-1.02 Chapter Organization

Chapter 3 is subdivided into six sections, 1) the Regional Transportation Management Center, 2) Surveillance Systems, 3) Control Systems, 4) Preferential Treatment Systems for HOVs, 5) Incident Management, and 6) Computer Systems. Each subdivision describes the purpose and nature of the systems in that subdivision, and provides guidelines for design and operation. In addition, a list of important terms used in freeway traffic management is provided below.

3-2.00 GLOSSARY

Bottleneck
A section of freeway where the capacity is less than previous sections thereby creating a restriction in the normal flow of traffic in peak-demand periods.

Capacity
The maximum number of vehicles that can pass over a section of roadway during typical conditions (normally expressed as vehicles per hour per lane).

Delay
An interruption of normal travel involving a slowing or stopping. It is the difference between interrupted and uninterrupted travel times.

Demand
The number of vehicles desiring to use a section of road during a specific time period.

Density
The number of vehicles on a section of freeway per unit of length, usually expressed in vehicles per mile.

Headway
The time (in seconds) between consecutive vehicles, measured from the front bumper of one vehicle to the front bumper of the next vehicle as they move past a given point.
Incident
An event on or near the roadway which blocks or restricts the flow of traffic or has the potential to do so. Examples are crashes, stalled vehicles, and spilled loads.

Metering Rate
The rate at which vehicles are permitted to enter a freeway via a ramp control signal usually measured in seconds per vehicle.

Occupancy
The percentage of time that a detector in a lane on a roadway is covered or occupied by a vehicle or vehicles. The occupancy is computed for given lengths of time, i.e., 30 seconds, one minute, or five minutes, and expressed as a percentage. Occupancy, as computed using 6’ x 6’ loop detectors, may be used as a direct measure of traffic density with each 10 percent occupancy being equivalent to 25 vehicles per mile.

Platoon
A group of vehicles traveling together as a group, either voluntarily or involuntarily, because of traffic signal controls, geometrics, or other factors. Traffic leaving a signalized intersection when the light turns green is a platoon.

Queue
A line of vehicles waiting at a traffic signal or ramp meter signal, or backed up at a bottleneck.

Recurrent or Recurring Congestion
Congestion that occurs at predictable times daily or weekly due to demand exceeding capacity.

Shockwave
The phenomenon which describes the movement of the point in a traffic stream where stopping or slowing of successive vehicles occurs. If the upstream flow rate is about equal to the downstream flow rate, the shockwave will stay in one location on the freeway (standing shockwave). If the upstream flow rate is greater than the downstream flow rate, the shockwave will move upstream. This is a principal cause of rear-end collisions on a freeway.

Weaving
A situation in traffic flow which describes necessary lane changing both right to left and left to right by numerous vehicles, usually at freeway entrances, exits, or diverge areas.

3-3.00 REGIONAL TRANSPORTATION MANAGEMENT CENTER (RTMC)
The original Traffic Management Center opened in 1972 as part of the I-35W Urban Corridor Demonstration Project. The new RTMC has re-located from downtown Minneapolis to the Waters Edge campus at 1500 West County Road B2 in Roseville. As part of the relocation, MnDOT’s Metro Maintenance Dispatch, MnDOT’s Metro District Traffic Operations Section, and the Department of Public Safety’s State Patrol Dispatch have integrated into a unified command center in the new RTMC.

Freeway corridor operations activities coordinated from the RTMC include traffic management system maintenance and operation, incident management, and integration of freeway operations with agencies operating arterial street traffic signal systems.

The RTMC currently operates 480 ramp meters, 800 closed circuit television (CCTV) cameras, 160 dynamic message signs (DMS), 330 lane control signs (LCS), the MnDOT Traffic Radio program, and provides traveler information for various media outlets including the internet and 511.

Fiber optic communications cables have been installed between the RTMC and a number of key agencies involved in arterial street traffic control, enforcement, transit operations, and incident response. These agencies include the State Patrol, MnDOT Maintenance Operations, Metro Transit, the cities of Minneapolis and St. Paul, and Hennepin and Ramsey counties. The fiber optic communications subsystem makes it possible to provide integrated corridor traffic management in the entire metro area. Fiber optic communications has also been extended to the Center for Transportation Studies (CTS) at the University of Minnesota providing video and data for a student traffic management lab and CTS traffic management research projects. CCTV signals have also been made available to many of the Twin Cities television stations.
3-4.00 SURVEILLANCE SYSTEMS

3-4.01 Purpose
Surveillance systems provide department personnel and computer systems with “real-time” information regarding traffic flow and incidents on the freeways so that appropriate control decisions and immediate action can be taken to maintain safe and efficient operation. Surveillance data is also used to provide information to motorists approaching an incident or congested area.

Continuous information is provided on the volume of traffic and level of congestion (lane occupancy) on each monitored freeway segment. This information is used to determine metering rates at ramp control signals, appropriate displays on DMSs and lane control signals, and the operation of a color graphics map display indicating volume or occupancy which allows department personnel to monitor overall operation of the freeway.

The principal surveillance systems used by the department are electronic vehicle detectors and CCTV. Additional surveillance is provided through visual observations via cellular 911 calls monitored by the State Patrol and local police radios, Freeway Incident Response Safety Team (FIRST) emergency response vehicles, and aerial surveillance via helicopter through a partnership with the State Patrol.

Detector data and CCTV pictures of incidents on the freeway provided to emergency service providers (police, fire, ambulance) allow them to accelerate dispatching.

3-4.02 Electronic Vehicle Detectors
Electronic vehicle detectors are devices used to indicate the presence of vehicles in a lane. MnDOT utilizes two types of vehicle detectors; inductive loops and microwave radar detectors.

Inductive loops are 6’ x 6’ loops of wire, cut and sealed into the pavement of the freeway. The wire in the loops is connected to an amplifier in a nearby cabinet. The electrical current in the loop sets up a magnetic field which is disturbed when a vehicle moves above it. This disruption is reported to a controller and in turn to a central computer at the RTMC. Through these detectors, it is possible to determine traffic volume (e.g., vehicles per hour, vehicles per five minutes, and vehicles per 30 seconds) and the general traffic density, level of congestion, and/or lane occupancy.

To measure lane occupancy of inductive loops, the controller records the percent of time, over a 30-second time interval, that the space monitored by the loop is occupied. If the loop is occupied 40 percent of the time (12 seconds of a 30 second period), the traffic density on the freeway is approximately 100 vehicles per mile. If it is occupied 20 percent of the time (six of the 30 seconds) the density is approximately 50 vehicles per mile.

Microwave radar detectors are electronic devices mounted on poles alongside of the freeway. They detect individual vehicles and measure their speed, occupancy, length, and lane assignment.

Vehicle detectors are the backbone of the freeway surveillance system because they provide continuous system-wide volume and lane occupancy data which can be monitored and analyzed by a computer. “Mainline” detectors at one half mile spacing measure volume and occupancy in each freeway traffic lane. “Queue” detectors are placed at the top of ramps upstream of ramp meters. These are used to measure queue lengths and ensure that vehicles do not wait more than the prescribed four minutes. “Exit” detectors count the number of vehicles leaving the freeway. “Entrance” detectors count the vehicles entering the freeway.

Data from mainline detectors are displayed in the RTMC which show the “real-time” status of traffic on the freeways. The display is a map of the freeways representing vehicle detectors in the roadway which show green, yellow, or red in response to occupancy (traffic density) on the freeway, as indicated by the computer analysis of the data received from the detectors.

3-4.03 Closed-Circuit Television (CCTV)
CCTV systems consist of a series of cameras mounted on 50-foot poles at strategic vantage points to provide a comprehensive visual surveillance of roadways. Good viewing capability is limited to about one half mile in each direction. Therefore, a spacing of one mile or less between cameras is necessary for total coverage.
Remote control of the cameras originates from a CCTV control panel located within the RTMC. Currently two types of cameras are used. One type of camera has pan and tilt capability, zoom lenses, iris and focus adjustment, environmental housing with thermostatically controlled heaters, and blowers. The other type of camera is the dome camera with zoom lenses, pan and tilt, and 360 degree rotation. Most of the CCTV signals are transmitted to the RTMC via fiber optic cable. The control of the camera and the camera environmental housing utilize fiber optic cable and a single pair of communication cables.

CCTV enables operators in the RTMC to view traffic conditions on the freeway. CCTV provides the operator the ability to respond quickly with the appropriate course of action to warn approaching vehicles. For example, a vehicle detector might alert the RTMC operator to a congestion problem. The operator would respond by aiming and focusing a camera in the area where the congestion was reported. If the problem was created by an incident, the dispatcher would contact FIRST or the State Patrol and relay all information as to type of incident, severity, and probable needed services. CCTV is also used to verify the validity and determine the severity of incidents detected by other means.

3-4.04 Radio Relay of Visual Observations
Surveillance information is also obtained in the RTMC by monitoring the State Patrol and local law enforcement agencies’ radio frequencies. This information enables the operator at the RTMC to locate incidents on the freeway, monitor complications, and proceed with incident management accordingly. Department personnel, who spend a considerable amount of time working or driving on the freeways, provide surveillance information by two-way radios and cellular phones.

3-5.00 CONTROL SYSTEMS

3-5.01 Purpose
Ramp metering has been used by MnDOT for more than thirty years to improve freeway traffic flow and to enhance motorist safety. One objective of ramp metering is to ease the merge of ramp traffic into the flow of traffic on the mainline. The main benefit at the merge area is to minimize the disruption of flow on the freeway caused by platoons of merging vehicles. Early in Minnesota’s experience with freeway traffic management, another necessary objective of ramp metering became apparent. If not controlled, flow on the freeway will exceed the capacity at critical bottlenecks and the resultant congestion (shockwave activity) will cause crashes and reduce traffic flow. To accomplish the second objective, the Minnesota algorithm has evolved into a real-time, density based, zone control equation.

3-5.02 Ramp Control Signal Systems
Ramp control signal systems are used for regulating or metering access to the freeway. Traffic signals are mounted on the freeway ramp approximately 500 feet (350 foot minimum) upstream from the point where the ramp and freeway merge.

Ramps with a two-lane, single vehicle release operation require a pedestal with dual signal heads mounted on each side of the entrance ramp. The signal heads are three-section, 8-inch circular red, yellow, and green indications mounted at 5 and 10 feet, respectively. One head is aimed at the stop line and one is aimed upstream at vehicles entering the ramp. Two lane ramps, with a pavement width of 22 feet, require similar pedestals with similar dual signal heads mounted on the left and right sides of the ramp.

The signing sequence for a two-lane, single-vehicle release operation consists of the “Signal Ahead” sign (W3-3) and a “ONE CAR PER GREEN” sign (R10-X2 or R10-X6) mounted on the pedestal shaft. Multi-lane, single vehicle release ramps also have appropriate lane signing mounted on the signal pedestal shaft.

Flashers are installed above standard “Signal Ahead” signs on high-speed ramps requiring advance warning of the metering operation. The flashers, 8-inch circular yellow indications mounted at a height of 10 feet, operate during the metering period.

Proper utilization of the ramp control signal system is achieved when a vehicle approaches the signal, stops for the red signal, waits for the green signal, and then proceeds onto the freeway. Subsequent vehicles utilize the
same operation. Vehicles are released alternately from each lane. In periods of light traffic flow on the freeway, the signal flashes yellow and vehicles may proceed directly onto the freeway.

In traffic-responsive metering systems, the ramp control signal operations are based on commands from a controller in a field control cabinet. The control cabinet in turn responds to the central computer at the RTMC. Ramp meters will begin metering as local (within three miles) traffic conditions approach congestion. The metering rate of a ramp control signal is based on the local traffic density as determined by the central computer using data from the surveillance system. The higher the traffic density, the more restrictive the ramp meters will be. Ramp conditions are also monitored and the signal timing is adjusted to avoid long wait times and vehicle queues backing up onto side streets. If conditions warrant, the RTMC control room staff can override the computer selected metering rate. (See Section 3-5.03 below for a detailed description of the metering rate algorithm.)

3-5.03 Ramp Meter Algorithm

3-5.03.01 Minnesota Experience
Freeway ramp metering has been used by MnDOT for over thirty years to improve freeway traffic flow and to enhance motorist safety. There are two main objectives of freeway ramp metering. The first objective is to ease the merge of traffic from an entrance ramp with traffic on the mainline. The benefit to the merge area is to minimize the disruption of flow on the freeway caused by platoons of merging vehicles. The second objective of freeway ramp metering is to minimize congestion. With little or no volume control of traffic on entrance ramps, flow rates on a freeway may exceed the capacity at critical bottleneck locations. The resultant shockwave activity (congestion) limits the flow rate on the freeway to below 1700 vehicles per lane per hour, and has the potential to cause an increased number of crashes. The Minnesota algorithm allows sustained flow rates on a managed freeway of 2200 to 2400 vehicles per hour per lane. To accomplish the second objective, the Minnesota algorithm has evolved into a real-time, density based control equation, called segment density ramp metering.

Segment density ramp metering considers traffic densities on the mainline and volumes on ramps, and attempts to maximize mainline traffic volume while limiting queue waits to four minutes on local access ramps and two minutes on freeway to freeway ramps. If queue detectors sense ramps queues exceed the limits or are backing up onto local streets, the metering rates increase which clears the queue backups in the ramps.

3-5.04 Ramp Design
The following are general design guidelines for metered freeway entrance ramps:

1. Minimum of 300 feet between the ramp control signal and the nose (end of physical curb separation between ramp and freeway).
2. Minimum storage distance of 25 feet per vehicle for a six-minute metered volume between the cross street and the ramp control signal.
3. Two-lane ramps with single-lane entrance for all ramps with projected volumes of 500 vehicles per hour or greater.
4. Adequate graded width on all ramps for future pavement widening to accommodate an HOV bypass ramp.
5. Maximum of plus one percent grade for the last 500 feet of the ramp.

3-5.05 Lane Control Signals

3-5.05.01 Standard Lane Control Signals
Standard lane control signal systems, such as the I-94 Lowry Hill tunnel system, are used to warn or control traffic on the freeway. Lane control signals are 18-inch square indications which display either a red X, a downward yellow arrow, or a downward green arrow. Lane control signal systems are used on potentially hazardous sections of freeway to provide adequate advance warning of traffic conditions in each lane.
3-5.05.02 Intelligent Lane Control Signals

Intelligent lane control signals (ILCS) are four (4) foot by five (5) foot full color matrix dynamic message signs mounted above each lane on overhead sign structures. ILCS are capable of displaying symbols as well as text to provide motorists advance warning of traffic conditions in each lane.

ILCS are used to display advisory variable speed limits. Advisory variable speed limits are posted on ILCS in advance of slowed traffic. The goal of the advisory variable speed limit system is to mitigate shock wave propagation from downstream bottlenecks by gradually reducing speed levels of incoming traffic flow.

The priced dynamic shoulder lane (PDSL) on I-35W is controlled using ILCS. Messages are displayed on the ILCS approaching and within the PDSL indicating the open or closed condition.

3-6.00 PREFERENTIAL TREATMENT SYSTEMS FOR HIGH OCCUPANCY VEHICLES AND MNPASS

3-6.01 Purpose

Preferential treatment for High Occupancy Vehicles (HOVs) (buses, car pools, and van pools) is one approach to improve the operational efficiency of freeways (i.e. moving greater numbers of people without moving greater numbers of vehicles). Time savings and higher Levels of Service (LOS) due to preferential treatments are meant to provide an incentive for Single Occupant Vehicle (SOV) drivers to change their mode of travel.

Preferential treatment systems for HOVs include ramps to allow HOVs to bypass meters, MnPass lanes, reversible lanes, and a cooperative effort with Metro Transit, called Team Transit (see Section 3-6.05).

3-6.02 Preferential Treatment Ramps

HOV preferential access to the freeway is generally provided with an adjacent ramp lane (meter bypass lane) separated from other ramp lanes by a raised island. Given right-of-way and freeway operational constraints (e.g., access openings, right-of-way costs, number and proximity of freeway access points, etc.), HOVs and SOVs generally should share ramp entry and freeway merge locations. In this case, it is important that the length of freeway ramp is sufficient to accommodate the ramp meter queue without blocking HOV access to the ramp meter bypass. Exclusive HOV ramps, with separate ramp entry and freeway merge points, may be constructed when justified.

Ramp meter bypasses are not metered unless platoons on the bypass have potential to cause problems on the freeway.

Preferential treatment for HOVs entering a freeway is provided whenever vehicle occupancies are such that person-delay at the ramp control signals is sufficient to warrant the expense of constructing special meter bypass ramps and sufficient right-of-way exists.

3-6.03 MnPass Express Lanes

MnPass express lanes are high occupancy toll (HOT) lanes which charge single occupant vehicles a fee for use but allow free use for vehicles with two or more occupants, buses and motorcycles. MnPass express lanes are designed and operated to provide a congestion free alternative to freeway general purpose lanes. MnPass lanes on freeways offer time savings and higher LOS over travel in congested mixed-use traffic lanes.

User compliance with MnPass express lanes may be difficult to enforce. To minimize problems with the user not understanding diamond lane requirements, HOV lane signing and diamond pavement markings should be displayed at frequent intervals.

3-6.04 Reversible Lanes

On some freeway segments where peak period travel demand is directional by time-of-day, reversible lanes for MnPass may be constructed to provide added capacity in the peak direction. MnDOT is currently using reversible MnPass express lanes on I-394 between I-94 and TH 100. The development of reversible MnPass
express lane facilities requires special traffic control systems. To ensure compliance to directional flow roadways, a physical control similar to a railroad crossing gate is used.

3-6.05 Team Transit
Team Transit is a cooperative effort by several transportation agencies including MnDOT, Metro Transit, and the Cities of Minneapolis and St. Paul. Together, the team plans and implements innovative improvements to the transportation system in order to move buses and other HOVs efficiently through peak period traffic congestion.

Bus-only shoulders allow transit buses to use the shoulder to pass traffic congestion on freeways and queues at traffic signals (i.e., T.H. 36 from T.H. 61 to I-35W). Currently there are over 250 miles of bus-only shoulders. There are operating guidelines that bus drivers must follow to ensure the safe use of the shoulder. Team Transit projects also include advantages for transit at ramp meters (i.e., ramp meter bypasses and bus-only gates) and other projects to encourage transit use (i.e., park and ride lots).

3-7.00 INCIDENT MANAGEMENT

3-7.01 Purpose
Incidents cause approximately 60 percent of the congestion and between 10 and 15 percent of the peak period crashes on metro area freeways. Incident management systems minimize the impact of incidents and reduce secondary crashes via the following:

1. Rapid detection, response, and removal.
2. Providing motorist information services.
3. Integrated corridor traffic management techniques.

The RTMC control room staff coordinates incident management activities with the State Patrol, MnDOT maintenance operations, Metro Transit, commercial radio stations, and other agencies responsible for traffic signal operations.

3-7.02 Incident Detection and Response
Most incidents are initially detected and reported by motorists who make 911 calls to the State Patrol dispatcher. Incident reporting in this manner is so fast that the RTMC currently does not employ an incident detection algorithm. Occasionally, the RTMC system operators observe an incident on CCTV that has not been dispatched on police scanners. In these cases, the system operators call the State Patrol dispatcher on a hotline.

Response to and removal of incidents is the responsibility of the State Patrol. The state trooper responding to an incident is in charge of on-site incident management and traffic control, including arranging for a tow truck and other emergency response vehicles as needed.

3-7.03 Motorist Information and Route Guidance
Traveler information systems provide real-time traffic information to motorists at a variety of locations before they enter the highway system, as well as en route. Information is presented on lane closures, congestion, incidents, and the advisability of taking an alternate route. The route guidance and vehicle navigation systems of the future are in the planning stages as part of the ITS program.

The following is a brief overview of the traveler information techniques utilized by the department.

3-7.03.01 Dynamic Message Signs (DMSs)
DMSs are used to provide real-time information to motorists on the freeway and on city streets prior to freeway entrances. DMSs mounted over the freeway provide advance warning of hazardous situations or incidents,
including their location and the action the motorist should take to assure safety and minimize delay. DMSs mounted on entrance ramps or on city streets provide advance warning of conditions on the freeway in order to allow motorists to consider taking an alternate route.

DMSs are used during weekday morning and afternoon peak periods to display freeway travel times. Travel times are calculated using information from vehicle detection stations throughout the freeway corridors. Displaying travel times provides motorists with information that assists them in planning their routes and allows them to divert away from congested freeway segments.

3-7.03.02 Commercial Radio

Commercial radio relays traffic information to the motoring public and has the advantage of reaching a large listening audience. However, drivers often need detailed and specific information regarding freeway segments. Commercial radio broadcasters are generally reluctant to broadcast information targeted for a limited listener segment unless it is a newsworthy item also of general interest to other listeners. The Traffic Operations Section recognizes commercial radio as an important and widely used source of traffic information. Therefore, it places a high priority in providing information to these broadcasters. Some commercial radio stations contract with private traffic information sources and a few stations gather their own information. This information is available to the RTMC and can be particularly helpful on those freeway segments where surveillance is yet to be deployed.

3-7.03.03 MnDOT Traffic Radio

In 1989, MnDOT established a metro area traffic advisory radio service partnership with Minneapolis Public Schools (MPS). This service utilizes the MPS non-commercial student training station, KBEM 88.5 FM. The partnership provides for metro area traffic reports from the RTMC control room every ten minutes between 6:00 and 9:00 A.M., and 3:30 and 7:00 P.M., and reports every half hour between 11:30 A.M. and 1:00 P.M. In the event of a major incident, KBEM broadcasts continuously at RTMC’s discretion. DMSs can be used to alert drivers to the continuous broadcasts. In addition to incident management, MnDOT Traffic Radio has also been used for special event traffic management.

3-7.03.04 511 Internet and Telephone Traffic Reports

MnDOT has made up-to-date traveler information available to travelers by phone, internet site, and mobile app. Dialing 511 will give the traveler information regarding highway traffic, and road, weather, and construction conditions. Internet site www.511mn.org gives information about current critical incidents, road and weather conditions, construction, commercial vehicle permit status, and camera images as well as a traffic congestion map. The 511 mobile app allows users to access many of the same features of the 511 internet site through their smart phones.

3-7.04 Emergency Response Vehicles

MnDOT’s Freeway Incident Response Safety Team (FIRST) primary purpose is to minimize congestion and prevent secondary crashes through the quick response and removal of incidents. The FIRST program, originally known as Highway Helper, was initiated in 1987. There are presently 10 heavy-duty pickup trucks that patrol 220 miles of the most congested freeway segments. An Automated Vehicle Location (AVL) system has been implemented to better manage the operation of the FIRST program. This program has provided an average of more than 22,000 assists per year for the last several years.

3-8.00 COMPUTER SYSTEMS

3-8.01 Purpose

Computers are an important part of freeway traffic management because rapid control decisions are needed and large amounts of data must be managed. Computers are used in freeway traffic management both to process data at interchange locations and to manage the overall system. They are used to provide continuous real-time response to freeway conditions and to provide off-line support for other freeway traffic management activities. At the system-wide level, the computer supports surveillance and control systems. It operates automatically
with minimal human intervention on a seven day, 24-hour basis to gather information, calculate parameters, and make traffic control decisions. Computers operate in real-time and are programmed so that events initiate processes and functions to handle freeway traffic situations. These functions are pre-established by traffic engineers. Computer systems also record system performance and perform related calculations and analyses.

3-8.02 Field Microprocessor Activities
Detector inputs are normally scanned at a high rate (30 times per second) by field microprocessors to accumulate lane volume and lane occupancy. Output commands are sent to field microprocessors which control many field devices, including ramp meter signals, lane control signals, and DMSs.

3-8.03 Intelligent Roadway Information System (IRIS)
The RTMC Intelligent Roadway Information System or IRIS, is an advanced traffic management system consisting of an IRIS network server and workstations. It is used to monitor and manage freeway traffic. The main functions of IRIS are to:

1. Gather traffic-flow information from the field vehicle detection devices.
2. Display real-time traffic conditions to system operators.
3. Provide real-time displays for each field device to the system operators.
4. Allow operators to display messages on dynamic message signs and lane control signals.
5. Activate and control ramp meter signals.
6. Calculate and display freeway travel times on dynamic message signs during peak periods.

3-8.04 Communication with Field Microprocessors
Data communications between the IRIS server and field microprocessors are achieved in a variety of ways. Traditionally, copper cables have been used with standard modems on each end, but newer devices use a network of fiber-optic communication lines. In a few locations, leased telephone lines and wireless cameras are used.

3-8.05 Communication with Control Center Devices
The IRIS server communicates with a number of peripheral devices via the network, including workstations, graphic displays, storage units, and printers. The server is also connected to the Metro local area network (LAN) and the MnDOT wide area network (WAN).

3-8.06 Operational Reports
The traffic management system requires reports to evaluate day-to-day activities and to maintain a record of the systems performance. The reported data includes lane and station volume and occupancy by various time periods, ramp vehicle counts, logs of activity for lane control signals and DMSs, and logs of equipment malfunctions.

3-8.07 Data Retention
Data is retained to prepare long-term operational evaluations. Computer data is stored on the network, then recalled and processed. The retained data includes volume and occupancy for various time intervals.
3-8.08 Research and Statistical Reporting

Installations performing freeway traffic management have the capability for a wide variety of research and statistical reporting activities. The huge amounts of traffic data and related information available along with the hardware and software necessary to perform analysis, evaluation, and reporting tasks in traffic management systems make an attractive research environment. Examples of statistical reporting include:

1. Travel time study reports.
2. Carpooling studies.
4. Various speed analyses.
5. Plots, charts, and other graphic reports.
7. Violation studies.

In addition, the computer may be used for research activities not directly related to traffic management data, e.g., For example, crash studies or studies concerning roadway systems other than freeways.
CHAPTER 4 - TRAFFIC RESEARCH

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4-1.00 INTRODUCTION
Traffic research is critical to fully utilizing existing transportation facilities and associated devices as well as to the development of new methods and devices. This chapter introduces the general concept of traffic engineering research.

4-1.01 Purpose
The purpose of this chapter is to: (1) familiarize the reader with the responsibilities and capabilities of the traffic research coordinator, (2) describe the nature and use of traffic engineering research activities, (3) improve the effectiveness of the district traffic offices and the central office traffic sections by facilitating the use of special skills, services, and knowledge that are available from the Research Services Section (RSS), and (4) improve the quality of research done directly by districts or other sections.

4-1.02 Scope
This chapter will discuss: (1) the role of traffic engineering research, (2) research program availability, and (3) the standard research process. This chapter will not describe past, current, or future research projects. Information on current MnDOT research is available through the traffic research coordinator and at the RSS website.

4-2.00 ROLE OF TRAFFIC RESEARCH
Traffic engineering research may be defined as the careful, systematic and patient study of traffic engineering concepts, methods and products undertaken to discover or describe facts, techniques, or applications related to traffic engineering. Typical projects study an important gap in traffic engineering knowledge; have an immediate need for engineering data; and a unique Minnesota concern. Many projects consider new techniques, new traffic control devices, or new traffic engineering concepts.

The concepts and methods used for traffic research projects are similar to those used for typical traffic engineering or operation analysis studies; the primary differences being the degree of effort, the level of detail, and the use of the results. In the case of operational studies, just enough data is gathered to permit a decision-maker to answer a question by making assumptions and supplying judgment. This information is compared to known principles and standards and applied to real-time problems. For the traffic research project, the researcher must gather sufficient data to satisfy statistical tests to prove that the conclusions are correct. The researcher gathers the same information as the operations analyst, but the researcher collects data in greater detail to search for new innovative facts, concepts, principles and/or techniques for future use and to advance the “state-of-the-art.”

4-3.00 TRAFFIC RESEARCH PROGRAM
There are literally thousands of people and numerous organizations involved in transportation and traffic research programs on the national and international levels. The Transportation Research Board (TRB), the Federal Highway Administration (FHWA), the Urban Mass Transportation Administration (UMTA), the American Association of State Highway and Transportation Officials (AASHTO) and the Institute of Transportation Engineers (ITE) sponsor hundreds of projects each year. In addition, there are many ongoing projects being done locally in cooperation with the Local Road Research Board (LRRB), Regional Transportation Management Center (RTMC), the Center for Transportation Studies at the University of Minnesota (CTS), other offices within MnDOT, and in partnership with various consulting firms.
4-4.00 INDIVIDUAL ROLES IN TRAFFIC RESEARCH

Effective traffic engineering research requires many people. The most important person in this process is the MnDOT technical lead. In many cases, the technical leads are people located in the districts who have the responsibility to deliver the improvement that is being evaluated. These technically minded people achieve the benefits for the department and actually create the situations that return the benefits from the research investments. All other persons in the process are designed to assist these technical lead persons. To become one of these people please submit your research ideas using the process located on the RSS website.

Every MnDOT research project is guided by a Technical Advisory Panel (TAP). Each member of the Panel has a particular role to play that is essential to the success of the research project.

TAPs guide the research, and review and approve deliverables. Every TAP is composed of at least three members: the principal investigator, who performs the research; the technical liaison, who is the champion for the research, and the project coordinator, who monitors the research contract. Additional members may also serve on the panel to bring needed expertise to the project. More information on the roles and responsibilities of the TAP members can be found on the TAP website.

If you are requesting a research project, you are likely a good candidate to serve on the TAP. Research Services can coach you on what is required. You can also learn more by watching the video series located on the RSS website.

The Office of Traffic Engineering has identified a Traffic Research Director to help assist with all of these processes and programs.
CHAPTER 5 - INTELLIGENT TRANSPORTATION SYSTEMS

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5-1.00 INTRODUCTION

5-1.01 Purpose
This chapter is intended to document currently available Intelligent Transportation System (ITS) technologies and their applications. This chapter will present uniform guidelines, procedures, and preferred practices used in the planning, design, construction, and maintenance of ITS systems.

5-1.02 Scope
ITS is the application of advanced technology to solve transportation problems, and supports the movement of people, goods, and services. ITS improves transportation safety and mobility and enhances productivity through the use of advanced information and communications technologies. ITS encompass a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion, improve safety, and enhance American productivity.

This chapter is intended as an overview of guidelines and procedures for the process of ITS design and operation in Minnesota. Please refer to the “MnDOT ITS Design Manual” (ITS Design Manual) for detailed information about designing ITS systems.

ITS system applications cover a wide range of uses, including freeway management, traffic signals, and work zone management. This results in some overlap between this chapter and other chapters of this manual, depending on the ITS system being discussed.

References to other applicable documents can be found in Section 5-9.00 of this chapter, the ITS Design Manual, and the Office of Traffic Engineering (OTE) website.

5-1.03 Chapter Organization
This chapter is organized into the following sections:

Section 1 - Introduction
Section 2 - Glossary
Section 3 - Systems Engineering Process
Section 4 - ITS Planning Guidance
Section 5 - ITS Systems
Section 6 - Power, Communications, and Control
Section 7 - ITS Development
Section 8 - Interagency Agreements
Section 9 - References
5-2.00 GLOSSARY

5-2.01 Definitions

Architecture
The organizational structure of a system identifying its components, their interfaces, and a concept of execution among them.

Automatic Vehicle Identification (AVI)
A technology system using transponders on vehicles and outside sensors to determine if vehicles on toll lanes are carrying a valid transponder and what the vehicle’s classification is (truck vs. passenger car, SOV vs. HOV). The system also processes the appropriate toll transaction based on the information.

Blank-Out Sign (BOS)
A type of Dynamic Message Sign that has the capability to show a blank message or one fixed message.

Changeable Message Sign (CMS)
A sign that is capable of displaying one of two or more predefined messages, or a blank message. This manual uses the term Dynamic Message Sign for Changeable Message Signs.

Closed Circuit Television (CCTV)
A video monitoring and security system used to provide continuous traffic monitoring by the facility operator along the length of the facility and particularly at points of entry and tolling locations.

Components
Components are the named “pieces” of design and/or actual entities (sub-systems, hardware units, software units) of the system/sub-system. In system/sub-system architectures, components consist of sub-systems (or other variations), hardware units, software units, and manual operations.

Design
Those characteristics of a system or components that are selected by the developer in response to the requirements.

Detector Loops (Loop Detector Amplifiers)
A loop of electrical wires embedded in the pavement and used to detect and classify the type of vehicles passing over them. The loops are linked to the lane controller and can be used individually to count traffic, detect vehicles at a traffic signal, or in tandem to measure vehicle speeds.

Dynamic Message Sign (DMS)
A sign that is capable of displaying one or more predefined messages automatically without user intervention. This manual uses the term DMS more broadly to include any sign system that can change the message presented to the viewer such as Variable Message Sign, Changeable Message Sign, Portable Changeable Message Sign, and Blank-Out Sign (BOS).

Dynamic Pricing
Tolls that vary in real time in response to changing congestion levels, as opposed to variable pricing that follows a fixed schedule.

Express Lanes
A lane or set of lanes physically separated from the general-purpose capacity provided within major roadway corridors. Express lane access is managed by limiting the number of entrance and exit points to the facility. Express lanes may be operated as reversible flow facilities or bi-directional facilities.

Firmware
The combination of a hardware device and computer instructions and/or computer data that resides as read-only software on the hardware device.

Gap Analysis
A technique to assess how far current (legacy) capabilities are from meeting the identified needs, to be
used to prioritize development activities. This is based both on how far the current capabilities are from meeting the needs (because of insufficient functionality, capabilities, performance or capacity) and whether the need is met in some places and not others.

**Hardware**
Articles made of material, such as signal controller, load switches, fiber optics, radar detectors, fittings, and their components (mechanical, electrical, electronic, hydraulic, and pneumatic). Computer software and technical documentation are excluded.

**High-Occupancy Toll Lanes (HOT lanes)**
Managed, limited-access, and normally barrier-separated highway lanes that provide free or reduced cost access to HOVs, and also make excess capacity available to other vehicles not meeting occupancy requirements at a market price.

**High-Occupancy Vehicle (HOV)**
A passenger vehicle carrying more than a specified minimum number of passengers, such as an automobile carrying more than one person. HOVs include carpools, vanpools, and buses.

**HOV Lane**
An exclusive traffic lane or facility limited to carrying HOVs and certain other qualified vehicles.

**Incident Management**
Managing forms of non-recurring congestion, such as spills, collisions, immobile vehicles, or any other impediment to smooth, continuous flow of traffic on freeways.

**Intelligent Transportation Systems (ITS)**
Intelligent Transportation Systems (ITS) are electronics, communications, or information processing systems or services used to improve the efficiency and safety of the surface transportation system.

**Interface**
The functional and physical characteristics required to exist at a common boundary - in development, a relationship among two or more entities (such as software-software, hardware-hardware, hardware-software, hardware-user, or software-user).

**Lane Controller**
A microprocessor ETC component that coordinates the activities of all equipment in a single lane and generates the transactions assigned to individual customers using that lane.

**Lane Management Tools**
Access – Limiting or metering vehicle ingress to the lane or spacing access so that demand cannot overwhelm HOT lane capacity. See also Limited Access.
Eligibility – Limiting lane use to specific types of users, such as HOVs, motorcycles, low emission vehicles, or trucks. For most typical HOT lane settings, eligibility requirements would be used during selected hours or at specific access ramps.
Pricing – Imposing a user fee on a lane that helps regulate demand by time-of-day or day-of-week. The fee increases during periods of highest demand.

**Legacy System**
The existing system to which the upgrade or change will be applied.

**Level-of-Service (LOS)**
Also known as “Traffic Service,” LOS is a qualitative measure describing operational conditions within a traffic stream. LOS assesses conditions in terms of speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. Six levels of service are defined by letter designations from A to F, with LOS A representing the best operating conditions, and LOS F the worst.

**Market Packages**
Potential products or sub-systems that address specific services (as used in an ITS architecture).
Metropolitan Planning Organization (MPO)
Federally mandated regional organizations responsible for comprehensive transportation planning and programming in urbanized areas. Work products include the Transportation Plan, the Transportation Improvement Program, and the Unified Planning Work Program.

National ITS Architecture
A general framework for planning, defining, and integrating ITS. It was developed to support ITS implementations over a 20-year time period in urban, interurban, and rural environments across the country. The National ITS Architecture is available as a resource for any region and is maintained by the US DOT independently of any specific system design or region in the nation.

Quality Assurance
A planned and systematic pattern of all actions necessary to provide adequate confidence that management, technical planning, and controls are adequate to establish correct technical requirements for design and manufacturing, and to manage design activity standards, drawings, specifications, or other documents referenced on drawings, lists or technical documents.

Queue Jump
Elevated ramps or at-grade lanes that can be used by motorists stopped in traffic to bypass congestion.

Regional ITS Architecture
A specific regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects in a particular region.

Specification
A document that describes the essential technical requirements for items, materials, or services including the procedures for determining whether or not the requirements have been met.

Stakeholders
The people for whom the system is being built, as well as anyone who will manage, develop, operate, maintain, use, benefit from, or otherwise be affected by the system.

System
An integrated composite of people, products, and processes that provide a capability to satisfy a stated need or objective.

System Element
A system element is a balanced solution to a functional requirement or a set of functional requirements that must satisfy the performance requirements of the associated item. A system element is part of the system (hardware, software, facilities, personnel, data, material, services, and techniques) that, individually or in combination, satisfies a function (task) the system must perform.

System Specification
A top level set of requirements for a system. A system specification may be a system/sub-system specification, Prime Item Development Specification, or a Critical Item Development Specification.

Systems Engineering
An inter-disciplinary approach and a means to enable the realization of successful systems. Systems engineering requires broad knowledge and a mindset that looks at the big picture. Systems engineers act as facilitators and skilled conductors of teams.

Transportation Demand Management (TDM)
Actions that improve transportation system efficiency by altering transportation system demand using such strategies and facilities as pricing, ridesharing, park-and-ride facilities, transit friendly development/zoning, and employer-based programs such as staggered work hours and telecommuting. TDM programs improve the efficiency of existing facilities by changing demand patterns rather than embarking on capital improvements.
Transportation System Management (TSM)
Integrated protocols and computerized ITS systems used to manage roadway and transit facilities. TSM techniques improve system capacity without physical expansion or behavioral changes. Typical TSM measures involve continuous management and operation of traffic systems and utilization of integrated traffic control systems, incident management programs, and traffic control centers.

Variable Message Signs
A type of DMS, which allows a user to create and download the message to be displayed into the temporary memory area of the sign controller. This manual uses the term Dynamic Message Sign for Variable Message Sign.

Video Surveillance
The use of pan-tilt-zoom, steerable moving picture cameras to survey a toll plaza, ETC collection area, or a segment of roadway to monitor for incidents.

5-2.02 Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AD</td>
<td>Archived Data Management</td>
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<tr>
<td>ADA</td>
<td>Americans with Disabilities Act</td>
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<tr>
<td>AMBER</td>
<td>America’s Missing: Broadcast Emergency Response</td>
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<td>APTS</td>
<td>Advanced Public Transportation System</td>
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<td>ATIP</td>
<td>Annual Transportation Improvement Plan</td>
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<td>ATIS</td>
<td>Advanced Traveler Information System</td>
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<td>ATMS</td>
<td>Advanced Traffic Management System</td>
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<tr>
<td>ATR</td>
<td>Automated Traffic Recorder</td>
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<td>AVL</td>
<td>Automatic Vehicle Location</td>
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<td>AVSS</td>
<td>Advanced Vehicle Safety System</td>
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<tr>
<td>AWOS</td>
<td>Automated Weather Observation System</td>
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<tr>
<td>CAD</td>
<td>Computer Aided Dispatch</td>
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<tr>
<td>CARS</td>
<td>Condition Acquisition and Reporting System</td>
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<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
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<tr>
<td>CICAS</td>
<td>Cooperative Intersection Collision Avoidance System</td>
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<tr>
<td>CVIEW</td>
<td>Commercial Vehicle Information Exchange Window</td>
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<tr>
<td>CVISN</td>
<td>Commercial Vehicle Information Systems and Networks</td>
</tr>
<tr>
<td>CVO</td>
<td>Commercial Vehicle Operations</td>
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<tr>
<td>DDS</td>
<td>Data Distribution Server</td>
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<td>DMS</td>
<td>Dynamic Message Sign</td>
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<tr>
<td>DTN</td>
<td>Data Transmission Network</td>
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<tr>
<td>DVR</td>
<td>Digital Video Recording</td>
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<tr>
<td>EAS</td>
<td>Emergency Alert System</td>
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<td>EM</td>
<td>Emergency Management</td>
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<td>EMS</td>
<td>Emergency Medical Services</td>
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<td>EOC</td>
<td>Emergency Operations Center</td>
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<td>EVP</td>
<td>Emergency Vehicle Preemption</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>FAST</td>
<td>Free and Secure Trade</td>
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<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>FIRST</td>
<td>Freeway Incident Response Safety Team</td>
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<tr>
<td>FMCSA</td>
<td>Federal Motor Carrier Safety Administration</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>HAR</td>
<td>Highway Advisory Radio</td>
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<tr>
<td>HAZMAT</td>
<td>Hazardous Materials</td>
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<tr>
<td>HOT</td>
<td>High-Occupancy Toll</td>
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<tr>
<td>HOV</td>
<td>High-Occupancy Vehicle</td>
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<td>HRI</td>
<td>Highway-Rail intersection</td>
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<tr>
<td>ICM</td>
<td>Integrated Corridor Management</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>IFTA</td>
<td>International Fuel Tax Agreement</td>
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<td>IRP</td>
<td>International Registration Plan</td>
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<td>ISP</td>
<td>Information Service Provider</td>
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<td>ITS</td>
<td>Intelligent Transportation Systems</td>
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<tr>
<td>IVR</td>
<td>Interactive Voice Response</td>
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<td>IWZ</td>
<td>Intelligent Work Zone</td>
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<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<td>LPFM</td>
<td>Low Power FM Radio</td>
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<tr>
<td>MCM</td>
<td>Maintenance and Construction Management</td>
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<td>MCMIS</td>
<td>Motor Carrier Management Information System</td>
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<tr>
<td>MDSS</td>
<td>Maintenance Decision Support System</td>
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<td>MDT</td>
<td>Mobile Data Terminal</td>
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<tr>
<td>MnDOT</td>
<td>Minnesota Department of Transportation</td>
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<td>MPCA</td>
<td>Minnesota Pollution Control Agency</td>
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<td>MSP</td>
<td>Minnesota State Patrol</td>
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<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>OS/OW</td>
<td>Oversize/Overweight</td>
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<tr>
<td>OTE</td>
<td>Office of Traffic Engineering (MnDOT)</td>
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<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
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<tr>
<td>PRISM</td>
<td>Performance and Registration information Systems Management</td>
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<tr>
<td>PSAP</td>
<td>Public Safety Answering Point</td>
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<tr>
<td>RASAWI</td>
<td>Rest Area Sponsorship, Advertising, and Wireless Internet</td>
</tr>
<tr>
<td>RCA</td>
<td>Resource Consumption Application</td>
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<tr>
<td>RDS</td>
<td>Radio Data Service</td>
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<td>RFID</td>
<td>Radio-Frequency Identification</td>
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<tr>
<td>RTMC</td>
<td>Regional Transportation Management Center</td>
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<tr>
<td>RWIS</td>
<td>Road Weather Information System</td>
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<tr>
<td>SAFER</td>
<td>Safety and Fitness Electronic Records</td>
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<tr>
<td>SEOC</td>
<td>State Emergency Operations Center</td>
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<tr>
<td>SOV</td>
<td>Single Occupancy Vehicle</td>
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<tr>
<td>STIP</td>
<td>State Transportation Improvement Plan</td>
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<tr>
<td>TMC</td>
<td>Transportation/Traffic Management Center</td>
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</tbody>
</table>
5-3.00 SYSTEMS ENGINEERING PROCESS

The International Council of Systems Engineers uses the following definition for “systems engineering”:

Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem:

1. Operations
2. Cost & Schedule
3. Performance
4. Training & Support
5. Test
6. Manufacturing
7. Disposal

Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.

ITS projects shall conform to the National ITS Architecture and Standards and development of the regional ITS architecture should be consistent with the transportation planning process. ITS projects funded with highway trust funds shall be based on a systems engineering analysis. Which should result in the final design of all ITS projects funded with highway trust funds shall be consistent with the regional ITS architecture.


The following sections provide a brief summary of the steps required in the Systems Engineering Process.

5-3.01 Regional ITS Architecture

The [Minnesota Statewide Regional ITS Architecture, Version 2014 - Overview Volume](http://www.dot.state.mn.us/it/strits/overview/) states:

The Minnesota Statewide Regional Intelligent Transportation Systems (ITS) Architecture Version 2014 is an update of the previous version that was developed in 2009. The purpose of this update is to: 1) foster integration of the deployment of regional ITS systems; 2) facilitate stakeholder coordination in ITS planning, deployment and operations; 3) reflect the current state of ITS planning and deployment; 4) provide a high-level planning for enhancing the state transportation systems using current and future ITS technologies; and 5) conform with the National ITS Architecture and the Federal Highway Administration (FHWA) Final Rule 940 and Federal Transit Administration (FTA) Final Policy on ITS Architecture and Standards.

The Final Rule and the Final Policy provide policies and procedures for implementing [Section 5206(e)](http://www.dot.state.mn.us/it/strits/overview/).
of the Transportation Equity Act for the 21st Century (TEA–21), pertaining to conformance with the National ITS Architecture and Standards. The Final Rule and the Final Policy ensure that ITS projects carried out using funds from the Highway Trust Fund including the Mass Transit Account conform to the National ITS Architecture and applicable ITS standards.

Regional ITS architectures help guide the planning, implementation, and integration of ITS components and systems. The National ITS Architecture is a tool to guide the development of regional ITS architectures. It is a common framework that guides agencies in establishing ITS interoperability and helps them choose the most appropriate strategies for processing transportation information, implementing and integrating ITS components and systems, and improving operations. The Minnesota Statewide Regional ITS Architecture is a specific application of the framework specified in the National ITS Architecture, tailored to the needs of the transportation stakeholders in Minnesota.

The Minnesota Statewide Regional ITS Architecture geographically covers the entire state of Minnesota, encompassing local, regional, and state transportation agencies and transportation stakeholders. It represents a shared vision of how each agency’s systems work together by sharing information and resources to enhance transportation safety, efficiency, capacity, mobility, reliability, and security. During the development of the Minnesota Statewide Regional ITS Architecture, agencies that own and operate transportation systems collaboratively consider current and future needs to ensure that the current systems, projects and processes are compatible with future ITS projects in Minnesota. The collaboration and information sharing among transportation stakeholders helps illustrate integration options and gain consensus on systematic and cost-effective implementation of ITS technologies and systems.

The Minnesota Statewide Regional ITS Architecture is a living document and will evolve as needs, technology, stakeholders, and funding streams change.


FHWA Rule 940 (http://ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf) provides policies and procedures for implementing Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA–21), Public Law 105–178, 112 Stat. 457, pertaining to conformance with the National ITS Architecture and Standards. The rule states, in part, that the final design of all ITS projects funded with Highway Trust Funds must accommodate the interface requirements and information exchanges as specified in the regional ITS architecture. The Minnesota Statewide Regional ITS Architecture is a specific application of the framework specified in the National ITS Architecture, tailored to the needs of the transportation stakeholders statewide.

After funding has been programmed for a specified ITS project, or a transportation project incorporating ITS elements, the focus is on having the ITS project follow a sound systems engineering process. The following are activities after funding has been programmed into the State Transportation Improvement Program (STIP):

1. **Refine Scope/STIP Authorization:** The MnDOT Project Manager, or if a local project, the local Project Manager will work with partners to develop agreements, refine scopes, etc.

2. **ATIP/STIP Authorization:** If the project is federally funded projects must be entered on the ATIP/STIP before authorization can be obtained.

3. **Identification of Projects to Demonstrate Rule 940 Conformity:** For federally funded ITS projects, several steps need to be followed as part of the systems engineering analysis and Rule 940 requirements. Rule 940 states that the systems engineering analysis shall include, at a minimum:
   - Identification of portions of the regional ITS architecture being implemented.
   - Identification of participating agencies roles and responsibilities.
   - Requirements definitions.
   - Analysis of alternative system configurations and technology options to meet requirements.
5-3.02 Concept of Operations
The Concept of Operations documents the total environment and use of the system to be developed in a non-technical and easy-to-understand manner. The Concept of Operations presents this information from multiple viewpoints, and provides a bridge from the problem space and stakeholder needs to the system level requirements.

5-3.03 System Requirements
Requirements are the foundation for building Intelligent Transportation Systems (ITS). They determine what the system must do and drive the system development. Requirements are used to determine (verify) if the project team built the system correctly. The requirements development process identifies the activities needed to produce a set of complete and verifiable requirements.

5-3.04 Detailed Design Documents
Detailed design documents are developed based on the Concept of Operations and the System Requirements. See the ITS Design Manual for guidance on the development of detailed design documents.

5-3.05 Test and Acceptance Plans
The software and hardware components are individually verified and then integrated to produce higher-level assemblies or subsystems. These assemblies are also individually verified before being integrated with others to produce yet larger assemblies, until the complete system has been integrated and verified.

5-3.06 Operations and Maintenance Plan
Once the customer has accepted the ITS system, the system operates in its typical steady state. System maintenance is routinely performed and performance measures are monitored. As issues, suggested improvements, and technology upgrades are identified, they are documented, considered for addition to the system baseline, and incorporated as funds become available. An abbreviated version of the systems engineering process is used to evaluate and implement each change. This occurs for each change or upgrade until the ITS system reaches the end of its operational life.

5-4.00 ITS PLANNING GUIDANCE
The purpose of this section is to assist in the decision making process of determining if an ITS device should be considered or to validate existing device deployments. As part of the ENTERPRISE Pooled Fund research project, planning guidance was developed for:

- Closed Circuit Television
• Dynamic Message Signs
• Highway Advisory Radio
• Road Weather Information Systems
• Variable Speed Limit
• Dynamic Speed Display Signs
• Ramp Meters
• Curve Warning Systems
• Intelligent Work Zones
• Intersection Conflict Warning Systems

Note: “ITS Warrants” changed to “ITS Planning Guidance” in 2014 to eliminate the statutory/legal implications associated with the publication of official warrants.

The following sections summarize the planning guidance for ITS devices that are available as of the date of this publication. The link below directs you to the ENTERPRISE Pooled Fund Study webpage that includes a link to the current ITS Planning Guidance, which includes detailed information regarding each guideline. See http://enterprise.prog.org/itswarrants/.

5-4.01 Closed Circuit Television (CCTV)

For purposes of the ITS planning guidance process, CCTV refers to a video or still picture camera system used to collect images and relay images to a central monitoring location, and project images onto a video monitor, television screen, Internet display, or other monitoring equipment. Six (6) planning guidelines have been identified to capture the most common purposes and uses of CCTV. While there are other purposes and uses for CCTV, the planning guidelines developed to date have focused on the following six.

CCTV Planning Guideline 1 – Traffic Observation for Signal Control Changes
CCTV Planning Guideline 2 – Traffic Incident or Event Verification
CCTV Planning Guideline 3 – Weather Verification
CCTV Planning Guideline 4 – Traveler Information
CCTV Planning Guideline 5 – Field Device Verification
CCTV Planning Guideline 6 – Intelligent Work Zone

A detailed description of the CCTV planning guidelines can be found at: http://enterprise.prog.org/itswarrants/cctv.html

5-4.02 Dynamic Message Signs (DMS)

For purposes of the ITS planning guidance process, DMS are defined as either fixed or portable signs capable of displaying any text message entered by an operator (either locally or through remote access). Eight (8) planning guidelines have been identified to capture the most common purposes and uses of DMS. While there are other purposes and uses for DMS, the following eight DMS planning guidelines developed to date have an ITS focus.

DMS Planning Guideline 1 – To Inform Travelers of Weather Conditions
DMS Planning Guideline 2 – To Inform Travelers of Traffic Conditions
DMS Planning Guideline 3 – Changing Traffic Control or Conditions
DMS Planning Guideline 4 – Special Events
DMS Planning Guideline 5 – Parking Availability
DMS Planning Guideline 6 – Transit Park and Ride Lot Availability
DMS Planning Guideline 7 – Evacuation Routes
DMS Planning Guideline 8 – Jurisdictional Information

A detailed description of the DMS planning guidelines can be found at: http://enterprise.prog.org/itswarrants/dms.html. A detailed description and guide regarding changeable message signs (CMS) can be found at http://www.dot.state.mn.us/trafficeng/workzone/wzmanual.html.
5-4.03 Highway Advisory Radio (HAR)
For purposes of the ITS planning guidance process, Highway Advisory Radio (HAR) refers to low power AM or FM radio transmissions where localized information is broadcast and travelers are alerted to the presence of the broadcast using static or dynamic signs. The localized transmissions may cover areas that range from 5 miles to 30 miles depending upon the terrain and technologies used. The radio transmissions may be either at fixed permanent locations or mobile devices that may be temporarily located and moved as needed. Four (4) planning guidelines have been identified to capture the most common purposes and uses of HAR. While there are other purposes and uses for HAR, the planning guidelines developed to date have focused on the following four.

HAR Planning Guideline 1 – Weather and Driving Conditions
HAR Planning Guideline 2 – Venue Parking/Route Guidance
HAR Planning Guideline 3 – Changing Traffic Conditions
HAR Planning Guideline 4 – Special Events

A detailed description of the HAR planning guidelines can be found at: http://enterprise.prog.org/itswarrants/har.html

5-4.04 Road Weather Information Systems (RWIS)
For purposes of the ITS planning guidance process, RWIS refer to in-field atmospheric and/or road weather monitoring devices that are capable of measuring conditions and reporting conditions back to a central server or a roadside device. Three (3) planning guidelines have been identified to capture the most common purposes and uses of RWIS. While there are other purposes and uses for RWIS, the planning guidelines developed to date have focused on the following three.

RWIS Planning Guideline 1 – Support Traveler Safety and Mobility
RWIS Planning Guideline 2 – Support Regional, Statewide, or Provincial Weather Monitoring
RWIS Planning Guideline 3 – Support Traveler Information Systems through RWIS at Key Locations

A detailed description of the RWIS planning guidelines can be found at: http://enterprise.prog.org/itswarrants/rwis.html

5-4.05 Variable Speed Limits (VSL)
For purposes of the ITS planning guidance process, VSL refers to a sign capable of displaying different speed limits to travelers (in which the speed limit is either an advisory (recommended) or statutory (mandatory) limit) that are either manually activated or controlled by a combination of detectors and algorithms to select appropriate speeds. Four (4) planning guidelines have been identified to capture the most common purposes and uses of VSL. While there are other purposes and uses for VSL, the planning guidelines developed to date have focused on the following four.

VSL Planning Guideline 1 – Maximize Capacity
VSL Planning Guideline 2 – Safe Stopping Distance
VSL Planning Guideline 3 – Safe Travel Speeds for Conditions
VSL Planning Guideline – Work Zones

A detailed description of the VSL planning guidelines can be found at: http://enterprise.prog.org/itswarrants/vsl.html

5-4.06 Dynamic Speed Display Signs (DSDS)
For purposes of the ITS planning guidance process, DSDS refers to permanent or temporary signs that detect and display a vehicle’s current speed to the driver. Often the speed display flashes if the vehicle is exceeding the speed limit. Dynamic Speed Display Signs are also commonly referred to as “Your speed is” signs, or “Driver Feedback” signs. Three (3) planning guidelines have been identified to capture the most common purposes and uses of DSDS. While there are other purposes and uses for DSDS, the planning guidelines developed to date have focused on the following three.
DSDS Planning Guideline 1 – Transition Zones
DSDS Planning Guideline 2 – Posted Speed Adherence
DSDS Planning Guideline 3 – Intelligent Work Zones

A detailed description of the DSDS planning guidelines can be found at: [http://enterprise.prog.org/itswarrants/dsds.html](http://enterprise.prog.org/itswarrants/dsds.html). See also [MnDOT Technical Memorandum 13-01-T-01: Dynamic Speed Display Signs](http://enterprise.prog.org/itswarrants/dsds.html).

### 5-4.07 Ramp Meters

For purposes of the ITS planning guidance process, Ramp Meters are defined by the Manual on Uniform Traffic Control Devices as traffic control signals that control the flow of traffic entering a freeway facility. Three (3) planning guidelines have been identified to capture the most common purposes and uses of Ramp Meters. While there are other purposes and uses for Ramp Meters, the planning guidelines developed to date have focused on the following three.

- Ramp Meter Planning Guideline 1 – Corridor-wide Freeway Traffic Management
- Ramp Meter Planning Guideline 2 – Localized Freeway Traffic Issues
- Ramp Meter Planning Guideline 3 – Work Zone Activity

A detailed description of the Ramp Meter planning guidelines can be found at: [http://enterprise.prog.org/itswarrants/rampmeters.html](http://enterprise.prog.org/itswarrants/rampmeters.html).

### 5-4.08 Curve Warning Systems

For purposes of the ITS planning guidance process, Curve Warning Systems are defined as a collection of devices deployed with the goal of reducing vehicle crashes and roadway departures within horizontal curves. Technology devices may include real-time warning signs triggered by vehicle factors (e.g. speed, height, weight, etc.) and/or roadway conditions (snow, ice, and rain) at approaches to curves. Three (3) planning guidelines have been identified to capture the most common purposes and uses of Curve Warning Systems. While there are other purposes and uses for Curve Warning Systems, the planning guidelines developed to date have focused on the following three.

- Curve Warning Planning Guideline 1 – Rural Two-Lane Highway Curves
- Curve Warning Planning Guideline 2 – High Risk Locations
- Curve Warning Planning Guideline 3 – Truck Rollovers on Ramps/Curves

A detailed description of the Curve Warning planning guidelines can be found at: [http://enterprise.prog.org/itswarrants/curvewarning.html](http://enterprise.prog.org/itswarrants/curvewarning.html).

### 5-4.09 Intelligent Work Zones (IWZ)

For purposes of the ITS planning guidance process, Intelligent Work Zones are defined as a collection of devices that collectively warn travelers of various hazards associated with work zones. The following Intelligent Work Zone Systems are addressed with the planning guidelines. Note that there are additional devices to consider when deploying an IWZ as well as existing system components to consider.

- DMS Planning Guideline 3 – Changing Traffic Control or Conditions
- CCTV Planning Guideline 6 – Intelligent Work Zone
- HAR Planning Guideline 3 – Changing Traffic Conditions
- VSL Planning Guideline 4 – Work Zones
- DSDS Planning Guideline 3 – Intelligent Work Zone
- Ramp Meter Planning Guideline 3 – Work Zone Activity

A detailed description of the IWZ guidelines can be found at: [http://enterprise.prog.org/itswarrants/workzone.html](http://enterprise.prog.org/itswarrants/workzone.html). Also see the Minnesota IWZ Toolbox Guide found at [http://www.dot.state.mn.us/trafficeng/workzone/wzmanual.html](http://www.dot.state.mn.us/trafficeng/workzone/wzmanual.html).
5-4.10 Intersection Conflict Warning Systems (ICWS)

For purposes of the ITS planning guidance process, Intersection Conflict Warning Systems are defined as a traffic control device placed on major, minor, or both roads of an intersection to provide drivers with a real-time, dynamic warning of vehicles approaching or waiting to enter the intersection. ICWS are typically installed to address crash factors associated with limited sight distance and poor gap selection at stop-controlled intersections.

ICWS Planning Guideline 1 – Intersections with High Crash Frequencies or Rates (Reactive Approach)

ICWS Planning Guideline 2 – Intersection Characteristics (Proactive Approach)

A detailed description of the ICWS planning guidelines can be found at: http://enterprise.prog.org/itswarrants/icws.html. Information regarding rural intersection conflict warning systems (RICWS) can be found at: http://www.dot.state.mn.us/trafficeng/signals/conflictwarning.html.

5-5.00 ITS SYSTEMS

MnDOT has deployed numerous ITS systems over the years in support of the goals and objectives presented in the Minnesota Statewide architecture. This section presents an overview of many of the typical ITS systems that have been deployed in order to provide an idea of the tools that are available to address specific needs using technology. The summaries include:

- Definition
- Purpose and Usage
- Components Used

The systems listed here are not all inclusive. The types of systems being deployed in Minnesota and across the country increase every day. Table 5.1 on the following 2 pages is organized by market package group from the Minnesota Statewide Regional ITS Architecture. The Statewide Architecture has established eight ITS development objectives, listed as headings across the top of the table. The table illustrates how each of the ITS Service Packages relates to each of the objectives.
### Table 5-1 MN ITS Development Objectives

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</table>
5-5.01 Archived Data Management (AD)
See the MN Regional ITS Architecture for a complete listing of AD Service Packages.

5-5.01.01 Future Placeholder

5-5.02 Advanced Traveler Information Systems (ATIS)
See the MN Regional ITS Architecture for a complete listing of ATIS Service Packages. The following sections highlight several more common applications.

5-5.02.01 511 Traveler Information

Definition
The Minnesota Department of Transportation’s 511 Traveler Information System provides real-time, accurate traffic information about current road conditions, including:

- Weather related road conditions
- Traffic crashes and incidents
- Construction and maintenance locations and information
- Traffic speeds
- Traffic camera views
- Oversize/overweight truck restrictions.

Purpose and Usage
The Minnesota Department of Transportation’s 511 Traveler Information websites, 511 App and phone provides the traveling public with up-to-date road reports 24 hours a day, seven days a week. The program allows travelers to sign up for a ‘Personalize Your 511’ account that features specific routes tailored to travelers’ needs. The 511 program offers the traveling public a wide range of options in planning their travels.

Components Used
Typical components used for MnDOT’s 511 Traveler Information System include the items listed below. See the ITS Design Manual for further discussion of the components and design considerations.

- Communications
- IRIS

5-5.02.02 Dynamic Way-Finding Systems

Definition
This system provides guidance to specific destinations based on real-time traffic conditions.

Purpose and Usage
These systems are used to guide the motoring public. Based on real-time traffic conditions, messages would be displayed on field devices and on websites providing recommendations for the best route to the destination. These messages could be generated by traffic management center operators, or through the use of control software that would automatically select the route based on current conditions. In Minnesota, dynamic way-finding systems have been deployed for parking availability in downtown St. Paul, and in Bloomington on the regional system around the Mall of America.

Components Used
Typical components used for a Dynamic Way-Finding System include the items listed below. See the ITS Design Manual for further discussion of the components and design considerations.

- DMS or Hybrid Signing
- Communications
- Power
- Surveillance and/or Detection
- Manual Control or control software to select route
5-5.02.03 Highway Advisory Radio (HAR)

Definition
Highway Advisory Radio (HAR) refers to low power AM or FM radio transmissions where localized information is broadcast and travelers are alerted to the presence of the broadcast using static or dynamic signs. The localized transmissions may cover areas that range from 5 miles to 30 miles depending upon the terrain and technologies used. The radio transmissions may be either at fixed permanent locations or mobile devices that may be temporarily located and moved as needed.

![Highway Advisory Radio (HAR) Sign (Iowa DOT)](image)

Figure 5-1  Highway Advisory Radio (HAR) Sign (Iowa DOT)

Purpose and Usage
HAR provides motorist information similar to DMS but can provide more detailed information. The information broadcast can include:

- Congestion reports
- Hazardous conditions
- Travel times
- Alternate routes
- Special event information
- Parking locations
- Weather and road conditions
- Construction information

HAR systems can be permanent or portable. FCC licensing is required, and each HAR site is limited to a maximum of 10-watts of power. HAR can broadcast either AM or FM radio signals, and the typical message length is up to two minutes. MnDOT does not currently operate HAR.

Components Used
Typical components used for a HAR project include the items listed below. See the ITS Design Manual for further discussion of the components and design considerations.

- HAR Field System
- Communications

5-5.03 Advanced Traffic Management Systems (ATMS)
See the MN Regional ITS Architecture for a complete listing of ATMS Service Packages. The following sections highlight several more common applications.
5-5.03.01 Closed Circuit Television (CCTV)

Definition
Closed circuit television (CCTV) cameras are a key part of traffic management systems. The primary benefit of CCTV is the ability to provide visual information required to make informed decisions. CCTV cameras are used for roadway traffic monitoring, verification of incidents detected by other means (e.g., cellular calls, speed detectors, etc.), and for assistance in determining appropriate responses to an unplanned event or incident. Beyond these tasks, cameras can be utilized for:

- Monitoring traffic movements on the mainline and ramps
- Dynamic Message Sign verification
- Verification of stranded motorists and incidents
- Observing localized weather and other hazardous conditions
- Dispatching of safety personnel

![Figure 5-2 CCTV Camera](image)

Purpose and Usage
CCTV cameras are one of the primary methods of monitoring traffic conditions and detecting incidents. CCTV cameras allow an operator at the Regional Transportation Management Center (RTMC) to monitor traffic on both freeways and surface streets to determine the location of congestion and incidents. If an incident or heavy congestion occurs on a freeway, traffic can be diverted to a parallel surface street, and the timing of the signals on the surface street can be modified to provide more green time in the direction parallel to the freeway.

- **Detecting Incidents and Advising Motorists**
  One of the primary purposes of CCTV is to assist with incident detection. CCTV cameras can be located on both freeways and surface streets. Cameras are especially useful at an interchange where a camera has a view of both the freeway and the surface streets. If an incident is detected on either a freeway or surface street, changeable message signs (CMS) may be used to alert drivers and to possibly divert traffic elsewhere.

- **Advising Motorists of Traffic Problems in the Area**
  CCTV cameras can be used to find a major traffic problem and dynamic message signs (DMS) can alert drivers to the problem.

- **Monitoring Traffic Conditions Resulting from Special Events and Advising Motorists**
CCTV cameras and DMS(s) are useful during special events, both planned (such as a concert or a football game), as well as unplanned emergencies (such as a terrorist attack or a storm). Special events create traffic patterns that are quite different from normal. Many drivers going to a special event may not normally drive through the corridor in question, and are not familiar with alternate routes. Roadway and lane configurations may be different; for example, a normally two-way road may be converted to one-way in the peak direction, or a road may be closed for security reasons or to provide access for emergency vehicles.

- **Assisting with Parking Information**
  CCTV cameras, as well as other technologies, can monitor a large parking lot to determine which lots or sections are full, and CMS(s) (or other methods of information dissemination) can notify drivers as to which parking lots are full or closed, and to direct drivers to parking lots that have available capacity.

**Components Used**
Typical components used for a CCTV project include the items listed below. See the [ITS Design Manual](#) for further discussion of the components and design considerations.

- Camera System
- CCTV Mounting
- Management System Control Software
- Control Cabinet
- Power
- Communications

### 5-5.03.02 Detection Systems

**Definition**
The different types of vehicle detectors available include, but are not limited to, the following types.

1. **Intrusive Detection (in-roadway)**
   - Inductive loop detects a change in resonant frequency by the introduction of a metal in the magnetic field of the detection zone.
   - Magnetic/Magnetometer detects moving ferrous metal objects – pulse.
   - Microloop detects a change by moving metal in the earth’s magnetic field – pulse. Small inductive loop placed on top of a magnetometer.

2. **Non-Intrusive Detection (above roadway or sidefire)**
   - Photo electric/Infrared/laser detects a break in a beam of light – presence or pulse.
   - Radar/Microwave detects moving objects by sending and receiving electronic pulses – pulse.
   - Ultrasonic detects sound with a microphone – presence or pulse.
   - Video detects a change in a video pixel range – presence or pulse.
   - Combination systems, i.e. combining video and radar.

Normal loop or magnetic detectors will operate in either the pulse mode or presence mode. The magnetic detector produces a short output pulse when detection occurs, no matter how long the vehicle remains in the detection area. The normal loop is intended to produce a detector output for as long as a vehicle is in the field of detection.

Non-intrusive detector technologies include active and passive infrared, microwave radar, ultrasonic, passive acoustic, laser, and video image processing. Active infrared, microwave radar, and ultrasonic are active detectors that transmit wave energy toward a target and measure the reflected wave. Passive infrared, passive acoustic, and video image processing are passive detectors that measure the energy emitted by a target or the image of the detection zone.

Traffic detection systems play important roles not only in traditional transportation management but also in advanced transportation management systems. Traffic detection systems provide data to meet different needs in transportation fields.
**Purpose and Usage**

The control of traffic relates to the movement of vehicles and pedestrians. Since the volume of these movements generally varies at different times of the day, it is desirable to be able to detect approaching movements by placing one or more devices in the path of approaching vehicles or at a convenient location for the use of pedestrians.

Most advanced management systems and technologies in the ITS field rely on real-time traffic data, which reflects current conditions of traffic network. Traffic detection is a critical part in many advanced traffic systems, such as responsive ramp metering control and freeway incident detection.

Ramp metering control is the most common technology for reducing freeway congestion. The system measures freeway mainline capacity and traffic flow, and controls the rate at which vehicles enter the freeway mainline. Many studies show that ramp metering increases freeway efficiency, and reduces accidents and recurring congestion.

In freeway incident management systems, detectors generally are used to detect two types of congestion: recurring and nonrecurring. Recurring congestion is predictable at specific locations and times. Nonrecurring congestion is caused by random, temporary incidents, such as accidents and other unpredictable events.

Traffic detector technologies are continuously incorporated into new ITS application fields. For example, a portable intelligent transportation system provides traveler information in specific sites to improve safety and operation in work zones. A computerized control system integrates detector (speed sensor) and traveler information dissemination technologies. The control system automatically determines appropriate responses according to current traffic conditions.

Another type of detection is the “speed analysis system”. This system is a hardware assembly composed of two loop detectors and auxiliary logic. The two loops are installed in the same lane a precise distance apart. A vehicle passing over the loops produces two actuations. The time interval between the first and the second actuation is measured to determine vehicle speed.

Newer inductive-loop detector electronics units and loop configurations are capable of vehicle classification. The electronics module uses artificial neural network software to classify the traffic stream into the 23 categories

**Components Used**

Typical components used for a CCTV project include the items listed below. See the ITS Design Manual for further discussion of the components and design considerations.

- Detection System (intrusive or non-intrusive)
- Control Cabinet
- Power
- Communications
5-5.03.03 Dynamic Message Signs (DMS)

**Definition**
Any sign system that can change the message presented to the viewer such as Variable Message Sign (VMS), Changeable Message Sign (CMS), and Blank-Out Sign (BOS).

![Example Dynamic Message Sign](image)

**Purpose and Usage**
A dynamic message sign is an electronic traffic sign often used on roadways to give travelers information about special events. Such signs warn of traffic congestion, accidents, incidents, roadwork zones, or speed limits on a specific highway segment. In urban areas, DMS are used within parking guidance and information systems to guide drivers to available car parking spaces. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents or just inform of the traffic conditions.

A complete message on a panel generally includes a problem statement indicating incident, roadwork, stalled vehicle etc.; a location statement indicating where the incident is located; an effect statement indicating lane closure, delay, etc. and an action statement giving suggestion what to do traffic conditions ahead. These signs are also used for AMBER Alert messages.

**Components Used**
Typical components used for a DMS project include the items listed below. See [ITS Design Manual](#) for further discussion of the components and design considerations.

- Dynamic Message Sign
- Management System Control Software
- Control Cabinet
- Power
- Communications
5-5.03.04 Dynamic Speed Display Signs (DSDS)

Definition
A dynamic speed display sign is a device that detects and display a vehicle’s current speed back to the driver.

![Dynamic Speed Display Sign](image)

Figure 5-4 Dynamic Speed Display Sign

Purpose and Usage
DSDS have been shown to have a significant speed-reducing effect in temporary applications such as work zones or neighborhood speed watch programs.

Components Used
Typical components used for a DSDS project include the items listed below. See the ITS Design Manual for further discussion of system components and design considerations.

- Sign(s)
- Speed Detector
- Power

See also MnDOT Technical Memorandum No. 13-01-T-01: Dynamic Speed Display Signs.

5-5.03.05 Electronically Operated Gates

Definition
These are electronically operated gates that are used to close a roadway for unplanned events (incidents, weather, etc.), or planned events (sporting events, reversible lanes, etc.).

Purpose and Usage
The purpose of using electronically operated gates at freeway on-ramps is to minimize the utilization of law enforcement vehicles and personnel as temporary roadway barriers. Traffic Gates allow for easy closure of freeway entrance ramps during planned incidents such as sporting events and unplanned incidents such as freeway emergencies.
Examples of electronically operated gates include:

- Interstate and non-interstate snow and ice closure gates
- Interstate 394 gate for reversible HOV
- Gates at transit stations to control transit flow
- Battery backup may be used for electronically operated gates.

**Components Used**

Typical components used for an electronically operated gate project include the items listed below. See the ITS Design Manual for further discussion of system components and design considerations.

- Foundation
- Gate Pole and Arm with electronic mechanism
- Management System Control Software
- Control Cabinet
- Power
- Communications

### 5-5.03.06 Enforcement - HOV/HOT Facilities

**Definition**

These systems provide police officers additional information to enforce compliance with HOV/HOT Lane facility requirements.

**Purpose and Usage**

This is a current Innovative Idea project.

**Components Used**

This section is reserved for future manual updates.

### 5-5.03.07 Enforcement - Speed Limit

**Definition**

These systems provide photo enforcement for speeding at locations where there is a history of crashes with excessive speed as a contributing factor or in work zones.

**Purpose and Usage**

This section is reserved for future manual updates.

**Components Used**

This section is reserved for future manual updates.

### 5-5.03.08 Enforcement – Traffic Signal Red Light Enforcement Enhancement

**Definition**

These are systems that will provide police officers with photo evidence or other data to verify red light running violations.

**Purpose and Usage**

This system represents portable or permanent photo/surveillance systems located at intersections with high crash rates. The purpose is to inform and educate the traveling public of the dangers of running red lights. The system is planned for MnDOT District 6 and evaluated in District 3.

In District 3, the project provided on-site officers with photo and video evidence that could be used at the time of the infraction to verify the violation.

**Components Used**

This section is reserved for future manual updates.
5-5.08.09 *Intelligent Lane Control Signals (ILCS)*

**Definition**

ILCS are devices mounted above each lane that provide guidance to motorists. The messages change based on current traffic conditions.

![Intelligent Lane Control Signals](image)

**Purpose and Usage**

Intelligent Lane Control Signals (ILCS) are dynamic lane signals used for incident management, speed harmonization, and priced dynamic shoulder lane. Figure 5.6 shows the available message options for ILCS.

![Intelligent Lane Control Sign Options](image)

**Components Used**

This section is reserved for future updates.
5-5.03.10 Ramp Meter

Definition
Ramp Meters are traffic signals on highway entrance ramps, and they are designed to reduce crashes, reduce congestion and provide more reliable travel times.

Purpose and Usage
Ramp metering is a system element for addressing recurring freeway congestion. They control the rate at which vehicles enter the mainline such that the downstream capacity is not exceeded, thereby allowing the freeway to carry the maximum volume at a uniform speed.

Another benefit of ramp metering is its ability to break up platoons of vehicles that have been released from a nearby-signalized intersection. The mainline, even when operating near capacity, can accommodate merging vehicles one or two at a time. However, when platoons (i.e., groups) of vehicles attempt to force their way into freeway traffic, turbulence and shockwaves are created, causing the mainline flow to breakdown. Reducing the turbulence in merge zones can also lead to a reduction in the sideswipe and rear-end type accidents that are associated with stop-and-go, erratic traffic flow.

Components Used
Typical components used for a Ramp Meter project include the items listed below. See Section 3.0 Freeway Management of this manual, and the ITS Design Manual for further discussion of the system components and design considerations.

- Ramp Meter Signals and Mounting
- Management System Control Software
- Control Cabinet
- Power
- Communications
5-5.03.11 Reversible Lanes

Definition
A reversible lane is a lane in which traffic may travel in either direction depending on traffic flow patterns.

Purpose and Usage
The reversible lanes on I-394 are separated from the general purpose lanes and are controlled by signs and automated gates. The flow is reversed for the morning and afternoon peak periods.

Components Used
Components include:
- Automated gates
- DMS
- Communications
- Power

5-5.03.12 Roadside Lighting System Control

Definition
These systems manage electrical systems by monitoring operation conditions and using the lighting controls to carry the amount of light provided along the roadside. These systems allow a center to control lights based on traffic conditions, time of day, and the occurrence of incidents.

Purpose and Usage
These systems can increase the safety of a roadway segment by increasing lighting and conserve energy at times when conditions warrant a reduction in the amount of lighting.

Components Used
The roadway lighting system will be able to be controlled through the RTMC’s fiber optic system. Lighting levels and intensities can be controlled remotely.

5-5.03.13 Speed Monitoring

Definition
A system used to monitor traffic speeds on the roadways.

Purpose and Usage
Every Federal Fiscal Year (October through September), quarterly and annual speed monitoring reports are prepared by MnDOT’s Office of Traffic Engineering (OTE) and submitted to the Federal Highway Administration (FHWA) Division Administrator. The results of this program are used to determine speed trends throughout the United States. Additional reports are sent to the Commissioner, all MnDOT Districts, the MnDOT Library, the Department of Public Safety, and the Legislative Reference Library.

Various methods are currently being used for the collection of data. Radar transmission devices, although useful in certain situations, are not used in the speed monitoring program due to manpower requirements. Below is a list of speed data collection devices.

Weigh-In-Motion (WIM) Stations
- These devices are located throughout the State and collect a variety of data including the weight and speed of vehicles. The information is collected automatically.

Automatic Traffic Recorders (ATR) Sites
- ATRs automatically collect information by means of in-pavement loop detectors. ATRs are located throughout the State and are typically used to determine vehicle counts. A small number of them have been installed to allow the collection of speed data.

Portable data collection machines with road tubes, in-pavement loop detectors, or portable magnetic sensing devices.
• This method of data collection requires the placement of a sensing device on the road surface which connects to the data collection machine located off the road. This method is undesirable due to manpower requirements.

**Components Used**  
Speed monitoring system components include a device to measure speed, such as radar, loop detectors, video detection, and portable data collection devices such as pneumatic tubes. The system also typically requires a power source, communications, and a cabinet with control device/software. See the [ITS Design Manual](#) for further discussion of system components and design considerations.

5-5.03.14 **Tolling - MnPASS HOT Lanes**  

**Definition**  
I-394, on the west side of the Twin Cities, and I-35W, south of Minneapolis, operates a High Occupancy Toll (HOT) lane. Carpoolers may use the lane for free and single occupant vehicles may opt to pay a toll to use the lane. The toll charged to single occupant vehicles varies according to conditions. The ongoing operations allows for toll collection to be entirely automated (no manual fare collection).

**Purpose and Usage**  
The purpose of this type of project is to improve travel times and reduce congestion for users along the highway, and to provide an uncongested express lane for high occupancy vehicles and single-occupancy vehicles paying an electronic toll. Drivers that use the MnPASS Express Lane will experience improved traffic flow, reduced congestion, and better commute times along the route.

**Components Used**  
This section is reserved for future manual updates.

5-5.03.15 **Traffic Signal Control**  

**Definition**  
See Traffic Signals, Chapter 9 of this manual.

**Purpose and Usage**  
See Traffic Signals, Chapter 9 of this manual.

**Components Used**  
See Traffic Signals, Chapter 9 of this manual.

5-5.03.16 **Travel Times**  

**Definition**  
Systems that calculate and disseminate travel times between two points on freeways and non-freeways in a real-time format.

**Purpose and Usage**  
In the Metro area, the Minnesota Department of Transportation (MnDOT) calculates and disseminates freeway travel times based upon freeway loop detector data. Currently there is not an operational approach toward monitoring or disseminating arterial travel times throughout the Twin Cities. Several recent initiatives now underway, including the performance based measures required by MAP-21, identify the need for travel time reporting on arterial routes. A key element to Integrated Corridor Management (ICM) is to present travelers with travel time comparisons for freeways, arterials, and transit. MnDOT has explored several options for cost effective arterial travel time monitoring and estimation.

**Components Used**  
Freeway Travel Times in the metro area use frequently spaced loop detectors, control cabinets, and a fiber optic cable backbone to collect data. An algorithm within the IRIS software calculates the travel time data, and displays messages on DMS as desired.
Non-freeway travel time systems that have been tested by MnDOT include:

- SMART-Signal (signalized arterials)
- SENSYS Systems
- Bluetooth Data
- INRIX
- Commercial Probe Data
- Cell Phone Traffic Data
- MATT (signalized arterials)
- Rural Travel Times During Construction (rural highways)

5-5.03.17 Truck Priority

Definition
Truck Priority is a system to grant trucks priority treatment at specified signalized intersections, typically two-lane highways. Currently there is a truck priority system in use in Sherburne County at Trunk Highway 24 and CSAH 8.

Purpose and Usage
Truck Priority is a means to improve the operation of heavy trucks passing through traffic signal controlled intersections on rural high-speed highways by detecting the presence of trucks and extending the green time sufficiently for the truck to pass through the intersection.

Components Used
The truck priority system components include two loop detectors spaced 30 feet apart (or other detection that can distinguish heavy commercial vehicles) connected to the traffic signal cabinet. Truck Priority requires additional logic programed into the traffic signal controller.
5-5.03.18 Variable Speed Limit (VSL)

Definition
VSL is a sign capable of displaying different speed limits to travelers (in which the speed limit is either an advisory (recommended) or statutory (mandatory) limit) that are either manually activated or controlled by a combination of detectors and algorithms to select appropriate speeds.

Figure 5-8 Variable Speed Limit (VSL) Signs

Purpose and Usage
Variable Speed Limit (VSL) signs are used across the country to lower posted speed limits in certain areas. They allow for operators to adjust the speed limit (either regulatory or advisory) without changing the sign. They are used in conjunction with Intelligent Transportation Systems to lower speed limits for several reasons including congestion, construction, accidents, fog, snow, and ice. VSL signs have been successfully tested by several state departments of transportation.

The MN MUTCD Table 2A-5 provides color standards for the illuminated speed limit and background of VSL Signs under Changeable Message Signs.

Components Used
Typical components used for a VSL project include the items listed below. See the ITS Design Manual for further discussion of system components and design considerations.

- Sign(s)
- Management System Control Software
- Control Cabinet
- Power
- Communications
5-5.03.19 Warning System – Bridge Height

Definition
This type of system detects over height vehicles moving toward obstacles such as bridges, tunnels and other overhead structures and individually warns drivers. A sign is activated when an over height vehicle is detected by the system.

Purpose and Usage
The purpose of this system is to detect over-height vehicles and warn the drivers of the impending problem. This will enable them to exit the freeway and avoid the possibility of contact with the bridge.

Components Used
Components include:
- Laser detection
- Communications
- Controller
- Power
- DMS.

5-5.03.20 Warning System – Curve Advisory

Definition
The Curve Warning System provides a programmable active warning based on the speed of the vehicle as it approaches the curve and provides a warning message to the driver to reduce speed if it is excessive.

Figure 5-9 Curve Warning Systems

Purpose and Usage
A dynamic curve warning sign (DCWS) is a technology that may help drivers select an appropriate speed when approaching a horizontal curve. A DCWS generally consists of a warning sign combined with a speed measuring device (e.g., radar) that activates a variable message (e.g., SLOW DOWN) when vehicles are traveling above a set threshold. The technologies used to create a DCWS are currently available and the devices have been implemented at various locations.

Currently there are two warning systems being used in Meeker County, one on southbound CSAH 25 and another on eastbound CSAH 3. These are county-only systems.

Components Used
Typical components used for a DCWS project include the items listed below. See the ITS Design Manual for further discussion of system components and design considerations.
5-5.03.21 Warning System – Foggy Conditions

**Definition**
This type of system is a highway visibility sensor that measures the density of roadway fog and is linked to traveler information systems.

**Purpose and Usage**
The need for a highway fog warning system has long been internationally recognized. With such a system, motorists can avoid tragic pile-up accidents caused by dense or patchy fog, which are often fatal.

MnDOT does not currently use this system.

**Components Used**
This section is reserved for future manual updates.

MnDOT does not currently have

5-5.03.22 Warning System – Highway Rail Grade Crossing

**Definition**
This element represents roadside equipment that alerts motorists of railroad crossings at at-grade intersections. Gates are activated and deactivated as trains are detected approaching and clearing the intersection.

**Purpose and Usage**
This section is reserved for future manual updates.

**Components Used**
This section is reserved for future manual updates.

5-5.03.23 Warning System – Icy Conditions

**Definition**
This system detects conditions where ice may be forming on the pavement, and provides notification to drivers of this condition.

**Purpose and Usage**
Warning systems for icy conditions are generally installed in locations where experience has shown that icy conditions are re-occurring, and that the potential for crashes is high. The system uses ground sensors installed in the road surface. The sensors measure (among other parameters) the surface temperature, the freezing point temperature, and the pavement surface condition (dry, damp, wet, slippery because of ice, black-ice, hoarfrost, or snow).

When icy conditions are identified, notification is given to the public via DMS, static signs with flashing beacons, and/or maintenance crews are notified of the condition.

MnDOT currently operates a static warning sign system with flashing beacons on I-35 in Burnsville next to the Buck Hill Ski Area. This system is activated by the Regional Transportation Management Center (RTMC) based on communication from Buck Hill staff when snow making operations are being employed.

There is also a static sign warning system in Wright County on Trunk Highway 12 between the cities of Dassel and Cokato.
Components Used
Components include:

• Pavement sensors capable of detecting icy conditions
• Power
• Control software
• DMS
• Communications back to a maintenance facility
• Static signs with flashing beacons

5-5.03.24 Warning System - Ramp/Curve Truck Rollover

Definition
Ramp/Curve Truck Rollover Warning Systems provide warning to commercial vehicles as they enter a curve or ramp at a speed that is likely to cause a rollover.

Purpose and Usage
The purpose of these systems is to reduce truck rollovers in locations that have a history of this type of incident. MnDOT’s Metro District has installed a system in Washington County at an interchange ramp located at the junction of I-694/I-94/I-494 and will be installing a system on I-94 at the Lowry Hill Tunnel in Minneapolis.

Components Used
Typical components used for a Ramp/Curve Truck Rollover Warning System include the items listed below.

• Non-intrusive detection
• Weigh-in-motion (WIM) sensors
• Loops
• Blank out signs with warning beacons or dynamic message signs with warning beacons
• Communication systems
• Power

One particular type of warning system gathers information on heavy commercial vehicles using WIM technology. This system collects and instantaneously analyses data to determine if a vehicle is traveling too fast for the roadway geometry. If so, the operator is warned via a dynamic message sign.

Another system gathers information based on vehicle height and speed. If a vehicle determined to be above a defined height travels at a speed greater than a predetermined speed, the vehicle operator will be warned via a dynamic message sign.

5-5.03.25 Warning System - Stopped or Slow Traffic Ahead

Definition
This system provides warning to motorists about stopped or slow traffic ahead, typically in a work zone situation.

Purpose and Usage
Stopped traffic on freeways poses safety and operational concerns to drivers, transportation agencies, construction and maintenance contractors, and enforcement and emergency service personnel. Safety issues relate to driver ability to make gradual transitions from freeway speeds to stopped conditions without erratic maneuvers or crashes. Operational concerns relate to the reliability and predictability of the freeway network. The primary type of multi-vehicle crash on a freeway facility is the rear-end collision, comprising over 50 percent of freeway crashes by some research findings, caused generally due to normal speed traffic encountering stopped traffic on the main lanes or ramps. Drivers frequently have minimal or no warning about downstream queuing, and information given on static signs is difficult to keep current with rapidly fluctuating queues in congested areas.
Components Used
Typical components used for a Stopped or Slow Traffic Ahead Warning System include the items listed below.

- Non-intrusive detection
- Warning signs with flashers or portable DMS
- Communication systems
- Power

See ITS Design Manual and the IWZ Toolbox for further discussion of system components and design considerations.

5-5.03.26 Warning System – Water on Road

Definition
A highway sensor that measures the presence of water on the roadway and is linked to traveler information systems.

Purpose and Usage
This system will detect the presence of water on a roadway. Once a predetermined level has been reached, the system will automatically activate a sign warning drivers and advising them not to pass. The system may also send a message to the agency notifying them of the condition.

MnDOT does not currently use this system.

Components Used
Typical components used for a Water on Road Warning System include the items listed below.

- Device to detect water levels
- Communications
- Power
- Control equipment,
- Warning signs with flashers

5-5.03.27 Warning System – Wildlife

Definition
The Wildlife Warning System detects the presence of large wildlife (deer, elk, moose, etc.) on the side of the road and activates signs warning the motoring public of the presence.

Purpose and Usage
The purpose of the Wildlife Warning System is to reduce the number of large wildlife vehicle crashes on instrumented roadway sections by detecting large wildlife and activating a flashing beacon on a standard deer sign, warning motorists of the presence of deer.

The Wildlife Warning System consists of two subsystems: detector stations and signs. The detector stations are placed along the roadside at distances of approximately 150 to 400 feet, depending on terrain conditions. Pairs of passive infrared beams are emitted by the detectors and both must be broken for a detection “event” to occur. Video detection has also been used to detect wildlife. When an animal is detected, a communications device connected to the detector receiver broadcasts a unique identifier over a radio network.

The duration of beacon flash and the list of associated detectors for each sign is user-programmable through a software application.

MnDOT does not currently use this system.

Components Used
Typical components used for a Wildlife Warning System project include the items listed below. See the ITS Design Manual for further discussion of system components and design considerations.

- Detection
5-5.03.28 Wrong Way Detection

Definition
This includes a system used to detect vehicle traveling in the wrong direction on a traveled way.

Purpose and Usage
An important area of concern relative to highway safety is the occurrence of drivers going the wrong way on one-way streets, highway mainline lanes, or highway entry or exit ramps. Along with significant signing, various monitoring approaches have been tried and implemented to provide immediate detection of vehicles going the “Wrong Way”. To date, systems using magnetic induction loops represent the most common solution for “Wrong Way” detection. With magnetic induction loop systems, two or more loops are placed in the roadway as shown in Figure 5.10. Relative to the correct direction of travel, loop #1 is the upstream vehicle detection sensor and loop # 2 is the downstream vehicle detection sensor. In the presence of traffic, vehicle detection at loop # 1 followed by detection at loop #2 indicates the correct direction of travel by the detected vehicle. Vehicle detection at loop #2 followed by detection at loop #1 indicates the incorrect direction of travel by the detected vehicle. When properly installed and maintained, the loop-based system performance should be reasonable.

Figure 5-10 Loop Based Wrong Way Detection

The Detection Zone (Area of Detection, Detection Area, Zone of Detection, Effective Loop Area, Field of Influence, Field of View, Sensing Zone, Footprint) is the area of the roadway within which a vehicle is detected by a sensor system.

Components Used
The wrong-way detection system utilizes:

- Loop detectors
- Control equipment
- Communications
- Power
5-5.04 Advanced Public Transportation Systems (APTS)

5-5.04.01 Real-Time Bus Arrival Signs

Definition
These systems provide real-time arrival/departure information to travelers at a bus stop.

Purpose and Usage
Real-time information for bus and light rail arrival/departure times will be displayed to passengers via electronic message signs at bus stops and light rail stations in the Twin Cities metro area. Signs will also be installed at key decision points for drivers along arterial roads and freeways prior to entrances to park-and-ride facilities. Commuter rail arrival/departure times could also be displayed to travelers in the future.

Components Used
System components include:

- DMS
- Communications
- Power
- Link to Metro Transit’s NexTrip Real-time bus arrival database

5-5.05.02 Transit Signal Priority (TSP)

Definition
These systems provide advantages for transit vehicles at signalized intersections by modifying the signal timing to give priority to transit vehicles.

Purpose and Usage
TSP Systems are implemented to improve schedule adherence, customer satisfaction, transit reliability, and travel speed. In Minnesota, TSP systems are currently operational in St. Cloud and the Minneapolis Metro Area.

St. Cloud’s system utilizes existing EVP detectors and emitters to provide communication between buses and intersections. The traffic signal controller has a TSP module that is programmable.

As part of the Urban Partnership Agreement (UPA) in 2009, Metro Transit deployed TSP at over 30 intersections (MnDOT, City of Minneapolis, and Ramsey County) and on approximately 800 Metro Transit buses. The system became operational in the Fall of 2010. The system will expand to the BRT Red Line that began service in 2013.

The system deployed in the Metro area, which uses real-time vehicle position data and a wireless communication network, was deployed within each signal cabinet and on the Metro Transit bus fleet. A priority request to provide a green light is automatically placed at an intersection equipped with TSP if the bus is determined to be behind schedule. The system is configured to log TSP requests and TSP activations to both Metro Transit and the operating agency to support intersection monitoring and system fine-tuning.

Components Used

- TSP components include:
  - TSP traffic signal controller module
  - Priority detectors mounted at the intersections
  - GPS mounted on the buses
  - Connection on the bus to the TransitMaster system to determine schedule adherence
  - Central control software
  - Power
  - Communications
5-5.04.03  Transit Customer Information Systems

**Definition**
These systems provide information regarding park-and-ride availability and trip time comparisons to key destinations between transit and passenger vehicles.

**Purpose and Usage**
Real-time information on availability of parking spaces at transit park-and-ride facilities will be displayed to drivers via electronic message signs at selected park-and-ride locations in the Twin Cities metro area.

**Components Used**
- System components for parking availability include:
  - Detection at the ramps
  - Communications
  - Power
  - DMS displaying parking availability.
- Trip time comparison systems components include:
  - DMS
  - Communications
  - Power
  - Link to Metro Transit’s travel time database

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5-5.05  Commercial Vehicle Operations (CVO)

5-5.05.01  Weigh-in-Motion

**Definition**
Weigh-in-motion (WIM) devices collect volume, classification, speed axle loadings, vehicle and axle configuration, and truck volume characteristics.

**Purpose and Usage**
MnDOT currently uses WIM system data in [Daily Weight Enforcement Reports](#) for a number of sites. Note that WIM system data is not enforceable.

When a vehicle passes over a WIM site, a sensor emits an analog signal whose strength is directly proportional to the axle weight of the vehicle, and the approximate weight is recorded.
After the volume, class, speed, and weight data from all WIM sites is processed and analyzed, the WIM Monthly Station Reports are posted online and data is submitted to the FHWA. Analysis of annual trends in the data can lead to a better understanding of changing truck fleet characteristics and truck weights.

Gross vehicle and axle weight monitoring is useful for a wide range of reasons, including:

- Pavement design, monitoring, and research
- Bridge design, monitoring, and research
- Size and weight enforcement
- Legislation and regulation
- Administration and planning

Components Used

Each weigh in motion system will consist of the following components. These components will vary with the type of system you require.

- Weight sensors - the hardware that weighs the vehicle. The type of sensor depends on your system requirements - portable or permanent installation.
- Cabling - connects the weight sensors to the computer.
- Computer Interface - data acquisition electronics that convert the scale readings to real weight.
- PC Software - does calculations on the weight readings and stores the data.

5-5.06 Emergency Management (EM)

5-5.06.01 Future Placeholder

5-5.07 Maintenance and Construction Management (MCM)

5-5.07.01 Intelligent Work Zones

Definition

Intelligent Work Zones (IWZ) are a system of devices that provides motorists, and/or workers, “real-time” information for improved mobility and safety through a work zone. MnDOT has prepared in “Intelligent Work Zone Toolbox” which can be used as a guideline to select the appropriate IWZ for a specific work zone traffic issue. The IWZ System descriptions contained in this toolbox are intended as brainstorming material and should lead to practical solutions to a project’s unique problems. The examples are purposely left void of many dimensions, except where particular distances are highly recommended, and engineering judgment is required to customize the system to a project.

The IWZ Toolbox can be found at: http://www.dot.state.mn.us/trafficeng/workzone/iwz/MN-IWZToolbox.pdf

Purpose and Usage

IWZ Systems may be sorted into 3 category types based upon detectable stimuli: (1) Traffic, (2) Vehicle, and (3) Environmental. The 3 categories are shown below with their typically associated systems: The real-time data collected for any of these systems may be combined, averaged, analyzed for trends, and utilized for several informational uses. For example, data collected for ‘Stopped Traffic Warnings’ may be to control a ‘Dynamic Merge’ system or to calculate “Travel Time” through a corridor.

1. Traffic Responsive Systems collect and respond to average traffic characteristics such as speed and volume of a group of vehicles and the systems react to trends of increasing/decreasing values. The combination of these basic systems form the basis for Route Management Systems (or Traveler Information Systems) by analyzing and reporting information in various ways. These applications may include:

   - Travel Time Information (Trip Time or Estimated Delay)
2. Vehicle Responsive Systems collect and respond to individual vehicle characteristics such as speed, dimensions, and location. When adverse conditions are detected by these systems, motorists need immediate warnings for quick response. These applications may include:
   • Excessive Speed Warning (including Dynamic Speed Display Signs)
   • Over Dimension Warning
   • Work Space / Haul Road Intrusion Warning
   • Construction Vehicle Warnings

3. Environmentally Responsive Systems collect and respond to changing non-traffic conditions of weather, roadway or working characteristics such as visibility conditions or roadway surface conditions and hazards. These applications may include:
   • Hazardous Condition Warnings (Flooding, Ice, Fog, Smoke, Dust, etc.)

Temporary Traffic Control Devices may be equipped with advanced communication and/or remote control capabilities that do not react "intelligently" to detectable field data, but the devices provide safer working conditions or improve incident response. Although these devices may not be "Intelligent", they have been included in the IWZ Toolbox as additional safety tools for consideration when an IWZ System is being deployed. These applications may include:
   • Changeable Work Zone Signage (WZ Speed Limit Signs)
   • Traffic Surveillance Cameras (removed from Toolbox)

Components Used
Each IWZ System in the Toolbox is a collection of standard system components which have been combined to produce a useful real-time system. The individual component functions include the collection of data, verifying the accuracy of the data, transmitting the data, storing and managing the data, analyzing the data, and/or providing the data to the motorist.

Detection Components
The detectors may include:
   • Radar
   • Pneumatic Road Tubes
   • Light Beams
   • Acoustical
   • Ultrasonic
   • Magnetic
   • Piezo-Electric
   • Video
   • RFID
   • Probe Injection Technologies, etc.

System Monitoring Components
Typical redundancies should be built into most systems (based upon risk assessment for the system failure) and the various types of quality control testing or system mode, monitoring may be utilized.

System Communication Components
The typical forms of transmitting data, some of these may include:
• Cellular Modems
• Internet - Wireless Access Points
• Radio
• Hard wired
• Optical, etc.

**System Analysis Components**
Analysis algorithms are designed or modified for each application of an IWZ System to fit the conditions of the project. Algorithms can be designed with apparent limitations and strengths, and field testing is necessary to ensure the quality of the data analysis.

**Data Management Components**
The storage of data and analysis of the data for various trends, events, etc. may utilize many different database systems.

**Dynamic Informational Components**
Dynamic components provide information to the motorists and may include:

• 511 Systems (internet & phone/cell phone),
• Dynamic Message Signs (DMS) in dynamic mode
• Static signs with dynamic features,
• Remotely activated traffic control devices,
• Audible or visual alarms,
• Real-time highway advisory radio (HAR),
• Public media announcements,
• CB Radio, etc.

**Supplementing Existing System Components:**
MnDOT, through its Regional Transportation Management Center (RTMC) and out-state Transportation Operation and Communications Centers (TOCC’s), has the capability to provide a variety of IWZ Systems for MnDOT construction and maintenance projects. However, MnDOT’s detection devices, communications networks or traveler information systems may not be adequate for a proposed IWZ System. Discrepancies may be due to construction interrupting permanent installations, or that the existing system components do not extend to the project area.

IWZ System components provided by a contractor would supplement the services of the RTMC or TOCC’s, when various devices/services are not currently available and may include any of the component types listed above.

**5-5.07.02 Road and Weather Information Systems (RWIS)**

**Definition**
A road weather information system (RWIS) is a combination of technologies that collects, transmits, and disseminates weather and road condition information. The component of an RWIS that collects weather data is the environmental sensor station (ESS). An ESS is a fixed roadway location with one or more sensors measuring atmospheric, surface (i.e., pavement and soil), and/or hydrologic (i.e., water level) conditions including:

• Atmospheric sensors – air temperature, barometric pressure, relative humidity, wind speed and direction, precipitation type and rate, visibility distance
• Surface sensors – pavement temperature and condition (dry, wet, ice, freeze point, chemical concentration), subsurface temperature, subsurface freeze/thaw cycles
• Hydrologic sensors (stream, river and tide levels)
Data collected from environmental sensors in the field are stored on site in a Remote Processing Unit (RPU) located in a cabinet. In addition to the RPU, cabinets typically house power supply and battery back-up devices. The RPU transmits environmental data to a central location via a communication system. Central RWIS hardware and software collect field data from numerous ESS, process data to support various operational applications, and display or disseminate road weather data in a format that can be easily interpreted by a user. Environmental data may be integrated into automated motorist warning systems, and transmitted to TMCs, emergency operations centers and maintenance facilities for decision support. This information may also be used to enhance forecasts and supplement mesoscale environmental monitoring networks (i.e., mesonets).

Weather service providers (who are often RWIS/ESS vendors) also use the data to develop tailored weather services and products, including:

- pavement temperature/bridge icing forecasts,
- ice and snow prediction,
- optimization of treatment routes and resource allocation and
- thermal mapping.

Thermal mapping is a process to quantify the variation in nighttime road surface temperatures across the roadway network. This variation can be 10°F or greater (depending on exposure, altitude, traffic, and road materials), which can impact which areas may become icy before others.

**Types of Road Weather Management Strategies**

Transportation managers utilize environmental data to implement three types of road weather management strategies: advisory, control and treatment.

**Advisory**

Advisory strategies provide information on prevailing and predicted conditions to both transportation managers and motorists.

**Control**

Control strategies alter the state of roadway devices to permit or restrict traffic flow and regulate roadway capacity.

**Treatment**

Treatment strategies supply resources to roadways to minimize or eliminate weather impacts. Many treatment strategies involve coordination of traffic, maintenance, and emergency management agencies.

Winter maintenance managers utilize road weather information to assess the nature and magnitude of threats, make staffing decisions, plan treatment strategies, minimize costs (i.e., labor, equipment, materials), and assess the effectiveness of treatment activities (by agency staff or subcontractors). Traffic managers may alter ramp metering rates, modify incident detection algorithms, vary speed limits, restrict access to designated routes, lanes, or vehicle types (e.g., tractor-trailers) and disseminate road weather information to motorists in order to influence their travel decisions. Some Traffic Management Centers integrate weather data with traffic monitoring and control software.

Emergency managers may employ decision support systems that integrate weather observations and forecasts with population data, topographic data, as well as road network and traffic data. When faced with flooding, tornadoes, hurricanes, or wild fires; emergency managers may use this data to evacuate vulnerable residents, close threatened roadways and bridges, and disseminate information to the public.

Note: RWIS uses a different key than other cabinets.

Minnesota’s RWIS is a system that automatically collects, processes, and distributes current and forecasted weather and road surface information.
Purpose and Usage

Minnesota’s RWIS includes in-field detectors, communications to relay data to a central processing center, and display mechanisms to display data and resulting information to maintenance and traveler information providers, as well as the traveling public.

Data gathered from a series of in-pavement sensors, sub-surface probes and meteorological equipment were combined with a weather forecast to predict pavement surface conditions up to 12 hours in advance. Advanced traveler information systems provided drivers and fleet operators with RWIS data including up-to-the-minute warnings about changing conditions. Highway operations managers use RWIS for timely and cost-effective snow plowing and deicing.

Components Used

Typical components used for a RWIS project include the items listed below. See the ITS Design Manual for further discussion of the system components and design considerations.

- RWIS
- Management System Control Software
- Power
- Communications
5-5.07.03 Work Zone Accident Reduction Deployment (WZARD)

**Definition**
A WZARD system provides unaware drivers with advance notification of the presence of maintenance, work zone, incident management and law enforcement vehicles in order to reduce crashes and improve safety along a project corridor.

**Purpose and Usage**
One of the primary goals of this WZARD is to put into place the infrastructure necessary to improve safety for snow/ice and other work zone operations. Other goals and objectives include reducing incidents by providing the traveling public with real-time information about corridor traffic operations between Rogers and St. Cloud, Minnesota. The goals and objectives for the WZARD project can be grouped into three main areas:

**Traffic Incident Management**
- Improve corridor safety during work zone operations
- Improve safety for traffic incidents and/or traffic enforcement activities
- Reduce the occurrence of snow plow/vehicle crashes
- Reduce the occurrence of secondary incidents

**Transportation System Efficiency**
- Improve traffic safety and mobility
- Improve travel times along the I-94 corridor
- Reduce corridor congestion
- Manage recurrent peak period congestion, including weekend seasonal traffic
- Reduce vehicle emissions

**Public Communications/Traveler Information**
- Provide real-time traveler information along the corridor
- Provide travelers with advance warning of maintenance operations upstream
- Provide CCTV images to RTMC, District 3 Operations and State Patrol

**Components Used**
Typical components used for a WZARD project include DMS and IRIS, in conjunction with AVL and Geofencing.

5-5.07.04 Computer Aided Dispatch (CAD)/Automated Vehicle Location (AVL)

**Definition**
This section is reserved for future manual updates.

**Purpose and Usage**
This section is reserved for future manual updates.

**Components Used**
This section is reserved for future manual updates.

5-5.07.05 Maintenance Decision Support System (MDSS)

**Definition**
This section is reserved for future manual updates.

**Purpose and Usage**
This section is reserved for future manual updates.

**Components Used**
This section is reserved for future manual updates.
5-5.08 Advanced Vehicle Safety Systems (AVSS)

5-5.08.01 Rural Intersection Conflict Warning System

Definition
Rural Intersection Conflict Warning System (RICWS) detects vehicles on the major and/or minor roads, and then provides an applicable warning to vehicles on the other roadway to alert them of potential conflict.

Purpose and Usage
These systems address crashes at stop-controlled intersections by providing drivers with a dynamic warning of other vehicles approaching the intersection. Crash reduction/modification factors can be found at the Crash Modification Factors Clearinghouse (http://www.cmfclearinghouse.org/study_detail.cfm?stid=315).

Crash reduction is heavily impacted by driver confidence in the system. Driver confidence can be influenced by system reliability both in detecting and activating for approaching/entering vehicles, system malfunction/ down time, and duration of warning as it relates to acceptable gap selection on the minor road.

Typical applications will include both a major road warning and minor road warning.

When major road ADT reaches high volumes (approximately 12,000 veh/day), the minor road warning will be active nearly continuously and may no longer be effective. For these situations, a major road warning only should be used.

Components Used
Typical components used for an ICWS project include the items listed below. Typical ICWS layouts are shown in Figures 5.7-5.9. See the ITS Design Manual for further discussion of system components and design considerations.

- Static and/or BOS signs
- Detection
- Control Cabinet
- Power
- Communications

In addition, see MnDOT’s RICWS page at: http://www.dot.state.mn.us/trafficeng/signals/conflictwarning.html and the ENTERPRISE Pooled Fund website at: http://enterprise.prog.org/.

For the RICWS concept layout, please refer to the MnDOT ITS Design Manual.
5-6.00 POWER, COMMUNICATIONS, AND CONTROL

5-6.01 Source of Power

Most ITS systems currently operate on 120 Volts AC with a power drop from the local utility company. Some systems operate using a low voltage DC power source, facilitating battery, solar power, or wind power options. ITS systems usually include sensitive electronics located in an outdoor environment and mounted on metal poles. A lightning storm can cause the equipment to fail if it is not properly protected. Every control cabinet should have a quality properly rated solid state surge suppression device located where the power conductors terminate in the cabinet. In addition to the grounding required by the National Electrical Code at the service cabinet, the control cabinet should also have a grounding conductor going from its ground bus to a ground rod. The ground rod may be the one used by the service cabinet or a different one if the cabinets are not co-located. If the system includes tall mounting poles and is not connected by metal conduit, the pole installation should also include a ground rod. As per the National Electrical Code, it is essential that all metal cabinets, poles, housings, conduits, etc. all be connected together into a properly bonded and grounded system. All communications and video field cables should have surge suppression at both ends where they enter an enclosure or cabinet. Much unfortunate experience has shown that systems that are not properly grounded or protected from surges will not last long in the outdoor roadside environment.

Part of the design of an ITS system should be consideration of failure modes. Any source of power is subject to failure. Some ITS systems are not safety critical and can tolerate the occasional power outage. For safety critical systems, battery backup is an option. Battery backup can keep the system operational for a certain period of time when utility power is out. The size of the battery backup system can be calculated based on the load drawn by the system and the length of time it must run on battery power. One consideration of battery backup is that the batteries will need to be replaced periodically, maybe every five to seven years, to ensure that they can still hold a charge. Battery backup should also be checked every six months to ensure that the systems are ready to work when called upon.

In remote rural areas, obtaining a utility power drop can be very expensive if there are no electrical utilities in the area. For some low-power ITS applications, solar and/or wind power is an option. These options are also environmentally friendly. Resources are available to aid in designing the solar power. Factors include the amount of power the system needs, the percent of the time the system is operating (such as flashers that only flash upon certain infrequent events), the amount of time the system must operate in the absence of any sunlight, and the geographic location which affects the amount of sunlight received.

It is a good idea to over design the solar power system with large safety margins. Experience has seen several solar powered systems whose operation was disrupted due to inadequate solar power configurations. In Minnesota in mid-winter, hours of sunlight are limited and the cold causes the batteries to be inefficient, which makes it a challenge for solar powered systems. Wind power provides a nice complement to solar power. Cloudy times having less sunlight are often accompanied by higher winds. Wind turbines work better the higher they are mounted, and so mounting height could become a cost issue.

Similar to solar power, resources are available to aid in designing wind powered systems. Off the shelf systems for solar and wind, including controllers, are available from multiple sources. Underground battery boxes for solar powered systems may fill with water and be ruined. Battery boxes located on sign structures require that the sign post be breakaway (u-channel post mounting is not appropriate.

5-6.02 Electronic Communications

Data communications between the central server and field microprocessors are achieved in a variety of ways. Traditionally, copper cables have been used with standard modems on each end, but newer devices use a network of fiber-optic communication lines. See the ITS Design Manual for guidance in fiber optic design. The RTMC had some issues with ice crush causing problems with fiber cables.

Solicit information from the RTMC when installing fiber cables. They can provide valuable information regarding the best installation method.

Wireless communications is another option. With wireless communications you have to do a site survey to
examine line of site. If the site survey is done in the winter, it may change in the spring when foliage returns to trees. Watch out for things that are likely to change in the future, like growth of trees or places where new buildings may be built in the line of site.

Other options may include Ethernet or Leased Telephone Lines.

5-6.03 System Control Software
IRIS (Intelligent Roadway Information System) is MnDOT’s Freeway Management System control software. IRIS is an open-source Advanced Traffic Management System (ATMS) software project developed by MnDOT. IRIS uses a General Public License (GPL). Figure 5.13 illustrates a screen from IRIS (DMS Control).

![Image](Figure 5-15 IRIS DMS Display)

As an alternative to IRIS, commercial software is available that can do many of these functions. If you only have to manage one or two types of devices, such as cameras and DMS, then often the device manufacturers have software that comes with the device that enables you to control just that type of device.

5-7.00 ITS DEVELOPMENT

5-7.01 Role of the Office of Traffic Engineering (OTE)
MnDOT’s OTE establishes guidelines and procedures, striving for uniformity in traffic engineering, throughout the state of Minnesota, and builds relationships between state, county, and city engineering staff to resolve questions about engineering and roadway safety.

The ITS Section of OTE provides the following services:

• Makes recommendations for ITS deployment projects
• Conducts pilot and demonstration projects
• Serves as technical advisors to districts and other agencies
• Manages ITS projects considered experimental
• Manages Guidestar ITS projects
• Manages and maintains the Minnesota Statewide Regional ITS Architecture
• Participates in National Pooled Fund Studies with other states

The MnDOT Office of Traffic, Safety, and Technology website includes a wide variety of traffic engineering information, including ITS: [www.dot.state.mn.us/trafficeng/index.html](http://www.dot.state.mn.us/trafficeng/index.html).
5-7.02 ITS Office and District Project Solicitation

MnDOT’s Office of Traffic, Safety, and Technology’s ITS Section solicits MnDOT Districts and Offices for ITS projects in Minnesota with up to $1 million per year in funding over four years. This funding program is intended to encourage ITS deployment by providing dedicated funds that do not compete with other construction priorities.

Projects can be stand-alone ITS projects or ITS components of other construction projects. Projects can be for any dollar amount up to the entire dollar amount available per year. To be considered an ITS project, the project must fit the description of one or more of the ITS “Service Packages” that make up the National ITS Architecture. A description of the service packages can be found at: http://local.iteris.com/itsarch.

Funding for the program will be District C Federal STP funds in the State Road Construction (SRC) appropriation, with the following intended purpose as stated in state law:

“This appropriation is for the actual construction, reconstruction, and improvement of trunk highways, including design-build contracts and consultant usage to support these activities. This includes the cost of actual payment to landowners for lands acquired for highway rights-of-way, payment to lessees, interest subsidies, and relocation expenses.”

THESE FEDERAL FUNDS WILL REQUIRE A 20 PERCENT NON-FEDERAL MATCH FROM THE DISTRICT. The district will be responsible for including selected projects in the STIP and obtaining appropriate state and federal project numbers. This program will not fund operations and maintenance of the ITS project, technology and/or equipment. The OTE ITS section will provide funding numbers for the federal funds.

According to Federal Final Rule 940, ITS projects using federal funds must fit within a regional ITS architecture and must follow a systems engineering process. Minnesota has a “Minnesota Statewide Regional ITS Architecture (Version 2014)” meeting the requirements of this rule. (http://www.dot.state.mn.us/guidestar/2006_2010/mnitsarchitecture.html). Depending upon the scope of the proposed project, the project may require development of a Concept of Operations document and a Functional Requirements document. The ITS section can provide assistance in determining what is needed and how to best meet the requirements of Final Rule 940 and will work with the districts whose projects are selected.

ITS projects should address identified needs. Section 4 of this Chapter explains some draft ITS warrants that may help justify the project, and Section 5 provide a list of projects that have been successfully implemented elsewhere in the state. The OTE ITS Section anticipates issuing this solicitation annually for any unused funds from the previous solicitation plus new funds for the year subsequent to the previous solicitation time frame.

PROCESS FOR SUBMITTING APPLICATIONS:

1. Obtain an application from OTE
2. Fill out the Office/District ITS Solicitation Application Form in Microsoft Word format (.doc or .docx).
3. Submit the application electronically to Susan Sheehan at susan.sheehan@state.mn.us.
4. Applications are typically due in April.

EVALUATION AND SELECTION OF APPLICATIONS

An evaluation committee consisting of OTE ITS Section staff, OTE management and possibly District Staff and a representative from the Office of Capitol Programs and Performance Measures will evaluate and select proposals. Criteria to be considered in selecting projects include the following:

- Project identifies a documented need
- Project meets an ITS warrant
- Project fits into a larger ITS plan or complements other construction projects
- Project utilizes proven technologies
- Office/District has identified a plan for operating and maintaining the system
- Office/District has identified a plan for delivering the project
Office/District has identified a source of state match

For more information, contact:
Susan Sheehan, OTE – ITS
651-234-7061
susan.sheehan@state.mn.us

5-8.00 INTERAGENCY AGREEMENTS

ITS projects can require permits, agreements, or partnerships with other agencies. Typical items to be discussed in an interagency agreement could include but are not limited to:

- Permits for acquiring power and/or communications
- Cost-sharing (infrastructure and ongoing)
- Maintenance
- Communications Sharing (fiber-optic cable)
- Sharing of video and/or data
- Shared operations of devices

Please contact OTE or the Permits office for more information and sample agreements.

5-9.00 REFERENCES

The pages contained within the manual are current at the time of publishing. Please keep in mind that the reference material is periodically updated, so the user is cautioned against using the reference materials included in the manual indefinitely, without checking the original sources for updates.

The following is a list of the reference material used for this manual.

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6-1.00 INTRODUCTION

6-1.01 Purpose

Traffic signs regulate, warn, and guide motorists, pedestrians, and other traffic on all public roads. The traffic sign is the most commonly used traffic control device, and it is the oldest device for regulating, warning, and guiding traffic. Signs are not ordinarily needed to confirm the basic rules of the road, but they are essential to inform highway users of specific regulations, to warn users where hazards are not self-evident, and to furnish information and guidance.

The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) provides legal standards, allowable limits, and alternatives for the design, use, and application of traffic signs. The purpose of this chapter is to describe typical applications and procedures related to placement of traffic signs on trunk highways.

Since the basic principles of signing are set forth in the MN MUTCD and must be adhered to, engineers, technicians, and maintenance personnel responsible for the design, placement, operation, maintenance, and uniformity of these devices should have ready access to and be familiar with the MN MUTCD.

6-1.02 Scope

This chapter covers general procedures for selecting proper traffic signs and implementing the correct installation of these devices. General principles of traffic signing and practical application guidelines are strongly emphasized.

The layouts show applications (selection and placement) of recommended traffic signs for typical situations which occur frequently. All distances shown on the layouts are approximate. Not all situations can be addressed; therefore, the applications shown must be considered and applied as directed by engineering judgment.

Although it is usually desirable to provide all traffic signs as shown in the layouts, situations arise where this becomes impractical. Engineering judgment may dictate modifications to the typical layouts. When modifications are made, factors such as traffic volume, speed, sign distance, right-of-way, etc. must be considered.

The major source documents for this chapter are the MN MUTCD, the MnDOT Standard Signs and Markings Manual, and the MnDOT Standard Specifications for Construction. Individuals responsible for designing and fabricating signs should have access to and be familiar with these reference materials. Technical support on the design of guide signs is available from the MnDOT Office of Traffic Engineering (OTE).

6-1.03 Chapter Organization

This chapter is organized into nine major sections. These sections cover (6-3) legal authority for placing traffic signs and (6-4) general principles of traffic signing, as well as application guidelines for (6-5) regulatory signs, (6-6) warning signs, (6-7) guide signs, (6-8) miscellaneous signs, (6-9) object markings, (6-10) delineation, and (Appendix A) supplemental guide signs. Preferred signing practice for construction and maintenance work zone traffic control is found in Chapter 8 of this manual.
6-2.00 GLOSSARY

A-Frame
The combination of vertical flanged channel sign posts with knee braces and lateral framing to form an assembly to which a sign panel is mounted.

Attrition
The process of evaluating existing traffic control devices and removing and/or replacing devices that no longer meet standards through scheduled construction or routine maintenance activities.

Breakaway Supports
Supports designed to yield when struck by an errant vehicle, thereby minimizing injury to occupants of the vehicle and damage to the vehicle itself. Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, published by the American Association of State Highway and Transportation Officials, indicates acceptable performance standards and dynamic test conditions.

Business Panel
A separately attached sign panel that shows, either individually or in combination, the brand, symbol, trademark, or logo of the business service.

Cone of Vision
A fan-shaped field of view extending in front of a vehicle operator.

Conventional Road – Single Lane
A two-lane, two-way trunk highway.

Conventional Road – Multilane
An undivided highway with more than one lane in each direction of travel and having a posted speed equal to or less than 60 mph or a divided highway with more than one lane in each direction of travel and having a posted speed equal to or less than 55 mph.

Direct Applied
Adhesive-backed pressure sensitive retroreflective sheeting.

Expressway
A high speed, multilane, divided highway which is generally an arterial road with a posted speed greater than 55 mph. Most intersections are at-grade, although grade separated interchanges may exist.

Extruded Section
An aluminum channel substrate 6 inches or 12 inches in height.

Freeway
A divided highway with full control of access.

Intersection
(a) The area embraced within the prolongation or connection of the lateral curb lines or, if none, then the lateral boundary lines of the roadways of two highways which join one another at, or approximately at, right angles or the area within which vehicles traveling upon different highways joining at any other angle may come in conflict.
(b) Where a highway includes two roadways 30 feet or more apart, then every crossing of each roadway of such divided highway by an intersecting highway shall be regarded as a separate intersection. In the event such intersecting highway also includes two roadways 30 feet or more apart, then every crossing of two roadways of such highways shall be regarded as a separate intersection. Minn. Stat. Sec. 169.011, Subd. 36.

Iso-tacs
Lines of equal wind velocity given in various mean recurrence intervals.
Knee Brace
A flanged channel sign post attached diagonally to a riser post or a lateral brace to increase stability of the sign structure.

Local Road
Any road that is not a trunk highway.

Overlay
A thin, flat aluminum sheet with sign face material applied, which is bolted or pop riveted to a sign panel.

Primary Guide Signs (freeways and expressways)
These signs consist of advance guide signing, exit directional signs, exit gore signs, destination, and distance signs.

Screening Process
Method of sign fabricating by screen printing with colored inks (pastes) over a given retroreflective sheeting.

Shop Drawing
Detail drawings of sign structures indicating materials used, dimensions, and fabricating processes.

Sign Base Material or Sign Blank (Substrate)
Sheet aluminum joined by backup splice plates, or extruded sections bolted together to form a flat surface.

Sign Face Material
Retroreflective or non-retroreflective sheeting material applied to the sign substrate.

Specific Service
Restaurants; rural agricultural or tourist-oriented businesses; places of worship; gasoline service stations and other retail motor fuel businesses; and motels, resorts, or recreational camping areas that provide sleeping accommodations for the traveling public. Minn. Stat. Sec. 160.292, Subd. 21.

Specific Service Sign
A rectangular sign panel displaying the name or optional business panel, or both, of a rural agricultural or tourist-oriented business, place of worship, motel, restaurant, resort, recreational camping area, or gasoline service station or other retail motor fuel business and, where appropriate, the direction to and distance to the rural agricultural or tourist-oriented business, place of worship, recreational camping area, motel, restaurant, resort, or gasoline service station or other retail motor fuel business. Minn. Stat. Sec. 160.292, Subd. 22.

Tourist-Oriented Business
(a) "Tourist-oriented business" means a business, service, or activity that receives the major portion of its income or visitors during the normal business season from motorists not residing in the immediate area of the business or activity.
(b) "Tourist-oriented business" includes, but is not limited to (1) a greenhouse or nursery, (2) a bait and tackle shop, (3) a marina, and (4) a gift or antique shop. Minn. Stat. Sec. 160.292, Subd. 25.

Spliced U-Post
The combination of two flanged channel sign posts nested together and bolted to obtain the desired post length.

Square Tube
A square steel tube formed of 10 or 12 gauge steel rolled to size and welded in the corners. Tubes have holes spaced at one inch intervals on all four sides along the entire length of the tube.

Stringer
A lateral structural member forming a frame to which the sign panel is attached. They also may provide additional strength to the assembly. Type D signs generally utilize flanged channel sign posts as stringers.
Supplemental Guide Signs
Guide signs which further orient the driver to geographical identification and secondary destinations. Destinations include cities, motorist services, and state parks. Exit numbers are included on freeway signs.

Trunk Highway
Any highway or segment of highway, including the interstates, under the jurisdiction of the State of Minnesota.

U-Post (Flanged Channel Sign Post)
A steel post of a channel or modified channel design, with flanges against which a sign panel will be placed. Holes are punched at a uniform spacing along the centerline of the back of the post.

Wind Loading
The pressure of the wind on the horizontal and vertical supports of a structure are given in Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, published by the American Association of State Highway and Transportation Officials.
6-3.00 LEGALITY - LEGAL AUTHORITY FOR PLACEMENT OF TRAFFIC SIGNS

6-3.01 Traffic Signs Installed by MnDOT Maintenance Forces

Minneapolis Statute (Minn. Stat. Sec.) 169.06, Subd.2, which provides that the Commissioner of Transportation (Commissioner) shall place and maintain traffic signs conforming to the MN MUTCD and the MnDOT Standard Specifications for Construction as deemed necessary to regulate, warn, or guide traffic on the Minnesota trunk highway system. MnDOT District Traffic Offices and maintenance forces act as agents of the Commissioner in this duty. Additional statutes may also be applicable.

6-3.02 Traffic Signs Installed by Contract

Under the provisions of Minn. Stat. Sec. 161.32, Subd.1, the Commissioner may elect to conduct sign installation work by construction contract rather than by maintenance forces. Additional statutes may also be applicable.

6-3.03 Traffic Signs Installed by Others by Maintenance Permit

Under the provision of Minn. Stat. Sec. 169.06 Subd.2, the Commissioner may authorize others to install approved traffic signs by maintenance permit (MnDOT Form 1723). All signs shall conform to the permit. District Traffic Engineers should approve all sign installations and ensure that all applicable standards and practices are followed (Traffic Engineering Manual, MN MUTCD, MnDOT Standard Specifications for Construction, statutes, etc.

6-3.04 Temporary Traffic Control Signs Installed by Construction Contracts and Public Utility Companies at Work Sites

The MN MUTCD Part 6, Temporary Traffic Control, provides standards and guidelines for placing traffic control signs at work sites to protect the public, workers, and equipment. Section 6A covers the legal responsibility of authorities having jurisdiction to comply with the requirements of Part 6.

6-4.00 GENERAL PRINCIPLES OF TRAFFIC SIGNING

6-4.01 Principles of Traffic Control Devices

As stated in the MN MUTCD Section 1A.2, in order for traffic signs to be effective, they should meet the following basic requirements:

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

6-4.02 Basic Considerations for Installation of Traffic Signs

As stated in the MN MUTCD, and summarized in the Transportation and Traffic Engineering Handbook (published by the Institute of Transportation Engineers), five basic considerations are employed to ensure that the above basic requirements are met. These considerations are:

1. Design: the combination of physical features such as size, color, and shape needed to command attention and convey a clear message.
2. Placement: the installation of devices should be within the viewer’s cone of vision, so that they will command attention and allow time for response.

A 20-degree cone of vision should be used for placement of signs. Signs must remain within this cone
of vision to be read. Care should be taken when placing signs near intersections so that they do not restrict intersection sight distance.

3. Operation: the application of devices so that they meet traffic requirements in a uniform and consistent manner. Devices should fulfill a need, command respect, and allow time for proper response.

4. Maintenance: the upkeep of devices to retain legibility and visibility, the removal of devices if not needed, and to aid in commanding respect and attention while fulfilling the needs of users.

5. Uniformity: the uniform application of similar devices for similar situations so that they fulfill the needs of users and command their respect. The importance of uniformity in signing cannot be overemphasized.

### 6-4.03 Functional Classifications of Traffic Signs

The **MN MUTCD**, Section 2A.5, classifies signs by their functional usage as follows:

1. **Regulatory signs** inform highway users of traffic laws or regulations and indicate the applicability of legal requirements that would not otherwise be apparent.

2. **Warning signs** are used to call attention to hazardous conditions, actual or potential, on or adjacent to a highway or street that would not be readily apparent to the motorist.

3. **Guide signs** are used to provide directions to motorists, informing them of intersecting routes, directing them to cities and other important destinations, and guiding them to available services, points of interest, and other geographical, recreational, or cultural sites.

   Further, guide signs for expressways and freeways have two sub classifications:

   a. Primary guide signs consist of advance junction signing, exit directional signs, exit gore signs, destination, and distance signs.

   b. Supplemental guide signs further provide the driver geographic orientation and secondary destinations at certain interchanges. Destinations include cities, motorist services, or state parks. Exit numbers are included on freeway signs.
6-4.04 Department Classification by Sign Design Type

While the previous sign classifications describe general functions, MnDOT has further classified signs by design type.

**Type A**
Type A signs are large breakaway guide, directional, or informational signs normally installed on mainline freeways, expressways, and occasionally on conventional highways. They are supported on wide-flange steel posts (I-Beams).

1. Support system - poured concrete footings or driven structural steel H-piles to support breakaway wide-flange steel posts.

2. Sign panel - bolted extruded aluminum sections covered with sheet aluminum and direct applied retroreflective legend. The sign panel is attached with post clips to wide flange steel posts.

**Type C**
Type C signs are primarily regulatory, warning, route marker assemblies as found in the MnDOT Standard Signs and Markings Manual. They are the most common sign type and are typically installed on driven U posts or driven square tube posts or attached to signal mast arms and poles.

1. Support system - ground mounted signs are spliced or single U-posts driven into subsoil, attached to a bridge railing utilizing O-posts, or banded to traffic signal pedestals or mast arm poles. Unsupported length and sign panel area determines the number of U-posts and need for stringers and/or knee bracing.

2. Sign panel - sheet aluminum with direct applied retroreflectorized or screen processed legend. Punching is specified in the MnDOT Standard Signs and Markings Manual.

3. Light Poles - Manufacturers have indicated that signs should not be placed on any breakaway light pole. Installation of signs on breakaway light poles is strongly discouraged but in some cases may be necessary only after standard installation methods are explored and rejected. Using the following criteria, signs may be placed on poles that are installed on a steel 6 bolt median foundation: 40 foot mounting height poles can have a sign with a maximum of 12 sq ft at 7 feet up from the roadway; 49 foot mounting height poles may have a sign with a maximum of 6 sq ft at a 7 feet up from the roadway.
Type D
Type D signs are the smaller guide, destination, or informational signs. They are supported on driven U posts or mounted on overhead structures (traffic signal arms, sign supports, bridges, etc) with punching and stringer spacing as indicated in the MnDOT Standard Signs and Markings Manual.

1. Support system - same as Type C signs but generally supporting greater sign panel area. They may be affixed to a bridge railing, traffic signal mast arm, etc.

2. Sign panel - same as for Type C signs but splice plates may be required as specified in the MnDOT Standard Signs and Markings Manual.

Type OH
Type OH signs are large overhead guide, directional, or informational signs, either spanning a roadway, cantilevered over the roadway/shoulder, or bridge-mounted. The requirements of the structural support system generally require installation or maintenance by contract. There are three types of Type OH sign support systems: (1) sign supports which include no walkway or sign lighting, (2) trusses which may or may not include walkway and sign lighting, and (3) bridge-mounted structures which may or may not include walkway and sign lighting.

Type OH signs are necessary where ground-mounted signs are not deemed effective. Applications include, but are not limited to the following:

- Freeway and expressway signing (distance, advance guide, and exit signs) where space is not available for ground mounted signs or where there are three or more lanes of travel.
- Guide and/or lane use control signing approaching intersections in urban areas.
- Approach warning sign/flasher for mid-block pedestrian crosswalks.
- Locations with restricted sight distance (may be coupled with other factors cited).
- Exit ramp or roundabout guide and/or lane use control signing where overhead signing for proper lane assignment is necessary and cannot be accomplished by ground mounted signs.

1. Support systems
   a. Sign support - poured concrete shaft footing(s) supporting a sign bridge or cantilever structure with a single horizontal support for attaching sign panels.
   b. Truss type - poured concrete spread, shaft, or median barrier footings supporting a sign bridge or cantilever structure. The horizontal truss supports panel-mounting posts for attaching sign panels. The horizontal truss may incorporate a walkway and sign lighting system.
   c. Bridge mounted - truss system attached to a bridge which includes sign panel supports for attaching sign panels. The truss may incorporate a walkway and sign lighting system.
Overhead signs can generally be mounted to bridges with less than a 30 degree angle of skew (10 degree angle for changeable message signs). The overhead sign panel or changeable message sign should be mounted at right angles to the direction of, and facing, the traffic that they are intended to serve. Each situation is unique and the District Traffic Office should contact the Bridge Design Office for consultation. It is not recommended to mount overhead signs to pedestrian bridges; especially the truss supported or prefabricated pedestrian bridges. Except for clearance signs and other Type D signs, overhead signs shall not be mounted to railroad bridges. Remove existing overhead signs mounted to railroad bridges through attrition.

2. Sign panels
   a. Sign support - sheet aluminum with direct applied retroreflective legend. The sign panel is bolted to a sign bracket assembly.
   b. Truss type and bridge mounted - bolted extruded aluminum sections covered with sheet aluminum and direct applied retroreflective legend. The sign panel is attached with post clips to the panel mounting posts.
Type EA and Type EO
Type EA and Type EO signs are extruded sign panels attached with U-posts or S4x7.7 panel mounting posts above Type A or Type OH sign panels, respectively. These panels are used to designate exit numbers.

Traffic Signal Mast Arm Signs
These signs are designed specifically to be mounted on traffic signal mast arms. Signs are limited in size due to wind loading factors considered in the design of these structures.

Guide signs mounted on mast arms are supplemental to those mounted on the ground with the same message and therefore should be limited in use. The number of signs, size, and location of the signs on the mast arm will impact the wind loading. Before placement of signs on mast arms, a wind load analysis is required. For more information on wind load analysis contact the OTE Signals Unit.

Figure 6.23A through 6.23F show example mast arm signing and placement.

Changeable Message Signs (CMS)
Changeable Message Signs (CMS) may be used to inform the road user of special conditions about advisory situations, traffic congestion, or safety messages as determined by the District Traffic Engineer.

6-4.05 Elements of Traffic Sign Design
Elements of sign design include shape, color, size, legend, border, retroreflective properties, illumination, and uniformity. These elements are discussed in the MN MUTCD, Part 2; however, some permitted alternatives are as follows.

If there is more than one sign panel on an overhead sign structure and the sheeting is being replaced on one sign panel, the sheeting should be replaced on all of the sign panels.

6-4.05.01 Shape
Sign shapes should be designed as stated in the MN MUTCD, except that it is the policy in Minnesota to use the rectangular shape (rather than trapezoidal) for recreation area signs.

6-4.05.02 Color
The color of signs, legends, and borders are specified in the MN MUTCD. For standard signs, see the MnDOT Standard Signs and Markings Manual.
All ground mounted warning signs and their supplemental plaques on MnDOT trunk highways shall be fluorescent yellow. All warning signs and their supplemental plaques associated with pedestrians, bicyclists, playgrounds, and schools shall be fluorescent yellow green. The SCHOOL plaque is also included. Additionally, the IN-STREET and OVERHEAD PEDESTRIAN CROSSING (R1-6 series and R1-9 series) signs and the SCHOOL SPEED LIMIT (S5-1) sign shall have fluorescent yellow-green retroreflective sheeting for only the warning color parts of the sign as shown in the MnDOT Standard Signs and Markings Manual.

6-4.05.03 Size

The sign dimensions are specified in the MN MUTCD and MnDOT Standard Signs and Markings Manual. Increases above these standard sizes are desirable where greater legibility or emphasis is needed. Special designs or large signs are prescribed for use on freeways and expressways. Standard shapes and colors shall be used and standard proportions shall be retained for enlarging signs insofar as practicable. The overall dimensions of sign panels should be in 6 inch increments. The use of smaller than standard size signs may sometimes be justified under the guidelines specified in the MN MUTCD.

6-4.05.04 Legend

MnDOT’s preferred practice is to use symbol messages when the MN MUTCD allows the use of word messages as alternatives to symbols.

New warning or regulatory symbol signs not readily recognizable by road users should be accompanied by an educational plaque which is to remain in place for at least three years after initial installation.

It is MnDOT guideline to use upper/lower case lettering on all guide signs with proper name destinations.

The SignCAD program is currently used by MnDOT staff in designing guide signs. Contact OTE for technical assistance in the design of guide signs and usage of this program.

See Charts 6.1A, 6.1B, 6.1C, 6.1D and 6.1E for guide sign design guidelines.

6-4.05.05 Retroreflective Sheeting Policy

Retroreflective sheeting requirements for construction, maintenance, utility, and incident management operations can be found in Chapter 8 of this manual.

All MnDOT permanent signs, markers and delineators shall use Type XI sheeting except as otherwise specified in the MnDOT Specifications for Construction (e.g. X4-13 cylinder style delineators use Type IV sheeting).

6-4.05.06 Sign Lighting

Driving on freeways and expressways is a complex and demanding task. Communication with the driver by signing is in constant competition for the driver’s attention, particularly in the urban environment. As a countermeasure, overhead signs are typically utilized on urban area freeways.

The following guidelines were developed as a result of studies and field trips. Generally, overhead sign lighting is not needed. Each District should conduct a field review to determine if it is necessary to light overhead signs. During the field review of each site, viewing of the signs should be made only with low beam vehicle headlights. Also, it is recommended that personnel unfamiliar with the sign message be part of the review team to ensure the most objective decision possible.

By turning off or not installing overhead sign lighting, MnDOT benefits by reducing energy and maintenance costs while maintaining adequate sign legibility.

Any one of the following guidelines may make it necessary to light overhead sign panels:

1. Advertising devices and/or lighting sources competing for drivers’ attention.
2. Engineering judgment based on various factors including, but not limited to:
a. At least 650 foot legibility distance.
b. At least 1000 foot detection distance.
c. Roadway and interchange geometrics.
d. High weaving traffic volumes.
e. Three or more overhead mounted sign panels on the same sign structure facing one direction of traffic (sign message overload).
f. Number of lanes (horizontal and vertical alignment).
g. Major forks.
h. Skewed bridge crossings.
i. Horizontal curves.

3. High density fog areas.

4. Roadway lighting located in close proximity to overhead signs causing glare from the sign panels.

5. Regulatory and diagrammatic signs.

Sign lighting shall be provided for all sign panels if one sign panel on a sign structure requires lighting. The details of sign lighting are discussed in Chapter 10 of this manual.

6-4.06 Lateral Offset and Vertical Clearance Requirements

6-4.06.01 Type A Signs


The typical placement for Exit signs (E5-1 and E5-1a), Merge signs (W4-1), and Added Lane sign (W4-3) is also shown on [http://www.dot.state.mn.us/trafficeng/signing/doc/placementstd.pdf](http://www.dot.state.mn.us/trafficeng/signing/doc/placementstd.pdf).

6-4.06.02 Type C and Type D Signs

See Figure 6.1 for normal lateral offsets and vertical clearances.

6-4.06.03 Type OH Signs

1. The lateral placement of sign panels is the relationship of the sign panel to the lane. This is to ensure that the sign message will be correctly interpreted by motorists and proper lane assignment is achieved. Even a small error in placement can have a detrimental effect on traffic operation and sign message clarity.

   The lateral offset of sign posts is normally 7.5 feet from the edge of shoulder or the face of curb to the center of the post. Post locations and guardrail requirements will be in accordance with the current edition of the [Road Design Manual](http://www.dot.state.mn.us/trafficeng/signing/doc/placementstd.pdf).

2. The minimum vertical clearance over the high point of the roadway or mountable curb shall be 17.33 feet. See [Technical Memorandum No. 11-16-B-07](http://www.dot.state.mn.us/trafficeng/signing/doc/placementstd.pdf) for additional information regarding MnDOT Vertical Clearance Standards for New Bridges and for projects where the pavement is to be constructed under existing bridges.
6-4.07 Sign Installation and Maintenance Practices

6-4.07.01 Sign Installation Practice

1. Utilities and underground traffic control components

Care should be exercised in the installation of signs with respect to underground and overhead inplace public service utilities. In addition, care should be taken when working around traffic control devices and communication installations such as signal system cables, signal interconnection conduit systems, surveillance cables, roadway lighting electric cables, and traffic counting cables.

Minn. Stat. Chap. 216D requires anyone who engages in any type of excavation to provide advance notice of at least 48 hours to underground facility operators who may be affected by the excavation. Excavation means an activity that moves, removes, or otherwise disturbs the soil by use of a motor, engine, hydraulic or pneumatically-powered tool, or machine-powered equipment of any kind, or by explosives.

Gopher State One Call is a statewide one-call/web notification system which was established as a result of Minnesota law to inform all Minnesota underground facility operators of intended excavation. See their web page for hours of operation and to submit an electronic ticket. Gopher State One Call is available for emergency calls 24 hours a day, seven days a week. An emergency is defined by state law as “A condition that poses a clear and immediate danger to life or health or a significant loss of property.”

PHONE NUMBERS
Twin Cities Metro (651) 454-0002
In or Out State-Toll Free (800) 252-1166
WEBSITE: http://www.gopherstateonecall.org/

A free brochure is available and should be obtained by personnel responsible for installing sign structures in the ground.

2. Sign groupings

Traffic signs of different functional classification should not be mixed in a given sign installation.

It is not always feasible to erect signs separately in urban areas where mounting space is limited and visibility problems occur. In such cases, a sign of major importance may be placed above a relatively small sign of routine or secondary significance. However, if the design of the individual panels could mislead or confuse the motorist, this practice should be avoided.

3. Spacing of signs

General - Signs in a series must be uniformly spaced so that a driver traveling at normal speed has adequate time for the proper response. Since one of the primary objectives of traffic signing is to convey a needed message to motorists, care should be taken to provide compatible and effective sign spacing and to avoid reliance strictly on minimum distances unless absolutely necessary. As a rule of thumb for guide signs, every one inch of capital letter text height is equivalent to 30 feet of legibility distance.

Rural Areas - Sign spacing in rural areas should not be less than the distance required to read each sign at the upper range of anticipated vehicle approach speeds. For minimum recommended distances between signs of different purposes on rural highways see Figures 6.24A, 6.24B, 6.25, and 6.26.

Urban Areas - In urban areas with speed limits of 35 mph or less, the minimum distance between signs is 100 feet. For 40 mph or greater, this distance is 150 feet.

Freeways - Although conditions may exist where lesser sign spacing will be found necessary, freeway guide signs should be spaced at least 800 feet apart. A spacing of at least 400 feet should be provided between guide signs and all other types of signs on freeways.
Double Signing - If sign spacing approaches the minimum distance, double signing (right and left shoulder) may be utilized. Double signing should be used if the number of traffic conflicts is high.

4. Specular glare

Care should be exercised in the placement of ground-mounted and overhead signs to reduce the problem of mirror reflection. This reflection is known as specular glare and is caused by motor vehicle headlights at night. Specular glare renders the sign useless by making the message impossible to read.

Normally, signs should be mounted approximately at right angles to the direction of, and facing, the traffic that they are intended to serve.

Where mirror reflection from the sign face is encountered in such degree as to reduce legibility, the sign should be turned slightly away from the road. At curve alignments, the angle of placement should be determined by the course of approaching traffic rather than by the roadway edge at the point where the sign is located. Sign faces normally are vertical, but on grades tilt the sign forward or back from the vertical to improve the viewing angle.

5. Wind Loading

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (current edition), governs the design of all permanent signing installations prepared for construction contract letting. Briefly, AASHTO specifies iso-tacs and corresponding wind pressures on sign panels as follows:

All ground-mounted and overhead signs should be designed for a 50-year mean occurrence interval, which results in 90 mph wind speeds for Minnesota.

6. A-Frame and U-Post mountings

MnDOT uses 3 lb/ft stub posts with 2.5 lb/ft posts for the remainder of the structure. Assuming an average distance of 10 feet from the bottom of the sign panel to the ground line, the correct sign structure design and post spacing should be determined by using Chart 6.2 and Chart 6.3.

To use these charts, first determine the total length of the sign panel. Then, determine the height of the sign panel or add the heights of all of the individual sign panels to be mounted on the same sign structure. Based upon these dimensions (in inches), determine the correct number of vertical U-Posts (riser posts) and knee braces from Chart 6.2. After determining the correct number of riser posts to be used for the sign structure, refer to http://www.dot.state.mn.us/trafficeng/signing/doc/canddsignground.pdf and the punch codes in the MnDOT Standard Signs and Markings Manual for the spacing from center to center of posts. If there is no punch code or the sign structure is unique, then refer to Chart 6.3 to determine riser post (center to center) spacing.

In lieu of using two riser posts (in accordance with Chart 6.2) for a sign panel, one riser post may be used for any of the following conditions:

a. Rocky soils where holes are drilled for sign posts.

b. Concrete sidewalk or median.

c. Protected area experiencing low wind speeds.

d. Urban location.

e. Other locations where the placement of two riser posts is impractical.

On a sign assembly with three or more riser posts, the posts and knee braces shall be spaced at least 45 inches on centers.

Sign structures using U-posts shall be assembled according to the details shown in http://www.dot.state.mn.us/trafficeng/signing/doc/canddsignground.pdf. These details were designed based on crash tests conducted at Texas Transportation Institute in 1988 and 1989.
6-4.07.02 Sign Maintenance Practice

1. Traffic sign management system
   Each District is charged with developing and maintaining a sign inventory in accordance with the statewide sign management system. A comprehensive record of all signs is vital to sound sign management and budgeting.

2. Missing or damaged signs
   Unless otherwise stated in this manual, agreement, or other document, MnDOT is responsible for replacing all damaged or missing signs, except Logo signs, on the trunk highway system. Generally, STOP, YIELD, and DO NOT ENTER signs have the highest priority for replacement. These signs warrant weekend or overtime work for repair or replacement. Other signs should be evaluated on a case by case basis to determine relative priority. However, each District should develop a procedure for dealing with reports of damaged or missing signs to assure the prompt replacement of critical signs.

3. Sign Replacement Schedule
   Each District is charged with implementing recurring sign maintenance. A sign replacement schedule should be developed using the following guidelines:
   - Minimum Expected Sign Life: 15 years
   - Maximum Expected Sign Life:
     - Type IV Sheeting: 20 years
     - Type IX or XI Sheeting: 30 years
   A sign can remain in service until its maximum expected sign life if a visual inspection indicates that the sign meets minimum retroreflectivity levels, including contrast. The visual inspection should be used at the following sign ages:
     - Type IV Sheeting: 15 and 18 years
     - Type IX or XI Sheeting: 15, 18, and 20 years, and yearly thereafter
   Non-prismatic sheeting should be inventoried and evaluated for action.
   Each District should develop a method or process for completing the visual inspection and appropriate documentation. Visual inspection should consist of nighttime and/or daytime reviews. As a sign ages, the nighttime inspection becomes increasingly important. The visual inspection should also consider structural integrity, contrast, vegetation or other visibility issues, and/or engineering issues. The FHWA provides guidance that may be incorporated into the nighttime inspection.
   Engineering judgment may be used to replace signs with specific characteristics outside of the above guidelines (such as color, type, facing direction, mandates, etc.) through blanket replacement.

6-4.08 Implementation of Signing

Each District decides whether signs should be installed by maintenance personnel or by contract. The following reasons usually justify the installation of signs by contract:

1. Need for breakaway supports.
2. Overhead or Type A guide sign installations.
3. Scope of work beyond capability of District forces.
4. Safety reasons.
5. Extensive need for refurbishment.

Installation of signs by maintenance personnel is generally authorized by a District Traffic Work Order (DTWO).
6-4.08.01 Work Programming

Each District decides to program any work to be done by contract.

6-4.08.02 Preliminary Design

1. Work authorization
   The District requests a charge identifier.

2. Preliminary plan
   The District prepares a preliminary signing plan for new roadway construction. The preliminary plan should be transmitted to the OTE Signing Unit for review and comment. The District shall also transmit a copy of the plan to any involved municipalities.

6-4.08.03 Detailed Design

Standard detail sheets for signing plans can be found on the OTE website: [http://www.dot.state.mn.us/trafficeng/signing/plans.html](http://www.dot.state.mn.us/trafficeng/signing/plans.html). Plan format and sequence of details is as follows:

1. Title sheet.
2. Statement of Estimated Quantities.
4. Sign tabulation sheets giving pertinent information for each sign.
5. Traffic barrier data sheets.
7. Sign panel drawings for all non-standard signs.
10. Electrical details.
11. Cross sections for Type A and Type OH signs

6-4.08.04 Signing Special Provisions (DIV ST)

DIV ST templates for signing plan special provisions can be found on the OTE website: [http://www.dot.state.mn.us/trafficeng/signing/plans.html](http://www.dot.state.mn.us/trafficeng/signing/plans.html).

The District or OTE, if requested, is responsible for writing the special provisions for items which are not fully covered in the Standard Specifications, including description of work, material requirements, construction requirements, method of measurement, and basis of payment. OTE may provide technical assistance.

6-4.08.05 Cost Estimating

If requested, OTE will provide guidance on preliminary cost estimates based on average bid prices.
6-4.08.06 Construction Activities

1. Inspection
   Generally, all materials designated for use on state projects are subject to requirements covered by MnDOT Standard Specifications for Construction, the plan, and the special provisions included in the contract proposal.

2. Technical assistance
   OTE provides technical assistance to District personnel when requested.

3. Placement of signs
   Type OH and Type A signs are located at plan stationing unless field conditions require relocation. Dimensioned elevation drawings of each sign and roadway cross section are included in the plan.
   The importance of the positioning of overhead sign panels cannot be overemphasized. Project personnel shall notify the District Traffic Engineer if panel placement cannot be as intended or if the overhead sign location is to be changed.
   Type A signs, excluding the exit direction sign (placed at the beginning of the deceleration taper) may be moved longitudinally up to 100 feet without generally affecting the sign system requirements.

4. Project critique
   Prior to job acceptance, the District Traffic Engineer, project engineer, and designer should critique the project. This critique should include construction problems and improving methods or procedures, condition of materials incorporated in the project, and workmanship.

6-5.00 APPLICATION GUIDELINES-REGULATORY SIGNS

6-5.01 Purpose
Regulatory sign applications that are discussed in this section are those which:

1. Are not specifically addressed in the MN MUTCD.

2. Provide additional guidance to that given in the MN MUTCD on application, location, and usage of certain types of regulatory signs.

3. Establish procedures relating to engineering and traffic investigation requirements for certain regulatory signs.

6-5.02 Typical Sign Placement
The MN MUTCD Section 2B, illustrates typical positions for a number of regulatory signs. Figures later in this chapter supplement the MN MUTCD in showing typical positions for regulatory signs at various intersections and interchanges on MnDOT trunk highways.

Appropriate signing for private and low volume entrances is the responsibility of each District. Therefore, each location needs to be reviewed on a case by case basis. This allows the flexibility to deny or install signing depending on the entrance specifics.

In order to clarify and ensure uniform application for installation and maintenance of signing at entrances with trunk highways, the following guidelines are provided:

1. Private driveway
   Stop signs and/or other signing should not normally be installed. If installed, maintenance will be performed by MnDOT.
2. Low volume entrance
   a. If the entrance serves a single business, stop signs and/or other signing should not be installed unless engineering judgment determines signing is warranted. If warranted, signing is installed by the District or the business itself through permit in accordance with State standards. Maintenance will be performed by MnDOT.
   b. If the entrance serves several small businesses (e.g., a small strip mall), a field investigation should be conducted to determine if a stop sign or other signing is warranted based upon high traffic volumes, restricted sight distance, crash experience, intersection geometrics, pedestrian activity, etc.
      1) Signing at an entrance for existing businesses, if warranted, is installed by the District or the business itself through permit in accordance with State standards. Maintenance will be performed by MnDOT.
      2) Signing at an entrance to a proposed new development, if warranted, is installed by the developer in accordance with state standards. Maintenance will be performed by MnDOT.

3. High volume entrance
   Stop signs are required at each entrance. Other regulatory signs may be required depending on the highway type. A field investigation may be necessary to determine if any additional signing is warranted.
   a. Signing at an entrance for an existing high volume business is installed by the District or the business itself through permit in accordance with State standards. Maintenance will be performed by MnDOT.
   b. Signing at an entrance to a proposed new high volume business is installed by the developer in accordance with state standards. Maintenance will be performed by MnDOT.

6-5.03 Bridge Load Restrictions

Posting requirements for bridges on trunk highways are determined by MnDOT’s Office of Bridges and Structures.

1. Bridge Weight Limit Signs (R12-1a, R12-5a)
   Additional Information on load posting is stated in the LRFD (Load and Resistance Factor Design) Bridge Design Manual, Section 15.13. Use and application of the R12-1a sign is stated in the MN MUTCD Section 2B.59.1.
   The R12-5a sign may be used when only the single unit truck (SHV) needs posting. When a bridge load rating is controlled by SHVs, the typical posting sign (R12-5) creates a problem with unregulated permit timber trucks from the “Timber Haulers Bill”. The timber trucks with loads greater than 40 tons are associated with the two combinations vehicles, represented by the M 3S2 and M 3S3 posting sign figures. Our current MnDOT posting guidelines require that if the SHV governs the load rating and requires posting, then M 3S2 and M 3S3 will automatically be set at 40 tons maximum. This means that timber trucks are not allowed to cross the bridge, even though the bridge load rating may be greater than allowable timber truck loads. With the new single unit posting sign (R12-5a), this will give the bridge owner an option to just post the bridge for the single unit truck.

   Bridge Weight Limit signs shall be installed either on or immediately in advance of the bridge or structure that is restricted. On state highways, the posting notification is sent by memo from the State Bridge Engineer to the District Engineer. The District office must inform the Bridge Management Unit when the posting signs are in place. When a bridge load rating is completed and indicates a bridge is to be posted, the posting signs must be erected within 30 days after notification of their requirement. If there are significant changes in the bridge condition or in the posted weight, temporary signs should be erected in the interim.
2. BRIDGE WEIGHT LIMIT Supplement Sign (R12-5 Supplement)

Use and application of this sign is stated in the MN MUTCD Section 2B.59.1. The BRIDGE WEIGHT LIMIT supplement sign shall be installed well in advance of bridges or structures that are restricted. Signs should be placed at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around.

6-5.04 Bus Shoulder Sign (R4-X7)

According to Minn. Stat. Sec. 169.306, USE OF SHOULDER BY BUSES, authorized buses are allowed to drive on designated shoulders on freeways and expressways in the Metro District. Typical signs and locations are shown in Figure 6.15.

The SHOULDER AUTHORIZED BUSES ONLY (R4-X7) sign shall be used to designate shoulders for bus use. The BEGIN/END (R4-X7p) plaque shall be used at the beginning and end of each section.

Where the shoulder width is less than 10 feet (11.5 feet on bridges) for a distance less than 1000 feet, the merge sign for buses (W14-X10) should be installed at the beginning of this restricted width. In locations where there is insufficient shoulder width for 1000 feet or greater, the END and BEGIN plaques should be used with the SHOULDER AUTHORIZED BUSES ONLY sign.

6-5.05 BYPASS LANE Sign (R4-X8) and BYPASS AND TURN LANE Sign (R4-X8a)

See Figure 6.16 for the typical signing of bypass lanes.

Sign bypass lanes in accordance with the following guidelines:

1. T-intersections - the 30” x 30” BYPASS LANE sign shall be installed adjacent to the bypass lane taper area.

2. Four-legged intersections - the 30” x 36” BYPASS AND TURN LANE sign shall be installed adjacent to the bypass/turn lane taper area. Use this sign in areas where right turning traffic may be present, including but not limited to roadways, high volume entrances, low volume entrances, driveways, and farm or field entrances..

6-5.06 DO NOT PASS Sign (R4-1)

MnDOT policy is to use the NO PASSING ZONE (W14-3) pennant sign (48” x 64” x 64”). This does not preclude use of the DO NOT PASS sign where it is deemed necessary based on engineering judgment.

6-5.07 Flashing LED STOP and YIELD Signs

Light Emitting Diode (LED) units may be used individually within the legend of a sign and/or in the border of a sign to improve the conspicuity or to increase the legibility of sign legends and borders. Flashing LED STOP and YIELD signs should only be considered for installation in situations necessitating enhanced visibility of the sign. When usage is limited to special circumstances, flashing LED STOP and YIELD signs may be effective safety countermeasures.

This guidance supplements the retroreflectivity and illumination information found in the MN MUTCD, Section 2A.7. It is intended for use in permanent installations of LED STOP and YIELD signs that flash continuously, but not for actuated systems.

Appropriate Usage

Flashing LED STOP and YIELD signs should only be considered for installation in situations necessitating enhanced visibility of the sign as determined by engineering study. These signs should be limited to locations with at least two of the following:
• Limited visibility on approach to the intersection, as determined by the sight distance criteria for Warrant 1 in Section 9-4.02.02 of this manual.
• A history of crashes documented to be caused by a failure to stop and deemed preventable by implementation of conspicuity improvements.
• At a rural junction of two or more high speed trunk highways to warn drivers of an unexpected crossing of another highway.
• At a rural junction of a trunk highway and a local road which has no STOP controlled intersection within five miles.

Prior to selecting a flashing LED STOP or YIELD sign, several of the following conspicuity improvement alternatives should be implemented at the intersection:

• Install a STOP AHEAD (W3-1) or YIELD AHEAD (W3-2) sign on approach to the intersection, appropriate to the intersection control.
• Increase the size of a standard STOP or YIELD sign.
• Install a second STOP or YIELD sign of equal or lesser size on the left-hand side of the roadway.
• Add one or more red or orange flags (cloth or retroreflective sheeting) above a standard STOP or YIELD sign, with the flags oriented so as to be at 45 degrees to the vertical.
• Add a strip of retroreflective material to the sign support in compliance with the provisions of MN MUTCD Section 2A.21.
• Install pavement marking messages appropriate to intersection control, such as STOP and/or STOP AHEAD, YIELD and/or YIELD AHEAD.
• Install in-lane rumble strips on approach to the intersection according to Chapter 4-4.02 of the MnDOT Road Design Manual.
• Add a stop beacon to a STOP sign according to Section 9-4.02.02 of this manual and Section 4L.5 of the MN MUTCD. The stop beacon alternative is not required prior to installing a flashing LED STOP sign. Stop beacons shall not be installed in combination with flashing LED STOP signs.

If a flashing LED STOP or YIELD sign is installed on a single lane approach, the LED sign shall be installed on the right side of the roadway and a second static STOP or YIELD sign may be mounted on the left side of the roadway. If the approach is a multilane approach and an engineering study determines that the installation of flashing LED STOP or YIELD signs on both the right and left side of the roadway is warranted, then the flashing LED signs shall flash simultaneously.

Device Characteristics
LEDs shall be red for STOP and YIELD signs.

Operation
The uniformity of the sign design shall be maintained without any decrease in visibility, legibility, or driver comprehension during either daytime or nighttime conditions.

Installation, Maintenance, and Replacement
Flashing LED STOP and YIELD signs installed by local agencies at intersections of local roads with trunk highways:

• Shall be installed via permit obtained from the District Office.
• Shall have all costs related to installation and maintenance be incurred by the permitted agency.
• May be subject to field reviews conducted by MnDOT at any time in order to verify proper installation, maintenance, and operation of the traffic control device.

In the event that a flashing LED STOP or YIELD sign is knocked down or otherwise rendered inoperable due to damage:

• The damaged sign shall be replaced immediately. Replace the damaged STOP or YIELD sign immediately with a temporary or permanent sign. A temporary non-LED STOP or YIELD sign may include an attached flashing beacon for enhanced conspicuity. The temporary sign shall remain on-site until a permanent sign is installed.
• Replacement flashing LED STOP or YIELD signs shall be installed at the expense of the permitted agency which requested the original flashing LED STOP or YIELD sign. The permitted agency shall reimburse MnDOT for the repair or replacement of any signs, permanent or temporary, LED or non-LED, related to inaction or slow response by the permitted agency.

• A permanent replacement STOP or YIELD sign may be a regular, non-LED sign if the maintaining agency wishes not to continue operation of a flashing LED STOP or YIELD sign at that location. This decision should be documented by the permitted agency, and sent to the District Traffic Office within one week of replacing the damaged sign.

Discontinued operation of a flashing LED STOP or YIELD sign leading to replacement with a regular, non-LED STOP or YIELD sign for any reason other than damage should require that the District Traffic Office be notified 30 days prior to replacement. This decision should be documented by the permitted agency, and sent to the District Traffic Office at the time of notification.

6-5.08 In-Street Pedestrian Crossing signs (R1-6 series)

In-Street Pedestrian Crossing signs (R1-6 series) may be used to remind road users of the state law that requires the driver of a vehicle to stop and yield the right-of-way to a pedestrian crossing the roadway within a marked or unmarked crosswalk.

With exception of installation at roundabouts, guidelines for installation of In-Street Pedestrian Crossing signs on state highways are as follows:

a. The sign shall be installed only by permit through MnDOT District offices.

b. The sign shall only be used in 35 mph or lower speed zones.

c. Only one sign structure shall be used per approach near marked crosswalks.

d. The sign shall not be used at intersections controlled by traffic control signals or on approaches controlled by STOP signs.

e. The sign should only be used at key locations, such as high volume pedestrian crosswalks, to avoid overuse.

f. The sign shall only be used as an in-street sign, not on the outside shoulder or parking lane. When installed, the sign shall not impede or obstruct any traffic movement including through or turning movements.

g. When the sign is used at or in advance of a school crossing to supplement ground mounted school warning signs, the sign should include the SCHOOL plaque.

h. The sign shall have the same sign message on both sides or a retroreflective strip mounted on the backside the same color as the centerline or lane line. To avoid driver confusion, back-to-back signs should only be used on two-lane two-way roadways. See the MN MUTCD Figure 2B-2.

i. The sign may be used seasonally to prevent damage in winter due to plowing operations, and may be removed at night if pedestrian activity is minimal.

6-5.09 Intersection Stop Control

The MUTCD does not address methodology for revising traffic control at an intersection, such as the following:

• Reduction of Stop Signs
• Increase in Stop Signs
• Reversal of Through Route
• Change from Yield to Stop
• Change from Stop to Yield
These types of changes to traffic control require careful consideration of potential safety impacts. When making these changes in stop control conditions, consider the following list. This list is not all-inclusive, but a starting point to help the traffic engineer. All of the following listed below are optional using engineering judgment.

Consider:

• Coordinating with your district PAC to discuss the best way to notify the traveling public of the upcoming changes.
• Notifying law enforcement (city, county, state) of the changes.
• Deploying enhanced conspicuity strategies for a period of time determined by the engineer. See MN MUTCD 2A.15.
• Installing advanced warning signs, either temporarily or permanently.
  o STOP AHEAD (W3-1)
  o TRAFFIC CONTROL CHANGE AHEAD (W3-X5)
  o CROSS TRAFFIC DOES NOT STOP (W4-4P)
  o NEW TRAFFIC PATTERN AHEAD (W23-2)
  o NEW (W16-15P)
  o NOTICE (W16-18P)
• Installing either temporary or permanent transverse rumble strips.
• Adding or removing pavement markings as appropriate.
  o Stop Bar
  o Stop Message(s)
  o No Passing Zones

6-5.10 Lane Designations

Under Minn. Stat. Sec. 169.18, Subd. 7(c), MnDOT may erect signs on Trunk Highways (or authorize the erection of such signs on local highways) directing traffic to use specific lanes. Special lanes may be designated when certain vehicles (for example, trucks) cannot maintain the speed required to keep the speed differential within 15-20 mph and there is adequate space available. TRUCKS USE RIGHT LANE (R4-5) may be installed according to MN MUTCD Section 2B. In addition, special bus and HOV lanes, known as restricted lanes, are designated on certain freeway mainline and entrance ramps.

6-5.11 Passing Lane Sections

See Figures 6.21A, and 6.21B for typical passing lane section signing.

6-5.11.01 Advance Passing Lane Sign (R4-X6)

The Advance Passing Lane sign should be used to notify and prepare drivers of the upcoming passing opportunity so that they can make effective use of the passing lane. One sign should be placed 1/2 mile upstream and additional advance signs are desirable 2-5 miles in advance of a passing section.

6-5.11.02 SLOWER TRAFFIC KEEP RIGHT Sign (R4-3)

The SLOWER TRAFFIC KEEP RIGHT sign should be placed at the beginning of the lane addition.
6-5.12 RIGHT LANE MUST TURN RIGHT Sign (R3-7) and LEFT LANE MUST TURN LEFT Sign (R3-7)

RIGHT/LEFT TURN LANE signs shall be removed through attrition unless otherwise noted. If any one RIGHT/LEFT TURN sign requires replacement before the end of its useful life, replace all turn lane signs at the intersection or on the exit ramp with the appropriate R3-7 signs or Advanced Lane Control signs.

Sign turn lanes in accordance with the following guidelines:

1. Conventional Roads

   All turn lanes should be signed unless the turn lane(s) is(are) included on an Advanced Intersection Lane Control (R3-8) sign(s). Signs may be omitted in urban areas.

2. Interchange exit ramps

   a. All turn lanes should be signed unless the turn lane(s) is(are) included on an Advanced Intersection Lane Control (R3-8) sign(s).

   b. See Figures 6.17A and 6.17B for typical Advanced Intersection Lane Control signs on ramps.

3. Expressways

   Sign all turn lanes based on the District sign replacement cycle. Adjoining Districts should coordinate installing RIGHT/LEFT TURN LANE MUST TURN RIGHT/LEFT signs within the same time frame on those highways that cross District boundaries.

6-5.13 SLOWER TRAFFIC MOVE RIGHT Sign (R4-3a)

The SLOWER TRAFFIC MOVE RIGHT signs advise slower motorists to move into the right or slower lane on interstate roadways throughout the state.

These signs were installed to educate motorists of Minn. Stat. Sec. 169.18, Subd. 1 which states that vehicles should be driven on the right unless:

1. Passing another vehicle.

2. The right lane is closed to traffic during road construction or repair.

3. On three-lane or one-way roads.

Signs were installed in the year 2000 in coordination with the Minnesota State Legislature and State Patrol. In greater Minnesota, signs were installed at 50 mile intervals and in the Metro District locations were selected based on engineering judgment. Notify the State Signing Engineer before removing a SLOWER TRAFFIC MOVE RIGHT (R3-4a) sign.

6-5.14 Speed Zone Signing

Minn. Stat. Sec. 169.14 establishes statutory speed limits on most typical roadways under ideal conditions. All other speed limits are set by the DOT Commissioner based upon an engineering and traffic investigation. Speed zone signs should be installed in the most advantageous locations to promote driver compliance. Speed zone signs should be installed according to the following criteria.

6-5.14.01 Speed Limit Sign (R2-1)

A Speed Limit sign shall be installed at the terminal points of each speed zone.

The first Speed Limit sign in a lower speed zone should be one size larger than the size designated for that type of roadway except freeways.
In addition to sign locations required by the standard in MN MUTCD 2B.13, signs should be posted beyond intersections with major traffic generators. Installation of signs in urban areas may be more frequent due to numerous access points while rural areas may be less frequent when the character of the roadway remains consistent.

6-5.14.02 Minimum Speed Limit Sign (R2-4b)

1. General

The Minimum Speed Limit sign shall be used on all freeways designated as interstates. The minimum speed limit should be 40 mph unless a traffic investigation identifies a unique traffic pattern justifying a different value. The minimum speed shall be omitted whenever there are warning signs with advisory speeds advising motorists of a value lower than the minimum. The minimum speed limit should resume after the hazard is passed.

Signs should be installed downstream of all entrance ramps. If sign spacing criteria cannot be met due to high sign density in urban areas, the Minimum Speed Limit sign should be placed at the first available location. The next smaller sign size may be used where proper lateral clearances cannot be achieved.

2. Rural interstates

On rural interstates located outside the limits of urbanized areas (population greater than 50,000 as defined by the Commissioner) the R2-4b Minimum Speed Limit sign shall be used. The speed limit shall be 70 mph. The spacing between signs should not exceed ten miles. Signs should be installed downstream of all entrance ramps.

3. Urban interstates

On urban interstates the R2-4b Minimum Speed Limit sign shall be used. A Speed Limit (R2-1) sign may be used if a traffic investigation determines that a minimum speed limit is not required.

6-5.14.03 Dynamic Speed Display Signs

Dynamic Speed Display (DSD) signs may be installed on trunk highways at key locations such as speed transitions, school zones or on a temporary basis for maintenance and construction work zones or enhanced speed enforcement. For temporary DSD signs see Chapter 8-6.02.05

1. Location and Mounting

   a. The DSD signs shall be mounted above, below or beside the regulatory speed limit sign. If the DSD is installed to supplement an advisory speed, it should be mounted beside the warning/advisory speed combination sign.

   b. Signs mounted beside each other shall be mounted at the same height. Standard mounting heights shall comply with the MN MUTCD.

   c. DSD sign installations shall comply with all MN MUTCD crashworthy requirements.

2. Device Characteristics

   a. All portions (the static sign and the changeable message portion) of the sign shall be compliant with the Mn MUTCD.

   b. The legend shall read “YOUR SPEED” as a static sign message centered on the sign.

   c. Legend and background colors of this static sign shall match the regulatory or advisory speed sign it is paired with. The changeable portion of the DSD sign shall have a black background with an amber (yellow) illuminated legend.
d. The changeable message portion of the sign shall display the approaching vehicle as “XX” in MPH. The following standards apply to the changeable message portion of the sign:

i) The DSD shall flash at drivers traveling over the posted speed limit.

ii) The flash rate should be between 50 and 60 cycles per minute.

iii) Threshold speed settings should be set at 10 mph over the posted speed limit for roadways with speeds limits under 45 mph, and 20 mph over the posted speed limit for roadways with speed limits over 45 mph or greater.

iv) For speeds measured over the speed threshold setting, the DSD sign shall go blank.

v) The DSD sign shall be blank when no vehicles are present.

e. For more product specifications, see MnDOT’s Approved Products List website.

3. Usage

a. DSD signs installed in permanent speed zones should operate 24 hours a day 7 days a week.

b. DSD signs installed on temporary speed zones should operate for the time period that the speed zone is in effect (e.g. school zones)

c. DSD signs installed by local agencies on Trunk Highways

i) The DSD sign shall be installed by permit only through MNDOT District Offices and. All costs related to installation shall be paid by the requesting agency.

ii) The usage of DSD signs is limited to one DSD sign used per approach of speed transition zones such as at city limits, school zones, or other large speed reduction transitions.

iii) A request to relocate a sign shall be approved by MnDOT. The cost to relocate the sign shall be paid by the requesting agency.

6-5.15 TRUCK ROUTE (R14-1)

Based on Minn. Stat. Sec. 169.87, Subd. 1e, when a local authority petitions MnDOT to establish a truck route for travel into, through, or out of the territory under its jurisdiction, MnDOT shall investigate the matter. If the request is approved, MnDOT may designate certain highways under MnDOT’s jurisdiction as “truck routes” and may restrict truck travel to those routes when signs are erected. However, except under conditions stated in Minn. Stat. Sec. 169.87, MnDOT is not authorized to prohibit truck travel on trunk highways. The designation of a truck route is based on the design of the roadway, the type and mass of trucks using the facility, load carried, and the weather conditions. Signs may be installed in accordance with MN MUTCD Section 2B.61.

6-5.16 TRUCK STOPPING LANE (R4-X4) at Railroad Crossings

See Figure 6.47 for typical sign placement approaching railroad crossings with truck stopping lanes. Install the TRUCK STOPPING LANE sign adjacent to the truck stopping lane taper area.

6-5.17 Two-Way Snowmobile Trail Signing

Signing of MnDOT permitted two-way snowmobile trails within trunk highway right-of-way is the responsibility of the Department of Natural Resources. Sign two-way snowmobile trails within the trunk highway right of way in accordance with the following:

1. Install 18” x 24” sign panels with black legend and border on orange background.
2. Install BEGIN and END plaques (18” x 6”) in black legend and border on white background above the two-way sign panel, designating the beginning and end of the two-way trail.

3. A 3” x 3” piece of yellow retroreflective sheeting shall be attached in the lower left corner on the back of the sign panel.

4. The sign post shall be on the FHWA approved listing of breakaway posts to support the sign panel at a mounting height of five feet.

5. The sign shall be installed on the right side of the trail.

6. All sheeting material shall be a minimum of ASTM Type III prismatic retroreflective sheeting.

6.5.18 VEHICLE NOISE LAWS ENFORCED Sign (R16-X13)

Large trucks use a method of braking which utilizes engine exhaust manipulation to slow the vehicle. This method, referred to as engine braking, may produce a very loud distinctive sound on a truck with a poorly muffled or un-muffled exhaust. Excessive exhaust noise may also be produced by other types of vehicles, including motorcycles.

MnDOT has developed the following guidelines for use of the VEHICLE NOISE LAWS ENFORCED sign to assist local law enforcement agencies in enforcing Minn. Stat. Sec. 169.69 MUFFLER and Minn. Stat. Sec. 169.693 MOTOR VEHICLE NOISE LIMITS.

General Criteria

1. Signing may be permitted on conventional highways and on segments of expressways without interchanges. Signing will not be permitted on freeways.

2. Only one sign shall be allowed per approach to a community. Signs shall not be installed for isolated driveways in rural areas.

3. The sign shall be installed on an independent structure and should measure 36” x 42” in size.

   NOTE: There shall be adequate spacing for each sign as determined by the District Traffic Engineer.

4. The request for installation of a sign(s) shall be made through the community.

5. It is the responsibility of the local law enforcement agency to enforce the sign(s).

6. The District Traffic Engineer may require that the community pass a resolution stating that it will enforce Minn. Stat. Sec. 169.69 (MUFFLER) and Minn. Stat. Sec. 169.693 (MOTOR VEHICLE NOISE LIMITS) prior to installing the sign(s).

Fabrication and Installation Guidelines

The District Traffic Engineer determines which of the following installation methods are used to install vehicle noise law signs:

1. The requesting community may fabricate and install the sign(s) with their own forces or under contract. A permit from MnDOT shall be required for placement of signs on trunk highway right-of-way. The location of the sign shall be approved by the District Traffic Engineer.

   The sign panel shall be fabricated with sheet aluminum and retroreflective sheeting in accordance with MnDOT standards.

   If a sign structure is to be located within the clear zone, it shall meet FHWA breakaway requirements.

   All future maintenance of signs (knockdown, replacement, etc.) shall be the responsibility of the community.

2. MnDOT forces may fabricate and install the sign(s). The requesting community shall pay all fabrication and installation costs prior to the start of the work.

   All future maintenance of signs will be performed by MnDOT forces at the expense of the community.
6-6.00 APPLICATION GUIDELINES - WARNING SIGNS

6-6.01 Purpose

Warning sign applications that are discussed in this section are those which:

1. Are not specifically addressed in the MN MUTCD.
2. Provide additional guidance to that given in the MN MUTCD on application, location, and usage of certain types of warning signs.
3. Establish practices relating to engineering and traffic investigation requirements for certain warning signs.

6-6.02 Acceleration Lane Signing (W6-X1, W6-X2, and W20-X3)

The MERGE w/Arrow sign (W20-X3) sign may be used at the beginning of the taper for the following situations:

1. The MN MUTCD Section 2C.42, states "Lane ends signs should not be installed in advance of the downstream end of an acceleration lane." Many acceleration lanes exist on the MnDOT highway system. Such situations may include escape lanes on freeways and right or left acceleration lanes on two lane conventional roads or expressways.

2. Where two lanes are carried through a roundabout or signalized intersection and the right/left lane ends within a short distance after the intersection. In these situations there is not enough physical space on the roadway to install advance lane ends signs but a sign is needed to mark the merge point.

Acceleration lanes at rural unsignalized intersections should be signed in accordance with Figure 6.18.

6-6.03 Advance Warning Signs on Local Road Approaches (W2-6a, W3-1, W3-2, and W3-3)

This section details the installation and maintenance of advance warning signs on local road approaches to trunk highway intersections.

The advance warning signs on local road approaches include, but are not limited to, the following:

Roundabout Ahead (W2-6a), Stop Ahead (W3-1), Yield Ahead (W3-2), and Signal Ahead (W3-3).

1. Although MnDOT maintains STOP and YIELD signs on local roads intersecting the trunk highway, maintenance of the advance warning signs on all local road approaches to trunk highway intersections is the responsibility of the road authority.

2. At new intersections, or at intersections where traffic control is revised by MnDOT, MnDOT will investigate the need for advance warning signs on the local road approaches, furnish and install the appropriate sign, and notify in writing the road authority(s) of the sign installations. Maintenance of the advance warning signs will be the responsibility of the road authority.
6-6.04 Advisory Exit and Ramp Speed Signs (W13-2, W13-3) and Combination Horizontal Alignment/Advisory Exit and Ramp Speed Signs (W13-6, W13-7)

The Advisory Exit and Ramp signs shall be installed in accordance with **MN MUTCD** Table 2C-5. When used, the advisory speed posted on these signs should follow the established engineering practice for determining advisory speeds as discussed under Advisory Speed Plaques, **6-6.05 Advisory Speed Plaque (W13-1P)** of this Chapter and Chapter 14 of this manual.

6-6.05 Advisory Speed Plaque (W13-1P)

The Advisory Speed Plaque shall be installed below horizontal curve warning signs in accordance with **MN MUTCD** Table 2C-5. If horizontal curve warning signs are installed on curves which have a speed differential of 5 mph or greater then the Advisory Speed Plaque shall be installed below the horizontal curve warning sign.

Advisory speeds will be determined by the established engineering practice using a ball bank indicator using the following criteria (**Chart 6.5**):

1. 16 degrees of ball-bank for speeds of 20 mph or less.
2. 14 degrees of ball-bank for speeds of 25 to 30 mph.
3. 12 degrees of ball-bank for speeds of 35 mph and higher.

More information on Advisory Curve Speed Studies is shown in Chapter 14 of this manual. An example form for taking field ball banking measurements is shown in **Form 6.2** of this Chapter.

On a new roadway or alignment when the established engineering practice of using a ball bank indicator is not possible, the District Traffic office should work with the designer to determine advisory speed based on the curve design speed. The signing plans should include the required warning signs based on this information. After construction is completed, it is recommended that a field review be performed based on the above established engineering practice for determining the advisory speeds and changes made to installed warning signs as necessary.

6-6.06 BRIDGE ICES BEFORE ROAD Sign (W8-13)

On state maintained roadways, the state is not liable for losses caused by snow or ice on roadways unless the state affirmatively creates the condition on the roadways.

**Minn. Stat. Sec. 3.736, Subd 3(d)** provides immunity for “a(ny) loss caused by snow or ice on any highway or other public place, except when the condition is affirmatively caused by the negligent acts of a state employee.”

An exception can be made if recent crash reports clearly define an unusual crash problem related to icing on a bridge. This situation is expected to occur only when a bridge is in an area of unique or unusual geometrics. If there are bridge locations which have a serious crash history related to icing, consideration should be given to correcting the situation rather than merely warning of it.

Application of these guidelines will best serve motorists by providing only those signs that are necessary to warn of an unusual situation.

Any existing warning sign for icy or frosty bridge conditions should not be replaced at the end of its useful life unless a crash problem exists, as stated above, and correction of the problem contributing to the crashes cannot be accomplished.

6-6.07 Channelized Intersections

Figures 6.19A and 6.19B indicate the signing required for channelized intersections.
6-6.08 Chevron Alignment Sign (W1-8)

The MN MUTCD provides Standards and Guidance regarding the use of the Chevron Alignment sign (W1-8). MN MUTCD Table 2C-5, states that the use of Chevrons and/or One Direction Large Arrow (W1-6) signs should be used on curves when the difference between the speed limit and advisory speed is 10 mph, but shall be used when this difference is 15 mph or greater. Generally, these signs are used for curves of over six degrees (a curve radius less than 900 feet).

The use of Chevrons on curves is preferred over the use of the One Direction Large Arrow. The exception is on conventional roadways when the speed of the turn/curve is 30 mph or less or there is a visual trap. Chevrons or delineators may supplement the One Direction Large Arrow if needed. A visual trap exists when a crest vertical curve is present before the beginning of the horizontal curve, or when a minor road, tree line, or line of utility poles continues on a tangent. In these situations the One Direction Large Arrow is used to help get the focus off of the visual trap.

The MN MUTCD guidance states, “Chevron Alignment signs should be visible for a sufficient distance to provide the road user with adequate time to react to the change in alignment.” MnDOT further clarifies this statement with the following:

When used on conventional roadways, expressways, and freeway mainline curves, chevrons should be installed from the beginning to the end of the curve. When used on exit loops, a minimum of 5 chevrons should be installed. Fewer signs are necessary on exit loops because road users expect that a loop ramp will continue to curve until it joins a new roadway. When used on exit ramps, use engineering judgment on the number and placement of chevrons required per MN MUTCD Table 2C-5. If chevrons are not required per MN MUTCD Table 2C-5, guide delineators may be used on the outside of the curve based on engineering judgment.

Chevrons shall be installed at a minimum height of five feet for flanged channel (U channel) sign structures measured vertically from the bottom of the sign panel to the elevation of the near edge of the traveled way. For other sign structures, a minimum mounting height of four feet from the bottom of the sign panel to the elevation of the near edge of the traveled way is allowed. Whenever practical, efforts should be made to place back to back chevrons on one structure rather than having a set of structures for each direction.

When installation of the chevrons cannot meet requirements (such as field conditions do not allow for installation of chevrons on a median barrier) then an engineering study shall be used to determine the appropriate traffic devices to emphasize the curve.

The formula for calculating the degree of curvature from the radius is $D = \frac{5729.578}{\text{Radius}}$. 
6-6.09 Non-Vehicular and Vehicular Traffic Warning Signs

Non-Vehicular and Vehicular Traffic Warning signs should only be used at locations where the condition, crossing activity, or shared use of the roadway is unexpected or where a sight restriction or other geometric constraint exists.

If used, Non-Vehicular or Vehicular Traffic Warning signs placed in advance of a crossing should be placed in accordance with the MN MUTCD Table 2C-4 or Chart 6.4 of this chapter.

If a crossing is to be signed, whether or not there are crosswalk markings, advance NON-VEHICULAR or VEHICULAR CROSSING signs should be installed.

6-6.09.01 Non-Vehicular Signs

Guidance for evaluating the installation of pedestrian crosswalks can be found in Chapter 13 of this manual.

Specific information for the installation of STOP HERE FOR PEDESTRIANS signs (R1-5 series) is in the MN MUTCD Section 2B.

1. Pedestrian Crossing Signs (W11-2)

Typical examples where special treatment should be considered include isolated intersections where there are heavy pedestrian volumes, pedestrian crossings where approach visibility is poor, and at mid-block crossings.

Special treatment is not usually required at normal intersections within municipalities or at rural intersections.

See Figure 6.20 for typical placement of a Pedestrian Crossing sign (W11-2) at an intersection. In urban areas, the distance for the advance crossing sign may be less where lateral clearance is limited or where inadequate sign spacing exists.

2. Snowmobile Crossing Sign (W11-6)

In addition to the criteria for installing Vehicular Traffic Warning signs, engineering judgment may be used to install signs for crossings based on unique trail geometric conditions, such as deep ditches, steep inslopes, narrow shoulders, or at locations where Minn. Stat. Sec. 84.87, Subd 1b(6) permits snowmobiles to be operated on highway bridges (other than part of the main traveled lanes of interstate highways) when no other method of avoidance is possible.

If an established crossing meeting the guidelines for signing remains in the same location for several years, the District may consider installing warning signs with diagonal down arrows at the crossing.

Snowmobile crossing signs should NOT be removed in the spring and reinstalled in the fall due to variations in the length of the snowmobiling season from year to year.

Do not sign all crossings since many Grant-in-Aid trail crossings move annually (some by as little as 100 feet).

If a snowmobile trail crossing is a multi-use trail and the criteria for sign installation are met, TRAIL CROSSING signs shall be used instead of Snowmobile Crossing signs.

3. Deer Crossing Sign (W11-3)

Data has shown that installing static deer warning signs has not been effective in reducing deer/vehicle crashes. As such, MnDOT policy is to no longer install static Deer Crossing signs. Remove deer crossing signs through attrition.
6-6.09.02 Vehicular Traffic Warning Signs

Sight restriction determination
MnDOT provides the following clarification and guidance in determining the justification of installing Vehicular Traffic Warning Signs.

In order to determine whether or not a sight restriction exists for a crossing that cannot be relocated, a simple procedure is frequently used. This procedure is based on the standard height-of-eye of 3.5 feet and a standard traffic cone height of 28 inches. The visibility distance used in this procedure should be obtained from the AASHTO Policy on Geometric Design of Highways and Streets using either Exhibit 3-1, Stopping Sight Distance on Level Roadways, or Exhibit 3-2, Stopping Sight Distance on Grades. See Chart 6.7 for Exhibits.

Procedure:
Temporarily place the traffic cone at the passenger pickup or drop-off site. Using a vehicle or measuring device where the operator is using the correct height-of-eye, move to the visibility distance, as determined above, in advance of the cone. If the cone is not completely visible, then the site will need to have the appropriate crossing sign installed. The sign placement should be based on the values in Table 2C-4, Advance Placement Distance, of the MN MUTCD or Chart 6.4.

6-6.09.02.01 Horse-drawn Vehicle Signs (W11-14)
These signs should be used in areas that have frequent horse-drawn vehicles sharing the roadway. The best way to know the approximate areas of travel is to talk to the local law enforcement agency to determine the physical extent of the community that uses horse-drawn vehicles and their frequent travel destinations.

Horse-drawn vehicles typically move at 5 to 10 mph. Signs should be placed when the roadway has a paved shoulder that is less than 6 feet. Roadways that have 6 feet or greater paved shoulders do not need signs placed along them since the horse-drawn vehicle will be utilizing the shoulder.

Signs should be placed:
• At the beginning of the area of frequent horse-drawn vehicles. This is typically at the nearest community outside of their area.
• Confirmation signs should be placed:
  o After major intersections
  o At the beginning of limited sight distance. If this is within 1 mile of a major intersection, the major intersection confirmatory sign may be omitted.
  o Approximately every 5 miles. This can be adjusted to accommodate the previous two confirmatory sign locations.

A supplemental distance plaque (W7-3aP) may be used. The distance noted on the plaque is to the end of the area used by the horse-drawn vehicles.

6-6.09.03 TRAIL CROSSING Sign (W11-15a)
A TRAIL CROSSING sign should only be installed for officially designated trails which cross the highway. To determine if the visibility distance is adequate, use the sight restriction determination procedure stated above.

6-6.09.04 Down Arrow Plaque (W16-7mP)
If a NON-VEHICULAR or VEHICULAR traffic sign is placed at a crossing, the supplemental DOWN ARROW plaque shall be installed below the crossing sign whether or not there are crosswalk markings at the crossing.
6-6.10 Low Clearance Sign (W12-2)

According to Minn. Stat. Sec. 169.81, Subd. 1, no vehicle loaded or unloaded shall exceed 13 feet 6 inches in height except double-deck buses with written authority from the Commissioner of Transportation. Per Minn. Stat. Sec. 169.801, implements of husbandry (farm equipment) are exempted from size, weight, and load provisions, but the operator must ensure that the operation does not damage a highway structure. In accordance with the MN MUTCD, Section 2C, the LOW CLEARANCE sign shall be installed to warn drivers that the clearance is less than the statutory maximum vehicle height of 13 feet, 6 inches clearance allowed plus one foot or 14 feet, 6 inches.

All structures with a clearance less than 14 feet 6 inches shall be signed. To allow for frost action, a reduction of 3 inches shall be reflected in the signing. For example, a clearance measurement of 14 feet, 3 inches will be signed as 14 feet, 0 inches.

Periodic checking of clearances needs to be done on bridges and other structures, especially when the roadway has been resurfaced.

6-6.11 No Passing Zones

6-6.11.01 NO PASSING ZONE Sign (W14-3)

It is MnDOT’s practice to use the NO PASSING ZONE (W14-3) pennant signs. This does not preclude use of the DO NOT PASS sign where it is deemed necessary based on engineering judgment. NO PASSING ZONE pennant signs used on conventional highways shall be 64” x 64” x 48”.

The purpose of this larger size on conventional highways is to provide added visibility of the sign for motorists.

6-6.11.02 Terminal Marker Posts

A yellow post may be used to mark each terminal end of a No Passing Zone. A yellow 360 degree visibility enhancer (or equivalent) should be mounted on the top of each marker post.

A 3 1/2” x 2” sticker stating “MnDOT NO PASSING ZONE TERMINAL MARKER” may be installed near the top of each visibility enhancer so that the sticker is visible from the roadway. The stickers are available from MnDOT’s State Sign Shop in Oakdale.

6-6.12 Passing Lane Sections

Signs should be placed in advance of the lane drop transition area as shown on Figures 6.21A and 6.21B. See Section 6-5.11 Passing Lane Sections for guidance on regulatory signs for passing lane sections.

6-6.13 SCHOOL BUS STOP AHEAD Sign (S3-1)

The MN MUTCD Part 7 - Traffic Controls for School Areas, Section 7B.13, requires the installation of School Bus Stop Ahead signs where a school bus, when stopped to pick-up or drop-off passengers, is not visible for an adequate distance and where there is no opportunity to relocate the school bus stop to provide adequate sight distance. MnDOT provides the following clarification and guidance in determining the justification of installing these signs in rural areas.

In order to determine whether a pick-up or drop-off location meets the required visibility distance, a simple procedure is frequently used. This procedure is based on the standard height-of-eye of 3.5 feet and a standard traffic cone height of 28 inches. The visibility distance used in this procedure should be obtained from the AASHTO Policy on Geometric Design of Highways and Streets using either Exhibit 3-1, Stopping Sight Distance on Level Roadways, or Exhibit 3-2, Stopping Sight Distance on Grades. See Chart 6.7 for Exhibits.
Procedure:
Temporarily place the traffic cone at the passenger pickup or drop-off site. Using a vehicle or measuring device where the operator is using the correct height-of-eye, move to the visibility distance, as determined above, in advance of the cone. If the cone is not completely visible, then the site will need to have a School Bus Stop Ahead sign installed. The sign placement should be based on the values in Table 2C-4, Advance Placement Distance, of the *MN MUTCD* or Chart 6.4 of this chapter.

The District Traffic Offices should maintain an inventory of existing signs.

The District Traffic Offices should regularly contact each school district to determine whether students are still picked up by a bus at locations presently signed, to determine if any new locations need signs, and if any locations may present unusual safety problems for students. This contact will result in a more consistent application of School Bus Stop Ahead signs and ensure that the signs provide the intended level of safety.

The School Bus Stop Ahead sign shall not be used in advance of a school bus loading area. See *MN MUTCD* Section 7B.13.1 for requirements of signing for school bus loading areas.

### 6-6.14 SHARE THE ROAD Plaque (W16-1P) with BICYCLE WARNING Sign (W11-1)

This section provides guidance as when to add the SHARE THE ROAD plaque (W16-1P) beneath the BICYCLE WARNING sign (W11-1).

This sign combination is generally meant for short distances (less than 1 mile) of roadway where there are a significant number of bicyclists traveling to and from a bicycle path or facility. They also can be considered for a bicyclist “hot spot” just off the shared-use path or facility that attract bicyclists.

This sign combination may be used where there is no shared-use path or wide (at least four feet of paved, usable space) shoulder that bicyclists can safely ride on causing them to ride in the traveled lane of traffic. These signs are warning signs and are meant to inform drivers of an unexpected bicyclist in their lane.

Consider providing these signs after major intersections or street entrances.

For urban areas, consider using BICYCLES MAY USE FULL LANE sign (R4-11).

For more information about these signs refer to the *MN MUTCD* Section 2C.60, 9B.19, and 9B.06.

### 6-6.15 SHOULDER NARROWS Sign (W5-X1) and NO SHOULDER Sign (W8-23)

The SHOULDER NARROWS sign (W5-X1) and the NO SHOULDER sign (W8-23) are suitable for certain rural high-speed locations (posted at 45 mph or greater) that have an abrupt change in the right side shoulder width.

At high-speed locations where the right side shoulder width abruptly reduces by at least three feet and results in a usable width of less than six feet, a SHOULDER NARROWS sign may be installed.

A NO SHOULDER sign may be installed at rural, high speed locations where the right side shoulder width abruptly reduces from a width of three feet or greater to a width of less than one foot.

Examples of how to apply this guideline:

1. If a vehicle on a through roadway is not required to stop at an intersection and the right side shoulder width is narrower (as described above) on the downstream side of the intersecting road, a SHOULDER NARROWS or NO SHOULDER sign may be installed.

2. If a vehicle is required to stop at an intersection and the right side shoulder width is narrower (as described above) on the downstream side of the intersecting road, a SHOULDER NARROWS or NO SHOULDER sign should not be installed.
3. If a shoulder width is narrower on the downstream side of a bridge than on the approach side, and that reduction meets the criteria set forth in the above guidelines, a SHOULDER NARROWS sign may be installed.

These guidelines do not apply where auxiliary lanes are present.

6-6.16 Speed Reduction Sign (W3-5)

The Speed Reduction sign shall be used if the reduction in speed limits between two zones is 15 mph or greater. This sign may be used if the difference between two zones is 10 mph or less, based on engineering judgment. In transition zones, engineering judgment should determine if placement of a speed reduction sign is necessary for the second reduction in speed.

The Speed Reduction sign should be 48" x 48".

If used, the Speed Reduction sign should be installed at least 1000 feet in advance of the reduced speed zone. If geometrics, grade, or sign clutter may impact the motorist's ability to reduce speed, the sign location may be as far as 1700 feet in advance of the reduced speed zone.

A two-line Distance (W20-100p) plaque may be installed on the left post directly below the speed reduction sign at the option of the District Traffic Engineer. Mounting height for a secondary sign mounted to one riser post is shown in Figure 6.1 of this chapter.

Inplace speed reduction signs (R2-5a, R2-5b, and R2-X1) shall be replaced through attrition.

6-6.17 Truck Hauling Signs

6-6.17.01 Sugar Beet Piling Station Signs

When a site is open to commercial trucks, the TRUCKS ENTERING sign (W11-X3) and the Slippery When Wet sign (W8-5) should be used on each approach to the access.

Both signs shall be: 48” x 48”, provided by the requester, and delivered to MnDOT for installation and maintenance. If requested, a flasher may be installed above the TRUCKS ENTERING sign under MnDOT’s permit process.

When the site is in operation, the signs shall be opened and closed by the requester. Changeable message signs shall not be used.

6-6.17.02 Corn and other Harvest, Gravel Pits, and Logging Operations

The MN MUTCD Section 2C provides guidance on the use of permanent and seasonal VEHICULAR TRAFFIC signs.

6-6.18 Typical Signing for Transitions Between Divided Highway Section and Two-Lane, Two-Way Sections

Figure 6.22 indicates signing for transitions between divided highways and two-lane, two-way highways.

6-6.19 Truck Rollover Warning Sign (W1-13)

If used, the advisory speed posted on these signs will follow the established engineering practice for determining advisory speeds using a ball bank indicator using 10 degrees of ball-bank. More information on Advisory Curve Speed Studies is shown in Chapter 14 of this manual.
6-6.20 WATCH FOR BUSES ON SHOULDER Sign (W14-X9)

The WATCH FOR BUSES ON SHOULDER sign should be placed on all applicable freeway and expressway ramps, intersecting city, township, and county roads, and high volume entrances. These signs should not be installed for low volume entrances and private drives.

6-6.21 WATCH FOR FALLEN ROCK (W14-X1)

Although it may be appropriate to install the FALLEN ROCKS (W8-14) sign in some cases, it is preferred that the WATCH FOR FALLEN ROCK (W14-X1) sign be used on trunk highways.

6-6.22 WEIGHT RESTRICTION AHEAD Sign (W14-X3)

See Section 6-5.03 Bridge Speed and Load Restrictions for use and application of the WEIGHT RESTRICTION AHEAD sign.

6-7.00 APPLICATION GUIDELINES - GUIDE SIGNING

6-7.01 Purpose

Guide sign applications that are discussed in this section are those which:

1. Are not specifically addressed in the MN MUTCD.
2. Provide additional guidance to that given in the MN MUTCD on application, location, and usage of certain types of guide signs.
3. Must be addressed because MnDOT is charged with developing and implementing design, use, and application of certain guide signs in accordance with Minnesota Statutes.

The MN MUTCD Sections 2D and 2E provide standards on guide signing for conventional roads, expressways, and freeways. Figures later in this chapter supplement the MN MUTCD in showing typical positions for guide signs at various intersections and interchanges on MnDOT trunk highways.

Typical signing for intersections is found in Figures 6.24A through 6.29.

Typical signing for crossroad approaches to interchanges is found in Figures 6.30 through 6.33.

Typical signing for auxiliary lanes with and without escape lanes on freeways is found in Figures 6.34A through 6.34D.

6-7.02 Freeways

6-7.02.01 Primary Guide Signing

Rural exits shall be identified by the route number of the U.S., State, or County highway intersected, cardinal direction, and destination as applicable, and the exit number on freeway interchanges. Criteria for selecting destinations is shown later in this section under Signing Destinations.

Urban and suburban exits to local road systems shall be identified by route number, street name, exit number and cardinal direction as applicable. Information on the use of destinations is shown later in this section under Signing Destinations. Cardinal directions should be displayed on freeway guide signs, in particular at cloverleaf interchanges (where the intersected highway either begins or ends at the interchange) and at interchanges with collector distributor roads or with a single exit splitting to serve both movements to the crossroad.
6-7.02.02 Supplemental Guide Signing

The installation of supplemental guide signing should be strictly controlled in areas with closely spaced interchanges due to the many demands on the motorist to make major decisions and the large number of requests from generators of high traffic volumes. Supplemental guide signs shall not interfere with primary guide signing and sign spacing criteria shall be met. Signs directing motorists to secondary or supplemental destinations should not be installed at interchanges of two or more freeways. Criteria for supplemental guide signing is shown in Appendix A MnDOT Supplemental Guide Signs of this chapter.

6-7.03 Signing Destinations

MnDOT shall fabricate, install, and maintain destination and distance signs on trunk highways. However, if a city, meeting the criteria in this section, requests to be added to an existing sign displaying less than three cities/destinations, the city shall pay for design, fabrication, and installation of the signs unless the existing sign is due for replacement. If the existing sign is due for replacement, the city name may be added at MnDOT’s expense.

1. Signing Destinations - At-grade intersections

   The MN MUTCD Sections 2D.36 through 2D.40 establish guidelines for destination signs at at-grade intersections. The following criteria also apply:

   a. Only one destination sign is permitted from the closest state highway on each approach to an intersection.

   b. The destination shown for each direction should ordinarily be the next county seat or the next principal city, rather than a more distant destination.

   c. Destination cities should be used which will be most meaningful to the motorist unfamiliar with the area. Lakes and rivers shall not be used as destinations.

   d. Normally only one destination per route or direction should be identified. Not more than three city names should be on one sign. A few exceptions have been made where multiple routes intersect at junctions. Arrangement of arrows on a sign panel should be consistent with the MN MUTCD.

   e. Destinations should be located on the intersected numbered highway. The destination selected for each route, in order of preference, should be:

      1) The county seat, if it is not too distant.
      2) The first city located at an important junction.
      3) The first large city, taking into account the size of cities in the general area.
      4) The next important junction.
      5) In rare instances, a major state or national park or other significant geographical site or traffic generator may be considered.

   f. For a city to be added to an existing destination sign the existing sign shall display less than three cities/destinations and the city being added should meet the selection criteria in a-e.

2. Signing Destinations - Freeways and interchanges on expressways.

   MN MUTCD Section 2E.13 provides guidance for destination signs on freeways. The following criteria also apply:

   a. Rural

      One or two destinations identifying the interchange may be included on primary guide signing for rural interchanges, based on the following criteria:

      1) Where the intersecting road is a U.S. or State highway, the destinations shown should
be the first city in each direction which is a county seat or is located at a junction with another major highway, unless another city better identifies the interchange to the majority of travelers.

2) At interchanges with county or secondary roads, the destination shown should be the nearest city in each direction. Cities identified on guide signs shall appear on the official Minnesota Highway Map. In the absence of such a city, a geographical area or other significant public land use may be shown.

In rural areas, one supplemental guide sign naming cities that did not qualify for display on the primary guide signing may be placed in each direction.

A city in each direction along the intersected route may be signed in accordance with the following:

1) The city(ies) shall be required to pay all of the signing costs (if new signs are installed or existing signs are modified or replaced) if the request is approved prior to the normal replacement of the existing signing.

2) The city(ies) shall not be required to pay for signing if the approved signing can be included in conjunction with the replacement of existing signing through attrition.

Future maintenance will be performed by MnDOT at no cost to the city(ies).

b. Urban-Suburban

At interchanges with county or secondary roads, destinations are not to be included on the primary guide signs. Destinations and street names cannot be combined on the same guide sign.

At interchanges having more than one exit to the intersecting highway, names of cities may be included only if they clearly aid in orienting the majority of the drivers. At freeway to freeway interchanges, destinations should be considered for placement on the primary guide signs if they would aid in orienting drivers.

Supplemental guide signs shall not be provided for suburban cities served by roads and streets within the metropolitan grid system in urban-suburban areas.

c. Adjacent Land Uses

The names of adjacent land uses such as airports may be shown if the exit has been provided specifically to serve that land use. These destinations may be signed only when they cannot be related to the street or road identified at the exit.

3. Distance signing

A distance sign indicates how far it is from the sign location to the center of the next city, geographical site, or important junction.

**MN MUTCD** Sections 2D.41 and 2D.42 establish guidelines to follow in selecting city names or other traffic generators, and in locating distance signs on conventional highways. Only one distance sign is permitted on each conventional highway leaving an intersection, municipality, or interchange.

**MN MUTCD** Sections 2E.39 and 2E.40 provide guidelines for distance signs on freeways.

City name selection shall be in accordance with the following guidelines:

a. The first city along the route.

b. The first county seat, route number of an intersecting conventional highway, or a significant geographical site or generator.

c. The next major destination or control city.
The following guidelines must be met for a city to be added to an existing distance sign:

a. The existing sign displays less than three cities/destinations.

b. If the city meets the selection criteria previously listed, the requesting city shall pay for all sign replacement costs if the request is made prior to the sign requiring replacement. The city name may be added to a sign, at MnDOT’s expense, at the time the existing sign is due for replacement.

6-7.04 Typical Junction Signing Layouts

The following typical sign installations should be used as guidelines in establishing sign locations and distances between signs at junctions.

1. T-intersection (two-lane, two-way) (See Figure 6.24A).
2. T-intersection (divided highway) (See Figure 6.24B).
3. Typical four-leg intersection (See Figure 6.27).
4. Typical intersection with county road/city street (See Figure 6.26).
5. Typical single lane roundabout intersection (See Figure 6.27).
6. Reduced conflict intersection (See Figure 6.28).
7. Named county road on an expressway (See Figure 6.29).

6-7.05 Independent Route Marker Assemblies

Follow the MN MUTCD Sections 2D.29 – 2D.32 for conventional roads and MN MUTCD Section 2E.27 for expressways and freeways for guidance on the use of route, junction, advance route turn and directional sign assemblies. Follow MN MUTCD Section 2D.34 for confirming or reassurance sign assemblies.

The color of the route marker auxiliaries shall match the color of the route marker it supplements (see MN MUTCD Section 2D.12). For example, white on blue auxiliaries supplement the Interstate and Minnesota route markers and black on white auxiliaries supplement U.S. route markers.

It sometimes becomes necessary to include two different color route markers on the same structure. When this happens the auxiliaries may not always match the color combinations of both route markers. To avoid this, install route markers side by side according to the most current MnDOT sign structure details, http://www.dot.state.mn.us/trafficeng/ signing/doc/canddsignground.pdf. When this is not possible use the following guidelines to determine the color of the route marker auxiliaries:

1. When two or more route markers must be mounted vertically on a single structure, the auxiliaries shall match the color of the route marker which takes precedence.

2. The order of precedence is Interstate, U.S., State, county, township, and then other routes.

This guideline applies to all route marker assemblies installed on trunk highways and to mark any detours of trunk highways.

6-7.05.01 County Pentagon Route Markers

The pentagon shaped Uniform County Route Marker (M1-6) is an alternate to the standard County Route Marker (M1-X4) in Minnesota.

Upon request by a county, each MnDOT District may elect to upgrade its county junction assemblies on state highways to include pentagon route markers at those county roads where they are being used. If the District decides to do this, pentagon
route markers may be installed as a part of the normal sign replacement cycle.

6-7.05.02 Business Route Markers

Route Requirements:
- Business Routes should only be created along the Trunk Highway system in rural areas at locations where a bypass has been constructed or where a Trunk Highway has been decommissioned and turned back to local governments.
  - The Business Route should be created by using the previous alignment of the Trunk Highway.
  - Business Routes should travel principally through the corporate limits of a city.
  - Business Routes shall leave and rejoin the same Trunk Highway route via different exits or intersections.

Implementation:
- Each road authority of which the Business Route is comprised of must approve of its establishment.
- New Business Routes shall be established through written request by a local government agency to the appropriate MnDOT District Office and should include the following information:
  1) A letter from the local government agency briefly explaining route need, acknowledging initial costs and future maintenance responsibilities.
  2) A letter of support from other local road authorities for trail blazing signs in their right of way, acknowledging initial costs and citing future maintenance responsibilities.
  3) A completed American Association of State Highway and Transportation Officials (AASHTO) U.S. Route Number Application. The application may be downloaded from the AASHTO website: AASHTO - Special Committee on U.S. Route Numbering - Home. For "recognition of" a business route a local vicinity map will be needed per page 3. On page 6 a short statement to the effect that there are no deficiencies on proposed routing, if true, will suffice.

The MnDOT District Office staff will evaluate the proposed Business Route and send their recommendation to the MnDOT Route Numbering and Control Section Committee (RNCS) for review. The MnDOT RNCS will process the application.

- If the business route is on a US Highway or Interstate, the MnDOT RNCS will submit to the AASHTO Special Committee on US Route Numbering for approval. The Special Committee on U.S. Route Numbering meets twice each year.
- Existing Business Routes established between MnDOT and local government agencies prior to the implementation of this policy will be subject only to their initial agreements.
  - If existing Business Route agreements between MnDOT and local agencies are amended at any time, the amendments should be made to more closely match this policy.

Sign Usage
- Guide signs referring to the highway exit / Business Route entrance shall display the existing route number or name as well as the route number of the designated Business Route.
- Business Routes shall be signed only prior to the first interchange exit or intersection leading to the Business Route in each direction.
  - If more than two exits or intersections exist on the Trunk Highway along a Business Route, no signs referring to the business route shall be placed on the Trunk Highway for the exits or intersections between the exit from and the entrance to the Trunk Highway.
  - "Downtown" and "Business District" signs directing motorists to the same exit or intersection as a Business Route shall not be allowed on the Trunk Highway.
- Trailblazing signs shall be installed along the Business Route prior to modifying the guide signs on the primary highway route.
Maintenance Requirements:

- All costs related to fabricating, modifying, installing, and removing signs for the purposes of establishing or disestablishing a Business Route shall be at the cost of the requesting agency. The District Traffic Office will decide if installation is completed by the community under the permit process or installed by MnDOT under the requester pay process.
- All maintenance responsibilities along the Business Route shall continue unchanged from before the Business Route’s implementation unless specified otherwise in the new agreement.
- New signs located within and related to the Business Route shall be maintained by the local government agency.
  - The agency shall be responsible for periodically checking the condition of trailblazing signs along the Business Route to ensure that they are well maintained.
  - Failure of the local agency to properly maintain the traffic control devices or fulfill other conditions of the Business Route agreement may result in MnDOT terminating the route’s status as a Business Route.
- If the requesting agency wishes to discontinue the route’s classification as a Business Route, notification must be sent to the appropriate MnDOT District Office 3 months in advance of when it is to be declassified.
  - The MnDOT District Office must notify the MnDOT Route Numbering and Control Section Committee of this change.
  - Signs referring to the business route shall be removed unless the sign panel contains other information relevant to the traveling public. If so, any legend referring to the Business Route shall be covered until the sign panel is replaced or overlayed.

6-7.06 Street Name Signs, Advance Street Name Signs, and 911 Address Signs

This section is based on Chapter 2D, Guide Signs - Conventional Roads (see Sections 2D.2, 2D.43 and 2D.44) of the MN MUTCD. Sign designs, including reflectivity, color, legend, and border shall follow the applicable requirements of the MN MUTCD and the MnDOT Standard Signs and Markings Manual and Summary. Structural mounting requirements shall follow applicable requirements as provided by the MN MUTCD or MnDOT structural details.

Standard street name signs (MN MUTCD Section 2D.43) provided by MnDOT and installed on overhead mast arm mounted signs or overhead bridge mounted signs will use the standard green background color for consistency on trunk highways and shall not include pictographs. Advance Street Name signs (MN MUTCD Section 2D.43) will follow the requirements as provided by the MN MUTCD and the standard sign designs set forth in the MnDOT Standard Sign Manual and Summary or the MN MUTCD.

6-7.06.01 General Criteria for Street Names

The following conditions will be used for street names used on MnDOT provided Street Name signs and Advance Street Name signs:

1. Street names shall be officially designated by the appropriate local government having jurisdiction over the road and match the 911 Emergency Telephone System street name.
2. Official street names may include the word lake, beach, or some other geographic point if the road serves only one such item. Otherwise, such word usage should be discouraged.
3. Combination names which attempt to incorporate multiple identifications are confusing and should not be used.
4. Signing for names which identify a specific business or establishment, in order to identify streets which lead to specific establishments or special commercial or private interest facilities, should be discouraged. Generic names are permissible.
5. The use of first and last names of individuals should not be used.
6. If the official road name is changed by the road authority prior to the sign requiring replacement, the requester will be responsible for all sign replacement costs. However, the road name may be changed at MnDOT’s expense at the time the original sign would normally be replaced.

6-7.06.02 Street Name Signs

6-7.06.02.01 Overhead mounted street name signs
Overhead signal mast arm and bridge mounted street name signs will be provided by MnDOT in rural and urban areas, as needed, to fulfill basic guide signing responsibilities. MnDOT’s practice is to install sheet aluminum retroreflective sign panels on traffic signal mast arms. Internally lit street name signs may be installed on signal mast arms by a road authority.

Specific criteria for internally illuminated street name signs mounted to signal mast arms:

The local road authority shall be responsible for all costs of fabrication, installation, power, and maintenance. MnDOT may require that internally illuminated signs be removed and replaced with standard sheet aluminum if any problems develop.

a. General Criteria
An internally illuminated street name sign may be displayed on the same mast arm with sheet aluminum signs (regulatory, warning, and guide signs).

b. Sign Face
The sign face shall use translucent prismatic retroreflective sheeting for the sign background. If the road authority has an established community-wide color scheme (green, blue, or brown) for the background color of street name signs, the background color of the internally illuminated street name sign may use this color. No other colors will be approved.

The sign legend may be screened or cut from translucent prismatic retroreflective sheeting. In the event of a complete lamp outage, the retroreflectivity of this material provides a fail-safe operation.

The legend (letters and arrows) on internally illuminated street name signs shall be white. No border is required since the sign face is framed by the sign housing.

Standard letter sizes, series, and spacing shall be used. In the event a route marker is to be displayed, it shall be of the standard size, 24” x 24”, unless mast arm loading becomes critical. In this case, an 18” x 18” route marker may be installed.

Detailed specifications for internally illuminated street name signs are located on OTE’s Signals or Signing websites.

6-7.06.02.02 Ground mounted intersection corner street name signs
The furnishing, installation, and maintenance of street name signs, ground mounted, slat style, and located at intersection corners, are the responsibility of the local road authority. Signs installed on MnDOT right of way follow the MnDOT permit process. Signs should be mounted in street corners opposite of STOP signs.

General criteria for ground mounted street name sign installations include the following:

1. The governing body shall have street name signs fabricated according to MN MUTCD requirements including retroreflectivity, legend size, border, color, and standard designs to provide the best target value both day and night.

2. Installation of signs shall not obstruct or interfere with existing traffic control devices. The physical location of the signs should be in accordance with the MN MUTCD, Section 2D.43, “In business or commercial areas and on principal arterials, Street Name signs should be placed at least on diagonally opposite corners. In residential areas, at least one Street Name sign should be mounted at each intersection. Signs naming both streets should be installed at each intersection. They should be mounted with their faces parallel to the streets they name.”
3. The mounting height of signs shall be in accordance with MN MUTCD Section 2A.18.
4. The street name sign assemblies shall be constructed so that the name plate cannot be turned.

Specific criteria for placement on separate sign structure from STOP sign:
1. The preferred lateral offset to the street name signs is 30 feet or greater from the roadway (near the right-of-way line if practical). The minimum lateral offset should be at least 12 feet from the edge of the shoulder. Unique locations should be reviewed with the District Traffic Office.
2. The street name signs are typically installed on a single post sign structure which shall conform to FHWA breakaway requirements based on the current edition of the AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals.

6-7.06.03 Advance Street Name Signs
In urban areas, advance street name signs for arterial and major streets on conventional highways will be provided by MnDOT, as needed, to fulfill basic guide signing responsibilities.

In rural areas, when the trunk highway intersects a public road, appropriate identification of that public road will be provided on conventional roads and expressways with at grade intersections by MnDOT (see Figures 6.26 and 6.29), based on all of the following conditions:
1. When so requested by the local governing body, MnDOT will furnish and install route marker assemblies on the trunk highway, provided that the intersecting local road is numbered and marked with route markers. Identification by number only should be encouraged whenever possible.
2. When a numbered public road is also known by an officially designated name, both types of identification may be used on a sign.
3. For road name signs, all initial signing costs, including overhead factors and installation by MnDOT, shall be paid by the road authority requesting the signing, at the current rate per square foot of sign, as established by MnDOT. MnDOT will maintain road name signs at its own expense.

6-7.06.04 911 Address Signs on Trunk Highways
Counties or private citizens are installing these signs at private driveways within trunk highway right of way. The following guidelines have been adopted for these signs:

a. The preferred sign location is near right of way line at access. This will allow the sign to be installed a minimum of 12 feet from the edge of the shoulder (typically gravel). Gopher State One Call shall be contacted prior to installing the sign.
b. Sign panel size is typically 16 inches long x 6 inches high.
c. Mounting height is a minimum of 4 feet from the bottom of the sign panel to the near edge of the pavement (driving lane).
d. Sign post size should be determined using the sign fabricator’s recommendations (typically 1.12 lb/ft, with a maximum size of 2 lb/ft.).
e. Sign color is white legend (typically 4 inch C Series) on blue background but other colors are possible. However, red and yellow should not be used in any circumstances.
f. MnDOT is not responsible for fabricating, installing, or maintaining the signs.

6-7.07 Boundary Signs
There is a need to provide certain boundary signs to give orientation and guidance to the motorist. Details on sign design for common boundary signs used on the trunk highway system are found in the MnDOT Standard Signs and Markings Manual.
6-7.07.01 City Name Sign (I2-3)

Under the provisions of Minn. Stat. Section 169.06 Subd. 2a, the Commissioner may construct and maintain signs at the entrance of each city, which sign shall have the name of the city and the population. City Name signs should be installed only for communities identified on the official Minnesota Highway Map and/or official county highway maps. Signs should normally be installed at the actual corporate boundary, subject to the following guidelines:

1. Urban areas
   Signs should be installed at or near the corporate limits on all trunk highways.

2. Rural areas
   Signs should be installed at or near the corporate limits on all trunk highways, excluding interstate highways. On interstate highways, the following criteria apply:
   a. If the corporate limits of a community are crossed by the interstate highway, and there is no interchange serving the community, install the sign on the interstate highway at the corporate limit crossings.
   b. If the corporate limits of a community are crossed by the interstate highway, and an interchange directly serves the community, and the community is not identified on either the major interchange guide signs or on a supplemental guide sign, install the sign on the interstate highway at the corporate limit crossings.
   c. If the corporate limits of a community are crossed by the interstate highway, and an interchange directly serves the community, and the community is identified on either the major interchange guide signs or on a supplemental guide sign, do not install the sign on the interstate highway.

Where proper city names have two words, it may be desirable to arrange the name on two lines rather than one, especially when the words are long. City names should not be abbreviated.

MnDOT will update population figures on city name signs every 10 years and use the population figure of the last official Federal or State census. If a community requests the population figure to be updated, MnDOT will update the population figure at the cost of the community. The updated figure should be from a documented official source and provided to MnDOT.

An exception to the above applies to unincorporated communities which warrant city name signs, but for which population counts are not available. These signs carry only the community name.

Occasionally, municipalities attach certain unauthorized sign panels, (e.g. Green River Ordinance Enforced, Radar Patrolled, etc.) beneath the CITY NAME sign on approaches to the municipality. These attachments, dealing with regulatory and enforcement issues, are not appropriate. The only attachments to signs on the trunk highway system are those allowed under section 6-7.07.03 Community Recognition Signing Program of this chapter. Extraneous and unauthorized sign panels should be removed and no such attachments permitted on any signs on the trunk highway system.

6-7.07.02 Community Identification Sign

Criteria for these signs, which are allowed outside the trunk highway right-of-way, are specified in Minn. Stat. Sec. 173.08 Subd. 1(10).

This signing program is administered by the District offices.

6-7.07.03 Community Recognition Signing Program

The Community Recognition Sign Program allows communities to express their own identity under Boundary signs. Permitting the displaying of sign panels allows the community to pick what is locally important to their community for installation on trunk highway rights-of-way.
Community Recognition sign panels shall not be installed on freeways.
The Community Recognition sign panels shall be initiated and coordinated by the community.
Political or commercial advertising will not be allowed on sign panels.
The sign panel designs shall be approved by the District Traffic Engineer.

1. Examples of permitted sign panels:
   a. Non-profit service organizations.
   b. Special programs, either permanent or temporary; e.g. DARE, Tree City, Storm Ready City, Fit City, Sister City, and Yellow Ribbon City/County.
   c. City pictograph.
   d. City recognition slogans; e.g. State Baseball Champions.
   e. Drinking Water Protection Area sign panel.
   f. Heart Safe Community Sign Panels - A “Heart Safe” designation recognizes a city’s efforts to prepare its staff and citizens to recognize when someone suffers a sudden cardiac arrest and how to respond.
   Cities are eligible for signing if they are determined to be “Heart Safe” by Allina hospitals and clinics.

2. Costs
   a. Installation of Community Recognition Sign panels shall be coordinated with the District Traffic Office. The District Traffic Office will decide if installation is completed by the community under the permit process or installed by MnDOT.
   b. If more than two small Community Recognition Sign panels or one large sign panel are to be installed by the community on an existing sign structure, the community shall pay an up-front charge of $200 to MnDOT for reimbursement of costs incurred by state forces to:
      1) Raise the existing CITY NAME sign panel to meet the required ground clearance and mounting height.
      2) Modify the U-channel sign structure to include knee braces if necessary in order to meet breakaway and wind loading requirements.
      3) Furnish and install a horizontal stringer for the mounting of the Community Recognition Signs.

3. Sign Format
   The sign panel background, or the predominant color, may be any color except pink, red, orange, yellow, purple, yellow-green, or the fluorescent colors thereof.

   The message on a sign panel shall not simulate a traffic control device or contain directional sign messages or advertising for a commercial product or service.

   The sheeting material on new Community Recognition Sign panels should be Type XI retroreflective sheeting.

   The sign base material shall be sheet aluminum or other material approved by MnDOT. See Minnesota Standard Specifications for Construction, 3352.

   Any combination of sign panels may be allowed up to a total of 72” in length by 24” in height having a total square footage not to exceed 12 square feet. These panels shall be installed horizontally below the CITY NAME sign panel.
4. Installation Guidelines

The attachment of Community Recognition Sign panels to horizontal stringers or sign posts shall be as shown in Figure 6.35, Community Recognition Signing and as follows:

   a. More than two Community Recognition Sign panels shall be installed on horizontal stringers (installed by MnDOT) by the community as shown in Figure 6.35, Community Recognition Signing.

   b. If less than three Community Recognition Sign panels are to be installed on an existing sign structure, install in accordance with the following:

      1) If only one Community Recognition Sign panel is to be installed, attach it to the sign post farthest from the roadway.

      2) If two Community Recognition Sign panels of the same size (24” x 24”) are to be installed, center horizontally on each existing sign post.

      3) If two Community Recognition Sign panels of different heights are to be attached to the sign posts, and the existing sign structure is located on the inslope, the sign panels should be mounted as shown in Figure 6.35. Attach the shortest sign panel to the sign post nearest the roadway and the tallest sign panel to the other sign post. This will provide the maximum clearance from the ground line to each sign panel. If the existing sign structure is located on the back slope attach the shortest sign panel to the sign post farthest from the roadway.

      4) If a sign panel is greater than 24 inches and less than or equal to 30 inches in height attach to the sign post furthest from the roadway. When the existing sign structure is located on the backslope, attach the sign panel to the sign post nearest to the roadway. Relocate in place sign panels less than 24 inches in height to another sign post to make room for the new, larger sign panel.

      5) Only one sign panel greater than 24 inches and less than or equal to 30 inches is allowed for each sign structure. If there is a desire to install a new sign panel of this size and there is a sign panel of this size in place on the sign structure, the city is responsible for deciding which two sign panels are attached to the sign structure.

MnDOT may check any Community Recognition Sign panel(s) for proper attachment hardware (see Figure 6.35). If an improper mounting procedure or hardware has been used, MnDOT may reinstall the sign panels with the correct hardware or remove it.

The replacement cycle (end of useful life) of the sign panels will be determined by each MnDOT District office.

6-7.07.04 County Name Sign (I2-5)

The County Name Marker (I2-5) sign is placed at all county line boundaries on the trunk highway system. When the county line is also at a river or municipal boundary, the sign should include both entities.

County Land Use Zoning signs shall not be installed or retained on trunk highways, either individually or as part of a sign assembly.

Extraneous sign panels shall not be installed on this structure, unless allowed under 6-7.07.03 Community Recognition Signing Program.

6-7.07.05 Drainage Divide Sign

The Minnesota state highway map displays drainage area divides. It shows the four major drainage divides for Hudson Bay, the Mississippi River, Lake Superior and the Missouri River crossing approximately fifty state highways. Nine highways are crossed at least twice by a drainage divide.
Drainage divides in Minnesota are not obvious to motorists and are not geographically distinct features, nor is their identification of interest, significance, or benefit to the majority of motorists.

Drainage divides shall not be signed on any trunk highways.

Drainage divide identification signs may be installed within a rest area or wayside parking area established at the site to accommodate vehicles off the roadway. Signing for drainage divides shall be paid for by the requester.

Remove existing drainage divide identification signs without roadside parking facilities at the end of their sign life.

6-7.07.06 Municipal Identification Entrance Sign

Under the provisions of Minn. Stat. 173.025 a local road authority may erect a municipal identification entrance sign within the right-of-way of a trunk highway with the written permission of the commissioner. Municipal identification entrance signs erected without the written permission of the commissioner are prohibited. These signs shall be located outside of the clear zone and installed through the MnDOT permit process.

Refer to the MnDOT Right Of Way Manual 5-491.514 for all applicable guidelines and provisions.

6-7.07.07 Reservation Boundary Sign

Signs may be installed for reservation boundaries which cross trunk highways, except freeways, with a limit of two signs per trunk highway.

The sign panel may include the name of the reservation, the tribal logo, and either the year of treaty or the reservation population. The panel must also be void of any commercial advertising. Sign size is variable based on sign message and font sizes. Sign panel designs shall be approved by MnDOT prior to fabrication.

The signs are to be fabricated, installed, and maintained by MnDOT unless otherwise directed by the District Traffic Office. Sign costs will be paid by the community.

6-7.07.08 Soil and Water Conservation District Sign

The Soil and Water Conservation District shall complete and submit a permit for approval to install a sign. If approved, install in accordance with all of the following criteria:

1. Locate signs on the top of the back slope just inside the right-of-way line. The sign cannot be placed on the shoulder slope or in the ditch bottom. The sign should be placed to obtain a minimum hazard location.

2. Signs are permitted only on non-freeway types of roadways.

3. Install signs on breakaway sign supports when located within the clear zone (MnDOT Road Design Manual, Chapter 4-6.04).

4. Design sign panels to be the same design or equal to that available from the National Association of Conservation Districts.

5. Maintain the signs in good repair. If this requirement is not met, the applicant will be notified to remove the signs.

6. A sign cannot be placed at a location where it will interfere with the effectiveness of any traffic control device, or interfere in any way with the safe operation of motor vehicle traffic or the safety of pedestrians and non-motorized vehicles.

7. The Soil and Water Conservation Districts will be responsible for furnishing the signs and posts, and for installation at the designated locations.
6-7.07.09 State Entry/Exit Signs

State Entry Monument (SEM) Program and Entry Signs
There are three Minnesota State Entry Monument marker types in use today: Type I and Type II monuments, and Type III metal sign panels.

Type I State Entry Monuments (constructed of precast concrete in the shape of Minnesota) and several Exit Monuments were designed in 1996 via a University of Minnesota student competition. They are typically located where interstate highways cross Minnesota's boundary, and at the Minnesota/Canadian border.

Type II State Entry Monuments were constructed circa 1939 through 1955, and were made of a stone masonry pylon with timber arm and wood sign panel. Type II Historic SEM are restored, but not replicated, because most are eligible for the National Register of Historic Places (NRHP).

Type I and Type II entry markers are managed by the Site Development Unit in the Office of Project Management and Technical Support.

Type III state entry (WELCOME TO MINNESOTA, I2-10) metal signs are managed by the District Offices. The colors on the Type III sign panel were revised in 2006. Type III metal signs are placed on highway entrance routes with the lowest traffic volume, where no Type I or Type II monuments are located. Inplace sign panels should be replaced through attrition. Type III metal signs should be removed if a Type I or Type II state entry monument is located in the same vicinity.

State Exit Monuments and Signs
Where road conditions allow, some Type I monuments and Type III signs have a companion exit monument or sign on the opposite side of the road. Type II monuments have no ‘exit’ counterparts, as they were not designed and built during the time of original construction. Type I and Type II State Exit Monuments are managed by the Site Development Unit in the Office of Project Management and Technical Support.

Type III state exit metal signs (VISIT AGAIN, I2-12) are managed by the District Offices. Type III metal signs are located where no Type I State Exit Monument or Type II State Entry Monuments are located. Type III metal signs should be removed if a Type I State Exit Monument or a Type II State Entry Monument is located in the same vicinity.

More information regarding State Entry Monuments and Signs can be found here:

6-7.07.10 Township Boundary Sign

Township boundary signs shall not be installed or retained on trunk highways, either individually or as part of a sign assembly. Township boundary signs do not have sufficient orientation value to warrant installation on the trunk highway system.

6-7.07.11 Watershed District Sign

Watershed districts are local units of government which exist to protect water resources. There are over 40 watershed districts throughout the state authorized by the Legislature in 1995.

They are established at the request of citizens, counties, or cities when water management problems escalate. The boundaries are widely variable and do not follow political boundaries.

Watershed districts in Minnesota are not obvious to motorists and are not geographically distinct features. Therefore, their identification is not of interest, significance, or benefit to the majority of motorists.

Watershed Districts shall not be signed on any trunk highway.

Watershed district identification signs may be installed within a rest area or wayside parking area established at the site to accommodate vehicles off the roadway.
Existing watershed district identification signs without roadside parking facilities shall be removed at the end of their sign life.

6-7.08 Designated Roadways

The practice of designating routes or roadways is a means of commemorating a person, place, or event, or for the purposes of tourism promotion. Designated roadways may include auto tour routes, state or nationally recognized routes, corridor-based promotions, and memorial routes and bridges.

MnDOT is required to mark trunk highways as designated by Minn. Stat. Sec. 161.14. A majority of the already approved sign designs for designated roadways are found in the MnDOT Standard Signs Summary. Sign designs for newly designated routes shall be designed or approved by OTE.

1. Auto Tour Routes - Auto tour route signs are designed to provide road users with route guidance in following an auto tour route of particular cultural, historical, or educational significance. Some auto tour routes are designated in Minn. Stat. Sec. 161.14 such as the Black and Yellow Trail, Viking Trail, Amish Buggy Byway, etc.

2. Eisenhower Interstate System - These signs have been installed on the rest area entrance ramp in each of the rest areas on the Interstate highways in Minnesota. These signs are not installed along the interstate highways within the State of Minnesota.

3. Great River Road - The federal Great River Road Program was established to provide a parkway-like road paralleling the Mississippi River, from its source at Lake Itasca to the Gulf of Mexico. There is a national and a state route in Minnesota. The Great River Road is identified in Minn. Stat. Sec. 161.142, 161.148, and 373.27. The Mississippi River Parkway Commission (MRPC) is the organization that provides governance for the route. Membership, funding, and responsibilities of the MRPC are established in State Statutes. Road authorities are responsible for signing route segments within their jurisdiction.

4. Minnesota Scenic Byways - The Minnesota Scenic Byways Program was established in 1992 by a memorandum of understanding between MnDOT, the Department of Natural Resources, Explore Minnesota Tourism, and the Minnesota Historical Society. This was reinstated by a memorandum of understanding in 2016. Four commission members represent each of the four agencies. The Commission designates Scenic Byways with an application process that requires local support and approval by the road authority. Some Minnesota Scenic Byways have been designated as State, National Scenic Byways or All-American Roads. The designations are conditional and require local byway organizations to actively pursue their objectives along the route. No additional signing is required for National Scenic Byways or All-American Roads.

The memorandum of understanding includes a commitment by the Commissioner of Transportation to fund the fabrication, installation and maintenance of the signs on state trunk highways. Byway organizations will negotiate signing on local road segments with the appropriate road authority.

To maintain the designation, the byway organization must submit an activity report to the State Scenic Byway Coordinator annually. Since there are only twenty-two designated scenic byways in the state, inactive byways are at risk of losing their designation in order to designate new byways.

Confirmatory signs on designated trunk highways may be installed at 20 to 25-mile intervals along the route.

5. Nationally Coordinated Trails - Some designated roadways in Minnesota are part of a larger, national initiative. One example is Prairie Passage. Minnesota, in partnership with five other states, has developed a corridor of roads called “Prairie Passage” to protect and restore remnants of prairie. The route runs through the western part of the state. It is part of a national Prairie Passage route that extends from Canada to Mexico through the central part of the nation. It was identified and signed in 2002. Signing for Nationally Coordinated Trails will be negotiated with MnDOT OTE on a case
by case basis. In the case of Prairie Passage, initial signing was funded through a Federal Highway Administration project.

6. **National Forest Scenic Byways** - The USDA Forest Service began designating scenic byways in national forests in 1987, prior to the state and national Scenic Byways programs. In Minnesota, all of these byways have also been designated as State Scenic Byways. Although these byways are designated as State Scenic Byways, the signing policy for Scenic Byways will be followed. Should they lose their designation by the Minnesota Scenic Byway Commission, sign maintenance and replacement will be funded by the USDA Forest Service in accordance with signing policy for memorial routes.

7. **Corridor-Based Promotions** - Examples include Heritage Trails, and Birding and Wildlife Trails. These trails involve a collection of specific interest sites located in a generalized area or in a general corridor. Sites are not all located on a specific roadway. The term trail is used metaphorically and connotes the trek from site to site along the trail. Heritage, birding, or wildlife trails are supported with mapping and supplementary information to help people locate and understand the significance of sites. Fabrication, installation, and maintenance of signs shall be funded by the sponsoring organization and meet the following guidelines:
   a. The corridor includes at least two cities.
   b. The corridor is part of a statewide marketing campaign.
   c. The corridor is approved by MnDOT and the Office of Tourism.
   d. Signing on the trunk highway is to be at the entrance to the site. If the site is located on a local road system, the road authority will sign on the local road at the entrance to the site.
   e. If the site is located within an existing signed facility (state park, historic site, etc.), a logo or icon may be attached to the right sign post on the in place signing (state park, historic site, etc.) on the trunk highway.
   f. Approve the design of the logo or icon sign panels by OTE prior to fabrication.
   g. Sheeting on sign panels will follow MnDOT’s current sign sheeting standard.
   h. Signs are to be installed by MnDOT forces.

8. **Wildflower Routes** - Wildflower routes were established in 1990. They were designated to identify and protect existing native vegetation along Minnesota roadides, restore native wildflowers and grasses, and increase public awareness of the value of native plants. There have been no new designations since 1990. Signs were fabricated and installed by MnDOT when the routes were designated. This signing program is no longer active for trunk highways. Signs should be removed through attrition.

9. **Memorial Routes and Bridges** - Memorial highways and bridges are established on trunk highways by statute to commemorate an individual or entity (See Minn. Stat. Sec. 161.14). MnDOT remains neutral on proposed memorial highway legislation on non-freeway routes as long as the section of highway has only one designated name. A map of legislatively designated memorial routes and bridges is shown on MnDOT’s Transportation, Data and Analysis website [http://www.dot.state.mn.us/roadway/data/data-products.html](http://www.dot.state.mn.us/roadway/data/data-products.html).

The Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) Section 2M.10, indicates that freeways and expressways should not be signed as memorial or dedication routes. If they are signed, the signs should be placed in nearby rest areas, scenic overlooks, or other appropriate roadside area locations where parking is provided. MnDOT recognizes that signing along freeways and expressways is in conflict with the MN MUTCD but because state law requires signing, MnDOT has developed the following guidance for signing memorial highways and bridges on trunk highways:
a. Freeways
For designated routes along freeways, signs shall first be considered to be installed in rest areas. If installation of a sign in the nearest rest area is not practical, install sign at the top of the freeway entrance ramp. If memorial highway signs are installed on freeway entrance ramps, one sign in each direction of travel may be installed at the top of the nearest entrance ramp at the beginning of the designated route. If installation of a sign on the entrance ramp is still not practical, then consider installation of a sign on the mainline. If memorial highway signs are installed on the mainline, one sign in each direction of travel at or near the beginning of the designation may be installed and is to be placed in an area which will not interfere with any other traffic control device.

b. Expressways
For designated routes along expressways, signs may be installed along mainline roadway. If memorial signs are installed on the mainline, one sign in each direction of travel at or near the beginning of the designation may be installed and is to be placed in an area which will not interfere with any other traffic control device.

c. Conventional Roadways
Memorial highway signs may be installed along conventional roadways in accordance the MN MUTCD. One sign in each direction of travel at or near the beginning of the designation may be installed and is to be placed in an area which will not interfere with any other traffic control device.

d. Bridges
Designated bridges will be signed for road users on the carrying roadway and not for the roadway beneath.

e. Rest Areas and Other Roadside Areas
Memorial highway signs installed in rest areas or other roadside areas and intended for viewing by non-motorizing public may allow for non-standard design, such as a photo of the person being commemorated or symbols. A new sign panel should be installed on its own structure. Standard signs installed on the entrance ramp are to be installed on the right side of the ramp, between the entrance gore and the parking area, with 150 to 200 foot spacing between signs.

f. Prohibition of Signs Mounted Overhead
Under no circumstances will memorial signs be mounted overhead on a roadway or bridge.

Memorial highway sign designs shall be designed in accordance with the MN MUTCD Section 2M.10. The sign designs shall use a six inch combination of initial upper case and lower case letters for the person or entity being recognized. Text size may be reduced in urban areas where physical space is restricted. New sign design requests should be sent to OTE State Signing Office.

The organization sponsoring the route or bridge designation shall reimburse MnDOT according to Technical Memorandum No. 17-06-T-01 or Chart 6.6, Requester Pay Signing Costs, for the cost of fabricating, installing, and maintaining signs on trunk highways. (See Minn. Stat. Sec. 161.139).

Memorial Highway Signing - Guidance for Requesters is available to MnDOT staff when assisting requesters through the process of memorial highway signing.

6-7.09 Supplemental Guide Signing Programs
The MN MUTCD, Minnesota Statutes, and MnDOT policy allow supplemental guide signs to be installed on trunk highways for a variety of public and private facilities. A complete list of allowable facilities, general criteria, and facility specific criteria can be found in Appendix A MnDOT Supplemental Guide Signs. Standard sign designs for a variety of supplemental guide signs can be found in the MnDOT Standard Signs Summary and Manual. All other sign designs will follow the design guidance in Charts 6.1A through 6.1D and the MN MUTCD.
MnDOT provides signs at no cost to the requester for qualified facilities under the following signing programs:

1. General Motorist Service
2. Hospital
3. Resort and Camping

Unless otherwise noted, qualified facilities under Appendix A MnDOT Supplemental Guide Signs, shall pay for signs following Technical Memorandum No. 17-06-T-01 or Chart 6.6, Requester Pay Signing Costs, found in this chapter.

6-7.09.01 LOGO Sign Franchise Program

Logo signs are permitted on interstate highways and urban controlled access trunk highways (freeways) as specified in Minn. Stat. Sec. 160.80 and the Logo Sign Franchise Program Agreement.

The MN MUTCD Part 2J covers standards and guidelines on the use of logo signing. Minn. Stat. Sec. 160.80 and the Logo Sign Franchise Program, authorize MnDOT to establish this program for the purpose of providing specific information on gas, food, lodging, camping, attractions and 24-hour pharmacies for the benefit of the motoring public on the right-of-way of interstate and certain other controlled-access trunk highways.

This program is currently operated by Minnesota Logos, Inc. under an agreement with MnDOT. Businesses interested in this program may contact Minnesota Logos, Inc.

Existing MnDOT installed GENERAL MOTORIST SERVICE signs should remain in place at each interchange if all businesses are not accommodated in the Logo Sign Franchise Program. Per the logo contract, the State Signing Engineer in conjunction with the District Traffic office will review and approve all site plans to verify that the proposed logo signs meet the contract requirements, will not have a negative impact on other required signing, proper sign spacing will be maintained, and no other known construction or permit projects will impact the sign locations.

6-7.09.02 Specific Service Signing Program (D9-X6)

The Specific Service Signing Program was mandated by the 1980 Legislature under Minn. Stat. Sec. 160.292 to 160.298. See these statutes for complete legislative intent. Portions of statutes described in this section and in Appendix A are shown using the Times New Roman italic font.

1981 - Permitted the inclusion of motels.
1984 - Permitted the inclusion of restaurants.
1988 - Added rural agricultural businesses and places of worship.
1989 - Added tourist-oriented businesses.
1996 - Added gasoline service station or other retail motor fuel business and optional business panel (logo).

Definitions:

1. Specific Service - restaurants, rural agricultural or tourist-oriented businesses, places of worship, gasoline service stations or other retail motor fuel businesses, motels, resorts, and recreational camping areas (Minn. Stat. Sec. 160.292, Subd. 21).

2. Specific Service Sign - a rectangular sign panel displaying the name or optional business panel, or both, of the specific service, the direction to, and where appropriate the distance to the facility (Minn. Stat. Sec. 160.292, Subd. 22).
3. **Specific Service Sign Assembly** - a combination of specific service sign panels on a single sign structure are to be placed within the right-of-way on appropriate approaches to an intersection or interchange (Minn. Stat. Sec. 160.292, Subd. 23).

4. **Specific Service Sign Cluster** - a grouping of specific service sign assemblies on appropriate approaches to an intersection or interchange (Minn. Stat. Sec. 160.292, Subd. 24).

**Installation:**
Specific Service signs should be installed in accordance with all of the following:

1. **Priority of installation**
   a. A business shall not be allowed to “bump” another business from a specific service sign.
   b. If two or more eligible businesses apply at the same time, year-round businesses have priority over seasonal businesses.
   c. Left- or right-oriented businesses have priority over straight-ahead oriented businesses. If a business is eligible for a left or right directional sign panel on one approach, then it is eligible for a straight-ahead directional sign panel on the other approach. Although straight ahead signing is to be discouraged, it may be permitted at certain intersections. See Figures 6.36A and 6.36B.

2. **Sign placement**
   a. *No specific service sign or assembly shall be placed at a location that will interfere with other necessary signing as determined by the Commissioner of Transportation* (Minn. Stat. Sec. 160.294, Subd. 2). Requests will be denied if space is unavailable.
   b. A specific service sign on a ramp shall not be allowed if the business is readily visible from the ramp terminal or effective directional signing is visible.
   c. A specific service sign should be installed on the right side of the roadway.
   d. A sign assembly shall be limited to four panels. Assemblies on mainline approaches to interchanges are limited to three panels and one action message panel, e.g. NEXT RIGHT.
   e. Specific service signs should be installed approximately 300 feet from any inplace signs on a conventional road and approximately 500 feet from any inplace signs on an expressway. Inplace signs are not to be removed to accommodate specific service signs.
   f. The maximum number of specific service sign assemblies per intersection approach should not exceed three nor be placed past the previous interchange entrance ramp.

3. **Order of installation**
   The following sequence of signs should be used at intersections on conventional highways to integrate specific service signs with other traffic signs in a uniform manner. The signs are listed in the order that a motorist would encounter them as they approach an intersection. The spacing of the signs should be as shown in Figure 6.26.
   a. Junction assembly (if applicable).
   b. Road name advance sign (if applicable).
   c. Directional sign to cities (if applicable).
   d. Other guide signing (hospital, landfill, etc. if applicable).
   e. Inplace RESORT/CAMPING motorist service signs (D9-X3 and D9-X4).
   f. Specific Service Sign (D9-X6) or assembly(ies).
g. Road name with arrow sign at or near intersection (if applicable).

h. Route marker directional assembly at intersection (if applicable).

i. Turn lane sign, where a turn lane is in place.

Only Specific Service Signs shall be installed on Specific Service Sign assemblies. Specific Service Signs are not allowed to be installed on any other sign type such as other guide signs.

4. Sign panel design:

a. Show distances in one mile increments. Omit distances for those less than one mile.

b. Mount left directional panels above right directional panels.

c. Only one business shall be displayed on a sign panel.

d. Businesses which have combinations of approved services may combine these names in their sign legend, if possible, e.g. “RESORT CAMPING”, “MOTEL CAFE”. The legend size should not be reduced. Abbreviations may be required, but only standard abbreviations may be used.

e. Proper name abbreviations may be used as determined by the District Traffic Engineer.

f. Inappropriate business names shall not be allowed to be displayed on sign panels.

g. Business Panels or Logos

1) Logos shall not resemble traffic control devices.

2) Inappropriate logos shall not be permitted.

3) Businesses supply either the business logo panel or the electronic image to the District Traffic Office. *If the business logo panel needs replacing due to damage beyond repair or other reasons, the District Traffic Office will work with the business on the best method of replacement (Minn. Stat. Sec. 160.296, Subd. 1b).*

4) Sheeting should match MnDOT’s current sign sheeting standard.

h. Both the ramp sign and the mainline sign shall be identical in format. Ramp signs shall have directional arrows (if needed) and mileage (for distances of one mile or greater).

i. All sign panels for seasonal services shall be covered or removed when the service is not available (Minn. Stat. Sec. 160.296, Subd. 2) and is the responsibility of the facility or business. A CLOSED plaque may be bolted over the arrow/distance portion of the sign panel, for seasonal businesses. CLOSED plaques are required on the mainline sign and not on the ramp sign at an interchange.

j. Specific service sign panel (D9-X6) details are shown in the *MnDOT Standard Signs and Markings Manual.*
6-7.10 External Sign Variance Committee

MnDOT retains the authority to deny requests for signing where acceptable standards cannot be met, including locations where other supplemental guide signs are already in place. Requests denied based on Minnesota Statutes or engineering standards (i.e. insufficient space and design standards) may not be appealed. At the discretion of the District Traffic Engineer, signing requests denied based on MnDOT policy may be appealed to the External Sign Variance Committee (ESVC).

The ESVC is composed of persons outside of MnDOT who meet periodically to consider various requests for signing. The group serves as a variance committee making recommendations to the Commissioner’s office on signing requests that have been denied by the District office. They review requests to see if the denials can be substantiated to have negative effects on the requester and/or motorists. The ESVC also reviews policies and criteria on informational signing matters.

The chairperson is a MnDOT employee who serves in a non-voting capacity to organize and schedule all functions of the ESVC. This individual serves as secretary and records decisions on sign variance requests. The chairperson represents the ESVC, not MnDOT, on all matters pertaining to the ESVC.

The procedures for this Committee are as follows:

1. The focal point for all sign requests shall remain with the District Traffic Engineer. If MnDOT policies or guidelines do not address a specific signing request, the District should confer with OTE staff and other Districts’ staff since all signing requests have statewide implications. If the District Traffic Engineer is uncertain as to whether or not a specific signing request should be approved, the request should be discussed with the District Engineer who will determine if the request is approved or denied. Once the District has made a ruling, the District Traffic Engineer will respond to the requester. If the request is denied and being referred to the ESVC, the District Traffic Engineer needs to ensure there is space for signing before referring the requester to the ESVC, that the Appeals Process form is included with the response and the ESVC chairperson is copied on the response. The form is available from the ESVC Chairperson or on the OTE Signing internal website. Provide any documentation pertaining to the request to the State Signing Engineer and the ESVC Chairperson.

2. A requester who has been denied signing by the District office and is interested in appealing the decision must submit a written request for a hearing by the ESVC. The requester should contact the chair of the ESVC directly, and will then be advised of procedures and meeting date. The ESVC hears the requester’s appeal and MnDOT’s presentation separately. The recommendations of the ESVC will be based on pertinent factors, and will always consider the degree of financial hardship to the requester and safety implications.

3. For each signing request, the recommendations made by the ESVC and the State Traffic Engineer are forwarded to the Commissioner’s office for review. Presentations on each request are made to a special committee (Internal Sign Variance Committee) appointed by the Commissioner for final concurrence or denial. The requester and the District involved will be notified by the chair of the ESVC of the decision made by the Commissioner.

4. If the ESVC and the Commissioner approve the variance, the letter from the ESVC will notify the requester and the District Traffic Engineer with additional instructions. The requester will then work with the MnDOT District responsible for installing the sign to complete the process. All costs pertaining to signing will be the responsibility of the requester.

5. If the ESVC and the Commissioner deny the variance, the requester will be unable to reapply unless there is a significant change in the request.

If the requester is unable to attend the appointed ESVC meeting, they are required to notify the ESVC Chairperson at least 48 hours prior to the meeting date. Nonattendance without prior notification will result in an automatic denial for the facility. The requester cannot present to the ESVC again unless there is a significant change in their request. If the variance is granted, it does not change the guidelines covering that specific sign issue, but only that specific situation.
6-7.11 Dakota and Ojibwe Language Signing Program

Background

Indian tribal governments are federally recognized in Minnesota. Each tribe is a separate sovereign nation unique unto itself and distinct from all other federally recognized tribes.

On August 8, 2013, Governor Dayton signed Executive Order 1310 Affirming the Government-to-Government Relationship between the State of Minnesota and the Minnesota Tribal Nations: Providing for Consultation, Coordination, and Cooperation. In accordance with this Order, the Minnesota Department of Transportation (MnDOT) established MnDOT Policy AD005, Minnesota Tribal Nations Government-to-Government Relationship with MnDOT, Providing for Consultation, Coordination, and Cooperation.

MnDOT recognizes the unique sovereign status of federally recognized tribes and the cultural values of all American Indian tribes in Minnesota and is committed to strengthening the government-to-government relationship with the tribes.

Tribal Governments have requested that certain traffic signs display both English and the Dakota or Ojibwe language on roads and highways that traverse tribal lands. MnDOT worked with the Advocacy Council for Tribal Transportation (ACTT) and the Federal Highway Administration Minnesota Division to develop this signing program. The purpose of the signs is to assist the Tribes with the revitalization of their language and to inform all people of the historic pre-settlement names of geographic features and the Dakota and Ojibwe words for other features on tribal lands that are included in this signing program.

Information about the meanings of the words on the signs will be publicly available on the MnDOT Tribes and Transportation webpage http://www.dot.state.mn.us/mntribes/ after signs are installed.

General Requirements

The Minnesota Manual on Uniform Traffic Control Devices for Streets and Highways (MN MUTCD) is the standard for all traffic control devices on any roadway open to public travel. All signs are traffic control devices. Uniformity of traffic control devices simplifies the task of the driver because it meets the motorist expectation which aids in recognition and understanding. For example signs are read from top to bottom, left to right and in a text size that can be read and interpreted by the motorist traveling at roadway speeds.

The MN MUTCD generally does not provide for the display of alternative or supplemental languages on traffic signs. Tribal Governments may request dual language signing on jurisdictional boundary and geographic features signs on or near tribal lands roadways under MnDOT jurisdiction. The following is MnDOT’s guidance on the display of both the English and the Dakota or Ojibwe language on traffic signs.

Guidance

The display of both the English and the Dakota or Ojibwe languages on a single sign or sign assembly may be approved by MnDOT, based on the following guidelines.

1. Requests may include any jurisdictional boundary signs (MN MUTCD Section 2H.2.2 County/City Name Marker Signs) or geographic features signs (MN MUTCD Section 2H.2.3 Lake and Stream) including the following:
   • Reservation Boundary signs,
   • City population signs,
   • County line boundaries and bodies of water such as lakes, rivers, streams, or creeks when that body of water is crossed by the trunk highway by the use of a bridge or the body of water is visible to the motorist.

2. A letter of concurrence from the City or County is required for city population signs or county boundary signs. The letter of concurrence needs to specify that they are in agreement that both languages be displayed and identify the placement, above or below, of each language.
3. Signs shall be limited to locations on or near tribal lands. Signs shall not be installed outside of tribal lands such as, but not limited to, concentrated ethnic neighborhoods or population centers.

4. The language legend shall be either Dakota or Ojibwe as specified by the Tribal Government.

5. Dakota and Ojibwe languages shall not be displayed on any other sign including, but not limited to:
   - Regulatory Signs,
   - Warning Signs (including School Zone Signs),
   - All other Guide signs including:
     - Destination,
     - Street Name,
     - General or Specific Service (Logo Signs),
     - Tourist-Oriented Directional (Specific Service Signs),
     - Auto Tour Route, and
     - Acknowledgment signs.

6. The use of such signs shall be limited to conventional roadways. Signs shall not be installed on freeways and expressways.

7. Signs shall be post mounted on MnDOT approved crashworthy roadside sign structures and not be overhead installations.

8. Installation of the signs shall not interfere with the placement of any other necessary signing and shall not compromise the safety or efficiency of traffic flow. The signing shall be limited to one sign at an appropriate location in each route direction.

9. All letters and numerals displayed on the sign for the main characters of the Dakota and Ojibwe language shall be as provided in the Standard Highway Signs and Markings reference publication. Unique characters that are necessary for the proper translation, but not provided in the FHWA Standard Alphabets, may be used. These unique characters are to be kept to a minimum and shall be based on the characteristics of the letter forms of the Standard Alphabets, such as stroke width and arc, to the extent practicable.

Process Overview

1. The ACTT representative as authorized by their Tribal Government will request signs through the MnDOT District Traffic Office.

2. The ACTT representative will include the following items with the request:
   a. Submittal Letter
   b. Documentation that illustrates action of approval by the Tribal Government to request signs. For example: minutes of a meeting or proceeding, letter from Tribal Government, resolution, etc.
   c. Letter of concurrence from the City or County which is required for any requested city population signs or county boundary signs. The letter or concurrence needs to specify that they are in agreement that both languages be displayed and identify the placement, above or below, of each language.
   d. List of requested signs as entered into the spreadsheet: http://www.dot.state.mn.us/trafficeng/signing/docs/dakotaorjibwelanguagesigns.xlsx. Because of the length of some Dakota and Ojibwe words, some signs could be very large unless the word or phrase is separated onto two lines. Where possible, recommend where the word or phrase can be separated onto two lines without changing the meaning.
   e. If possible, submit electronically the spreadsheet referenced above to the MnDOT District Traffic Office so information can be added to the spreadsheet as described below.
3. The MnDOT District Traffic Office will provide the following information back to the ACTT representative:
   a. Sign Panel designs (PDF)
   b. Completed spreadsheet: Dakota or Ojibwe Language Signs.xlsx.
   c. A Dakota or Ojibwe Language Signs Application

4. The ACTT representative will review the sign panel designs for accuracy and if approved, will send the MnDOT District Traffic Office a completed application. If there are errors, the ACTT representative should contact the District Traffic Engineer with revisions prior to completing the application.

5. When the completed application is received, signs will be ordered for fabrication and installation.

6. The MnDOT District Traffic Office will send the completed spreadsheet to the MnDOT website coordinator who will make the English words, the Dakota or Ojibwe language words, the English translation of the Dakota or Ojibwe words, and a phonetic representation of the words available on the MnDOT Tribes and Transportation website.

Sign Panel Design

1. The Dakota and Ojibwe legend may be placed above the English legend on a case by case basis. Both legends are upper lower case lettering.

2. Due to the length of some Dakota and Ojibwe words and phrases, it is recommended to use the highway font Series D instead of E Mod. Series D is a similar font to E Mod but has less breadth to the letters by approximately 35%. By using the Series D font and one inch less than the standard font height, the overall width of the signs when placing the Dakota or Ojibwe language on two lines should, in most cases, fit on U channel post sign structures. If the word or phrase cannot be displayed on two lines the overall size of the sign may require a larger sign structure. This will increase the cost of the sign.

3. The I3-1 (Body of Water) and I2-5 (County Boundary) sign will include the Dakota or Ojibwe language in Series D, 5-inch font and the English legend in E Mod, 6-inch font.

4. The I2-3 (City Population) sign will include the Dakota or Ojibwe language in Series D, 7-inch font and the City Name with the English legend in E Mod, 8-inch font. Below the city name, the word population is abbreviated as POP and number per the standard sign drawings for I2-3.

6-7.12 Treaty Boundary Signing Program

Background
The Advocacy Council for Tribal Transportation (ACTT) requested that MnDOT erect signs to designate the approximate location of treaty boundaries established by land cession agreements between the U.S. Government and the sovereign Indian tribes living in the areas of what is now the State of Minnesota. The purpose of the signs is to inform people of the historic boundaries.

A treaty is a very significant document in which inherent rights such as hunting, fishing and gathering rights were retained in the treaty.

Because tribes are the original owners of the land, courts have held that tribes keep the right to use the land unless they expressly give up that right. Tribes preserve all their rights to use the land until then. This doctrine is known as the "reserved rights doctrine"; it was first used by the Supreme Court in United States v. Winans, 198 US 371 (1905) where the Supreme Court held: “The treaty was not a grant of rights to the Indians, but a grant of rights from them - a reservation of those not granted.” [http://www.wabanaki.com/treaty_rights.htm](http://www.wabanaki.com/treaty_rights.htm)

Information on Land Cession Treaties
People who are interested in learning more about the treaties can find information through a number of avenues, including the internet. The most comprehensive website is the Treaties Matter website, [http://www.treatiesmatter.org](http://www.treatiesmatter.org). This is a companion website to the traveling exhibit Why Treaties Matter which was created
through a partnership of the Minnesota Indian Affairs Council, the Minnesota Humanities Center, and the Smithsonian’s National Museum of the American Indian in Washington, D.C. in August 2010. The Treaties Matter website has information on 12 Dakota and Ojibwe land cession treaties. The treaties were established before Minnesota became a state and the boundaries of some treaties extend into adjacent states. The Why Treaties Matter exhibit travels throughout Minnesota to educate the general public about treaties.

**Signing Standards:**

1. Treaty Boundary will follow the standards of other boundary signs such as reservation boundaries, county boundaries, etc.

2. The signs will include a white legend on a green background.

3. The sign will include the year of the land cessation treaty, the words “Treaty Boundary,” and a pictograph comprised of a white silhouette of the State of Minnesota with the area of the treaty shown in green.

4. Signs will be placed at a maximum of two locations along state highways under MnDOT’s jurisdiction where the area is entered from opposite directions of travel.

5. Signs will not be placed at entrances to the State of Minnesota unless the treaty ceded territory boundary and the state boundary coincide.

6. Approximate sign location along State owned highways will be provided by the requester based on the boundary defined in the treaty.

7. The sign will be placed at the approximate location of the treaty boundary.

8. The sign will not be surveyed in.

9. The sign does not demark the ownership or use rights of land on either side of the sign.

10. Sign fabrication, installation and replacement cost will be paid by the requester through a signing agreement.

**Signing Process:**

1. MnDOT Tribal Affairs will serve as the liaison between MnDOT and the requester(s).

2. All Minnesota tribes who are signatory to the treaty must be in agreement to the treaty boundary area and signing of those boundaries along state highways. The Minnesota Tribes signatory to the treaty will submit tribal resolutions or an official letter signed by the Tribal Chairman/Chairwoman/President requesting treaty boundary signs through the MnDOT Tribal Liaison.

3. The MnDOT Tribal Liaison in coordination with the requesting Minnesota tribes will contact the MnDOT State Signing Engineer.

4. The request for signs from the Minnesota Tribes signatory to the treaty must include the approximate sign location along state highways based on the treaty boundaries defined in the treaty and a pictograph of the treaty boundary overlain on the State of Minnesota to be include on the sign as shown in the signing example below.

5. The State Signing Engineer will coordinate with the MnDOT District Traffic Engineers whose districts are included in the treaty area.

6. The State Signing Engineer will follow the current requester pay process including sending a letter of approval, application and cost estimate to MnDOT Tribal Affairs and appointed tribal government representative. Once the State Signing Engineer receives the completed application and payment from the requester, the signs will be ordered for fabrication and installation.

7. If the sign needs to be replaced because it is damaged, the replacement cost will be the responsibility of the requester.
**Signing Design Example:** (dimensions are shown in inches)

Conventional roadways i.e. Two lane - two way highways:

Freeways and expressway, i.e. high speed four lane divided roadways, signs are larger to allow motorists the opportunity to read the sign at higher speeds. These signs will look the same as illustrated above however they will be 72 inches wide by 48 inches high with 8 inch tall letters and a 13 inch pictograph.
6-8.00 APPLICATION GUIDELINES - MISCELLANEOUS SIGNS

6-8.01 Adopt-A-Highway Sign Program (I-X1)

This signing program is administered by the District offices under the direction of the Office of Maintenance. MnDOT shall fabricate and install signs. One sign shall be installed in each direction at the beginning of the adopted highway segment. Volunteer group names should be limited to a maximum of 18 characters per line to maximize legibility. Each space between words and each type of punctuation takes up a character on a line. All letters shall be uppercase.

A 60” x 18” plate with the words THIS SECTION AVAILABLE should be attached to the bottom half of the 60” x 36” sign panel if a group ceases to participate in the Adopt-A-Highway program and no other group adopts that section of highway for a period of time. This plate is to be attached to the sign panel with bolts utilizing spacers to minimize damage to the retroreflective sheeting on the overlaid sign panel. The colors on the bottom 60” x 18” portion of the sign panel were reversed (white legend and border on blue background) in 2006. A 60” x 18” panel may be attached to the bottom half of the 60” x 36” sign panel for new volunteer groups until the 60” x 36” sign panel reaches the end of its useful life.

A Reference Location sign panel may be combined with an Adopt-A-Highway sign panel on the same structure. For ease of reference and termini location for litter pickup, many Districts have installed the Adopt-A-Highway signs either adjacent to, or in close proximity to reference post markers on rural sections of freeways and expressways.

Rather than two separate sign structures close together, both sign panels may be combined on one sign structure in accordance with all of the following criteria:

1. The Adopt-A-Highway sign panel is the primary sign panel on the sign structure.


6-8.02 Adopt-A-Rest Area Sign Program

MnDOT non-interstate rest areas, waysides, scenic overlooks, and historic properties not serviced by MnDOT’s statewide custodial service provider or by a facility partner may be adopted by groups for the purpose of litter pickup, similar to adopting a highway segment. For a current list of facilities available for adoption, contact the MnDOT Safety Rest Area (SRA) Program Manager. See [www.dot.state.mn.us/restareas](http://www.dot.state.mn.us/restareas) for contact information.

For historic properties, contact the MnDOT Historic Roadside Properties Manager for guidance with respect to the placement of Adopt-A signs. Additional restrictions on the placement of signs apply at historic sites. See [www.dot.state.mn.us/roadsides/historic](http://www.dot.state.mn.us/roadsides/historic) for contact information.

One ADOPT-A-REST AREA sign (I-X1), 42” x 24” may be installed along the entry drive into the property or within the site as approved by the SRA Program Manager and/or as determined by the Historic Roadside Properties Manager, where applicable. All other pertinent guidelines of the Adopt-A-Highway program shall apply to the Adopt-A-Rest Area program.
6-8.03 Community Wayfinding Sign Program

Generally, guidelines that are discussed in this section are those which (1) are not specifically addressed in the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) Part 2D.50, (2) provide additional guidance to that given in the MN MUTCD on application, location and usage of signs, and (3) must be addressed because MnDOT is charged with developing and implementing design, use and application of certain guide signs in accordance with Minnesota Statutes.

1. Introduction

The community must develop a master plan for Community Wayfinding signing which contains a map of the community, including the city street/local road system and a concept design of the community wayfinding sign structure and sign panels.

2. Community Map

The map of the community shall include:

a. Exact locations of private and publicly owned destinations and attractions to be included in this signing program. Destinations or attractions must be key civic, cultural, visitor, and recreational attractions and other destinations of general interest to tourists and the traveling public and shall not be a retail, business, or manufacturing center. In addition, this type of signing shall not display advertising for a commercial product or service.

Only those destinations/attractions which qualify under MnDOT’s Minor Traffic Generator Signing program guidelines are eligible for signing (contact the MnDOT District Traffic Engineer to obtain the listing of destinations/attractions eligible for signing). Community requests for other types of destinations/attractions may utilize MnDOT’s sign variance process.

b. Conventional highway approaches to city street/local road intersections where signing is proposed.

c. Which destination(s) and attraction(s) are to be signed on each conventional approach at each city street/local road intersection.

d. City street/local road intersections where trailblazing signing is required to direct motorists to each facility. If signing is approved on the conventional highway to a facility, trailblazing signing shall be installed on the city streets/local roads by the community before signing is installed on the conventional highway.

3. General Requirements

When interested, a community initiates, coordinates and submits a master plan to the MnDOT District Traffic Engineer. The master plan needs to include a resolution (see Form 6.1) and one lead contact person within the community through which all MnDOT correspondence and contact will be made.

If a community obtains MnDOT approval for Community Wayfinding Signing, MnDOT will remove any existing minor traffic generator signs within the community. No requests for minor traffic generator signing will be approved within the community while the Community Wayfinding Signing program is in effect.

For those facilities that MnDOT considers eligible for signing on state trunk highways, the eligible community is responsible for the construction, installation, and maintenance of the community wayfinding sign structures and sign panels at its own expense.

If community wayfinding signs are not properly maintained, MnDOT will request that the community remove the signs at its own expense. If the signs are not removed within 30 days of notification, MnDOT will remove the community wayfinding signs at the expense of the community.

4. Criteria for Community Wayfinding Signing

a. Signing may be permitted on conventional highways within a community.
b. Sign locations on conventional highways shall be approved by the MnDOT District Traffic Engineer. Installation of signs shall be through the MnDOT permit process.

c. Only one sign structure is allowed in each direction approaching an intersection and should be located on the right side of the roadway.

d. A sign shall not obscure or detract from any existing traffic control devices.

e. If a sign structure is located in the clear zone, it shall meet FHWA breakaway requirements based on the current edition of the AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals, or be protected as approved by the MnDOT District office.

f. Sign panel offset and mounting heights shall be in accordance with the MN MUTCD and shall not be mounted overhead.

g. Signing is allowed for left and right turning movements. Straight ahead confirmatory signing may be permitted in unique circumstances.

h. A specific destination may only be displayed on one sign structure in each direction on a conventional highway unless straight ahead confirmatory signing is also approved by the District Traffic Engineer.

i. Roadway reconstruction and/or installation of new regulatory, warning, or guide signs may necessitate relocation or removal of community destination signs by the community at its own expense.

5. Sign Design Criteria

a. Following MN MUTCD 2D.50, the sign panel background color shall not use red, orange, yellow, purple or the fluorescent versions thereof, fluorescent yellow-green or fluorescent pink.

b. The sign panels shall be made using retroreflective sheeting (see MnDOT Standard Specifications for Construction Section 3352.2A2b). Fluorescent sheeting shall not be used on sign panels.

c. The sign base material should be sheet aluminum (see MnDOT Standard Specifications for Construction Section 3352.2A1a).

d. If separate sign panels are to be used, each sign panel should not exceed six feet in length and two feet in height.

e. Pictographs may be used on community wayfinding signs and if used, comply with the requirements of the Community Wayfinding section of Part 2D in the MN MUTCD. The city pictograph, if displayed, shall be simple, easily recognizable and placed at the top of the sign structure (independently or on the top of a sign panel).

f. The lettering of a city name shall be of a font style and high color contrast for motorists to read at normal highway speeds. If used, place near the top of the sign panel.

g. Symbols, business logos or other forms of advertising for destinations and attractions are not permitted per the MN MUTCD.

h. Up to three destinations/attractions may be displayed on a sign structure (three separate sign panels or one sign panel with three destinations).

i. Destinations shall be displayed (from top to bottom of sign) in the following sequence: straight ahead destination followed by left-oriented destination followed by right-oriented destinations. Closer destinations shall be displayed above further destinations if they are in the same direction.
j. Lettering shall be 6-inches high. The suggested font is Series C Federal Highway Gothic font (or a similar font style that does not detract noticeably from legibility) with approximately a maximum number of 14 characters per line (including spaces between words). Abbreviations, if used, should be standard abbreviations.

k. Lettering and arrows shall be the same color.

l. Arrows shall be MnDOT standard arrows or similar so as to be legible and not a distraction without encircling accents or contrasting mini-backgrounds.

m. Left arrows and upward pointing arrows shall be displayed on the left side, and a right arrow on the right side of a sign panel. If a border is used, it shall be plain, not decorative.

n. All sign panel designs should be reviewed by the MnDOT District Traffic Office before fabrication.

o. The sign shall not contain any animated or moving parts or flashing disks.

p. Distracting flashing or moving lights are not allowed. Lighting which presents a new message, pictorial image, or changes illumination at a rate less than once every six seconds is determined to be a flashing or moving light and is in violation of Minn. Stat. Sec. 173.15, Subd. 7.

6-8.04 Emergency 911 sign

This sign informs motorists entering Minnesota that emergency services may be reached by dialing 911. It should be installed within five miles of the state border on major entry points into the state. Additional signs may be placed at locations such as airports, weigh stations, and rest areas.

6-8.05 Reference Location Sign (D10-1, D10-2, and D10-3)

Reference Location signs, often referred to as Reference Post markers, shall be erected along trunk highways to assist drivers in estimating their progress, provide a means for identifying the location of emergency incidents, and aid in highway planning and maintenance efforts. The zero mile point should begin at the south or west state line or at the south or west terminus where routes begin.

The Office of Transportation Data and Analysis (TDA) shall be notified of new installations of Reference Location signs. Notification shall also be made for replacement of the sign if the previous location cannot be accurately determined (i.e. knockdowns). TDA will provide correct location information for the signs. Notification should be made during the plan development stage.

A Reference Location sign shall be installed within six feet of its correct location. When a Reference Location sign cannot be installed within this distance, it may be moved and installed within 50 feet of its correct location; in this case TDA must be notified of the change. If it cannot be placed within 50 feet of its correct location, it should not be installed.

Further information about Reference Location signs can be found in the MN MUTCD Section 2H.5 and in Chapter 14-5.09 Reference Point System of the Traffic Engineering Manual.

For the design and size of Reference Location signs refer to the MN MUTCD.

MnDOT installs One Tenth Mile (X4-8) delineators on freeways and expressways to further enhance the usefulness of the Reference Location Sign System. Fabrication and installation details are specified later in Section 6-10.04.06 Tangent of this Chapter.
6-8.06 Rest Area Signing

Signing for Rest Areas is shown in the MN MUTCD Section 2l.5.

6-8.06.01 Bus Parking in Rest Areas

Signing within rest areas provides guidance to separate parking locations for autos and for trucks and trailers. When the need arises to sign for bus parking in a particular rest area, the following signing and pavement message guidelines are recommended:

1. Fabricate and install a plaque reading Buses above the “Trucks/Trailers”, “Autos”, or “Trailers/Autos” sign located at the roadway split to the parking areas until such time that the existing sign panels are to be replaced. When the existing sign panels are due to be replaced, add the word “Buses” to the legend of the sign panel.

   NOTE: Buses should be directed to that parking area which not only has the availability and storage capacity for parking, but also provides adequate year round access to the rest area facilities.

2. To designate the specific bus parking locations, either install pavement markings in the designated parking stalls or fabricate and install a sign reading BUS PARKING ONLY along the designated parking stall(s).

6-8.06.02 Teletypewriter (TTY) Facility Signing in Rest Areas

This symbol sign provides travelers that have hearing impairments or speech difficulties advance notice of TTY equipped public pay telephones located in several MnDOT Class I rest areas.

Guidelines for fabrication and installation of TTY sign panels are as follows:

1. The TTY symbol sign panel may be installed on an existing advance rest area sign structure for each of the rest areas equipped with TTY equipment. If there is more than one rest area sign, OTE and District Traffic Office staff will determine which advance sign structure will display the TTY symbol sign panel.

2. If the advance rest area sign panel is on a ground mounted sign structure, attach the TTY symbol sign panel in accordance with the following size guidelines:
   a. U-channel sign structures - Mount the sign panel directly below the rest area sign panel on the right U-channel post with standard sign panel mounting hardware.
   b. I-beam sign structure mounting will be determined by OTE and District Traffic Office staff.

3. If the advance rest area sign panel is mounted overhead, mount the TTY symbol sign panel overhead. The mounting location will be determined by OTE and District Traffic Office staff. If there is more than one overhead mounted advance rest area sign panel, OTE and District Traffic Office staff will determine which advance sign structure will display the TTY symbol sign panel.

4. All costs for the TTY symbol sign panels (fabrication, installation, and removal) will be borne by MnDOT, since MnDOT is providing this equipment and let the statewide contract for the installation and maintenance of the TTY equipment in all Class I rest areas.
6-8.06.03 WAYSIDE REST Sign (D5-X1, D5-X2)

Wayside rests (State owned and maintained facilities only) are rest stop facilities with limited services located on conventional highways in rural areas (see Figure 6.37). If the wayside rest is closed for the season, a CLOSED plaque may be installed.

1. Install a WAYSIDE REST advance sign approximately 1/2 mile in advance of the point of turn. Place appropriate supplemental signs below the D5-X1 or the D5-X2 sign.

2. Install a WAYSIDE REST with arrow sign (D5-X2) prior to the point of turn.

6-8.07 Road/Weather Information System (R/WIS) sign

MnDOT has approved signing for the R/WIS program, which provides road and weather information to the motorist. These signs have been installed statewide to promote this program.

6-8.08 Seat Belt Sign (R16-X11 and R16-X12)

Seat Belt signs are used on all trunk highways near state entrance points to alert motorists entering Minnesota to the state law regarding seat belt usage and promote safety for the traveling public.

Install the R16-X11 sign at all state border entrances on the trunk highway system and at entrances from airports.

The R16-X12 (36” x 36”) sign may be installed at an entrance from a weigh station or a rest area.

The R16-X12 (18” x 18”) sign may be installed at an entrance from a parking lot or a park and ride lot.

6-8.09 Enhanced Conspicuity of Standard Signs

Based on engineering judgment, where the improvement of the conspicuity of a standard regulatory, warning, or guide sign is desired, methods shown in MN MUTCD Part 2A may be used.

6-8.10 Unauthorized Sign Attachments

Extraneous and unauthorized sign panels should be removed and no such attachments are permitted on any signs on the trunk highway system.

6-8.11 Test Section Signing

Test sections are developed and monitored by the Office of Materials and Road Research and by District maintenance forces. When requested, sign in accordance with the following guidelines.

1. The Office of Materials and Road Research should track these sections and work with the District traffic and materials engineers to determine which test sections should be signed.

2. Identify test sections by one of the following methods:
   a. The preferred method is paint, retroreflective tape, or some other device embedded in the pavement at the outside edge of the shoulder (if paved) or the edge of the roadway.
   b. Signs or markers located at the edge of the right-of-way line. If this method is used, a sign panel should identify the number of the test section. The sign panel design uses black, 2-inch high numbers and border on a white non-retroreflectORIZED background.

3. All test section signing installations should be coordinated by the District Traffic Offices.

4. All inplace test section signs should be removed at the end of their useful life, with the exception
of Strategic Highway Research Program (SHRP) signing which should be retained as long as the program is still operating.

If a test section is to be retained when signs are due to be removed, the test section, with the exception of SHRP signing, should be identified by one of the methods specified in Item 3.

6-8.12 Alternative Fuel Corridor Signs

Install a begin or end sign assembly at the beginning and end of the corridor. Install additional confirmatory assemblies including only the D18-1 and D9-X11P panels at 30 to 60 mile spacing. Consider rural/urban environments and bypasses when spacing signs. For example, the rural area spacing can be 60 miles however urban areas with bypasses may need an additional assembly at or around 30 mile spacing.

6-9.00 OBJECT MARKERS

6-9.01 Purpose

Object markers are used to mark obstructions within or adjacent to the roadway and mark the end of a roadway.

6-9.02 Types of Object Markers

For object marker types, colors, and uses, consult the **MN MUTCD** Sections 2C.63 through 2.66. Additionally, MnDOT uses markers uniquely designed for snow plow operations which are not referenced in the MN MUTCD. See the **MnDOT Standard Signs Summary and Manual** for MnDOT sign designs and sizes for use on MnDOT highways.

6-9.03 Applications and Guidelines

6-9.03.01 Bridge Abutments, Piers, and Rails

Bridge abutments, piers and rails within the width of the approaching shoulders should be marked with Type 3 Object Markers (X4-4). A typical application can be found in Figure 6.38.

6-9.03.02 Bridges - Narrow Bridges/One Lane Bridges

Narrow bridges should be marked and delineated as shown in Figure 6.39. More information on signing narrow bridges can be found in **MN MUTCD** 2C.20.

One-lane bridges should be marked and delineated as shown in Figure 6.40. More information on signing one lane bridges can be found in **MN MUTCD** 2C.21.

6-9.03.03 Cattle Passes/Large Culverts

Cattle passes and larger culverts that meet one of the following descriptions are subject to the provisions of this subsection:

1. Headwalls are present and are not protected by guardrail, subject to engineering judgment.
2. Minimum width of 42 inches and a maximum width of 20 feet. Large culverts 20 feet or wider may be treated as a bridge, subject to engineering judgment.
3. Any culvert with an end or opening that is within eight feet of the outside edge of the shoulder. This eight foot distance was selected because it may allow a motorist to pull off of a narrow shouldered roadway if other conditions permit.
4. Other structures as determined by the District Traffic Engineer.

All cattle passes and larger culverts meeting the above criteria should be marked with Type 2 object markers as described in Section 2C.63 and 2C.65 of the **MN MUTCD** and as follows:
1. The Type 2 Object Marker (X4-3) used should be constructed of 0.062-inch aluminum or other lightweight material such as fiberglass or flexible urethane sheeting. Use fluorescent yellow prismatic retroreflective sheeting of a type compatible with the base material.

2. Mount two markers back-to-back on a flexible post or 2-pound steel post. A flexible post is preferred due to its resistance to being knocked down by snowplows and farm equipment. Additionally, it provides better daytime visibility. Install the two-way marker assembly on the near right side immediately in front of the structure as shown in Figure 6.41.

6-9.03.04 Driveways

A property owner may mark each side of a driveway entrance with reflectors. Blue colored reflectors are preferred although white (colorless) may be used. Place each reflector on its own structure (not to exceed a 1.0 pound post), not more than five feet above the ground, and at least 12 feet from the outside edge of the shoulder to prevent snowplow damage.

Red or yellow reflectors should not be used since they can be easily confused with motor vehicle tail lights. MnDOT may remove existing reflectors if they obstruct or interfere with the effectiveness of any traffic control device (Reference: Minn. Stat. Sec. 169.07).

6-9.03.05 End of Roadway

A typical placement of markings for a roadway that ends with no alternative vehicular path is shown in Figure 6.38.

6-9.03.06 Guardrails

The approach end of plate beam guardrail installations should be marked with a Type 3 Object Marker in accordance with the MN MUTCD Section 2C.65.

On guardrail installations with flat end treatments, the object marker shall fit within the recessed area. On installations with round end treatments, the object marker shall wrap around the circular end treatment and shall be mounted so that the top of the marker is even with the top of the circular end treatment.

Both ends of all guardrails shall be marked with the Snowplow Marker (X4-5) as shown in Figure 6.38.

6-9.03.07 Infiltration Areas (X3-6a)

Special drainage infiltration areas are built as part of construction projects. Each infiltration area may be marked with the standard sign X3-6a to identify the area to field personnel. For more information about infiltration areas see MnDOT Tech Memo 14-06-ENV-01.

6-9.03.08 Islands

A typical application of the placement of object markers on islands can be found in Figure 6.38.

6-9.03.09 Snowmobiles or Recreational Vehicles on MnDOT Trunk Highway Right-of-Way.

It is MnDOT policy and practice to not sign or mark obstacles for snowmobiles or other recreational motorized vehicles on trunk highway right-of-way.

6-9.03.10 Snowplow Operations

The Snowplow Marker (X4-5) is used to indicate to a snowplow operator the beginning and end of a guardrail installation. The snowplow marker is shown in Figure 6.38. An alternate to the snowplow marker is a Snow Pole.

Interchange gores (freeways and expressways) are marked with a 12” x 24” Type 3 Object Marker Center (X4-4C).
6-9.03.11 Other Objects

Objects located within the clear zone should be marked with the proper object marker. The clear zone should be determined as stated in MnDOT Road Design Manual, Chapter 4-6.04.

6-10.0 DELINEATORS

6-10.01 Purpose

Delineators are guidance devices used where the alignment might be confusing or unexpected, such as lane reduction transitions and curves. They are effective guidance devices at night and during adverse weather and remain visible when the roadway is wet or snow covered.

6-10.02 Types of Delineators

For delineator types and colors, consult the MnDOT Standard Signs Summary and MnDOT Standard Signs and Markings Manual for use on MnDOT highways. Commonly used delineators types are shown in Figure 6.42 of this chapter.

6-10.03 Placement

Delineator placement guidance can be found in the MN MUTCD Section 3F. Delineator height and lateral placement are shown in Figure 6.44.

6-10.04 Applications and Guidelines

Examples of delineator installations are shown in the MN MUTCD Section 3F.

6-10.04.01 Guardrail

Delineate three-cable guardrail as shown in the current version of MnDOT Standard Plates Nos. 8330 and 8331. The color of the retroreflective sheeting shall match the color of the adjacent edge line.

6-10.04.02 Horizontal Curves

When applied on the approaches to and throughout horizontal curves, spacing should permit several delineators to always be visible along the curve ahead of the driver. The MN MUTCD Figure 3F-1 and Table 3F-1 show the approximate spacing for delineators along horizontal curves. Figures 6.44 through 6.46 of this chapter have additional information regarding delineating curves on interchange ramps. A simple method for field personnel to determine the degree of curve or the radius of a curve is shown in Chart 6.8 of this chapter.

6-10.04.03 Interchanges

Delineation of cloverleaf and diamond interchanges is shown in Figures 6.44 through 6.46 of this chapter. The yellow guide delineator used on the left side of exit ramps complies with MN MUTCD Section 3F.3. Spacing should follow either Plan A for an exit ramp or Plan B for an exit loop.

6-10.04.04 Intersections

Intersection delineation guidance can be found in MN MUTCD Section 3F.4.1 and placed as shown in MN MUTCD Figure 3F-2. Delineation of intersection median corners on divided-highway crossovers is shown in Figure 6.43 of this chapter.

6-10.04.05 Lane Reductions

The MN MUTCD Section 3F.3 gives guidance on delineation of lane reductions and refers to MN MUTCD Figure 3B-14.
6-10.04.06  **Tangent**

Per the **MN MUTCD**, Section 3F.3 requires single delineators to be installed on freeways and expressways except where continuous lighting is in operation between interchanges. The **MN MUTCD** Section 3F.4 provides guidance that delineators on mainline tangent sections should be spaced between 200 and 530 feet apart. MnDOT uses the Tenth Mile Delineator (X4-8) and spaces it approximately at 0.1 mile apart (530 feet).

6-10.04.07  **Vertical Curves**

When applied on crest vertical curves, the spacing should permit a minimum of three delineators to be visible from all points along the centerline of the curve at an eye level of four feet above the pavement.

6-11.0  **REFERENCES**


RURAL
TYPICAL SPEEDS
45 MPH AND ABOVE

URBAN
TYPICAL SPEEDS
BELOW 45 MPH

NOTES:
1. 5 ft on conventional roads; 7 ft on expressways and freeways.
2. When a secondary sign is mounted to more than one riser post, the mounting height from the elevation of the roadway to the bottom of the secondary sign shall be 5 ft on conventional roads and 7 ft on expressways and freeways.
3. When a secondary sign is mounted on a single riser post, the mounting height from the elevation of roadway to the bottom of the secondary sign may be 1 ft less than the height specified in note 2.
4. When a secondary sign is mounted on a single riser post the mounting height of the secondary sign may be mounted 5 ft. above the ground.
5. All dimensions are minimums.

Text Ref.: 6-4.07

May 2015

SIGN PLACEMENT

FIGURE

6.1
REGULATORY SIGNS ON DIVIDED HIGHWAYS AT ENTRANCES

Legend
* Optional
** Refer to MN MUTCD Part 2B to determine traffic control device need/warrant.

Text Ref.: 6-5.02

November 2016

FIGURE 6.2
REGULATORY SIGNS FOR DIVIDED HIGHWAY - T INTERSECTIONS

NOTES:
1. If “ONE WAY” signs are to be used, both shall be installed.

Legend
- Cylinder Style Delineator (X4-13)
- Optional
  ① ONE WAY signs are optional if KEEP RIGHT signs are installed.
  ② Refer to MN MUTCD Part 2B to determine traffic control device need/warrant.

Text Ref.: 6-5.02

November 2016

REGULATORY SIGNS FOR DIVIDED HIGHWAY - T INTERSECTIONS

FIGURE 6.3
REGULATORY SIGNS FOR DIVIDED HIGHWAY INTERSECTIONS - MEDIANS LESS THAN 30 FT. WIDE

Legend
- Cylinder Style Delineator (X4-13)
  - Optional
  - ** ONE WAY signs are optional if KEEP RIGHT signs are installed.

Text Ref.: 6-5.02

November 2016

FIGURE 6.4
REGULATORY SIGNS FOR DIVIDED HIGHWAY INTERSECTION - MEDIAN WIDTH 30 FT. OR GREATER

NOTES:
① If placement of the ONE WAY signs in the median creates confusion see Figure 6.5B.
2. See Figure 6.2 for DO NOT ENTER and WRONG WAY signs.

* Optional

Text Ref.: 6-5.02

November 2016
NOTES:

1. Exercise engineering judgment in determining placement of ONE WAY signs. Field experience has shown that when placed in the median, the ONE WAY signs above the STOP/YIELD signs point towards each other causing confusion to motorists from the approaching cross streets. The MN MUTCD states to install ONE WAY signs in the near right and far left corners of each intersection. Instead of placing a ONE WAY sign in the near right corner (typically mounted above the STOP/YIELD sign in the median), consideration could be given to installing that sign in the far right corner of the intersection as shown in the figure above.

2. The ONE WAY sign should be mounted on the back side and above the STOP or YIELD sign.

3. See Figure 6.2 for DO NOT ENTER and WRONG WAY signs.

Text Ref.: 6-5.02
REGULATORY SIGNS FOR DIVIDED HIGHWAY INTERSECTIONS WITH FRONTAGE ROADS

NOTES:
1. The signing is the same for both approaches to the intersection.

Legend
- Cylinder Style Delineator (X4-13)
- Optional

Text Ref.: 6-5.02

November 2016

FIGURE 6.6
REGULATORY SIGNS FOR DIVIDED HIGHWAY INTERSECTIONS WITH A ONE-WAY STREET/RAMP

NOTES:
1. See Figure 6.5B for optional location of ONE WAY signs above YIELD signs.
2. The DIVIDED HIGHWAY sign should not be used when the roadway is divided only at the junction.

Text Ref.: 6-5.02

November 2016
EXTENDED LEFT TURN LANE

LEFT LANE MUST TURN LEFT

OR

LEFT LANE

Text Ref.: 6-5.02

FIGURE 6.8
NOTE:
Install ONE WAY signs on or as near to the signal pole as possible.

* Optional
** If used, the near right ONE WAY sign is not required.

Text Ref.: 6-5.02

May 2015
RIGHT IN - RIGHT OUT INTERSECTIONS

ALL RIGHT TURN MUST TRAFFIC

OR

YIELD

* Optional

Text Ref.: 6-5.02

REGULATORY SIGNS
RIGHT IN - RIGHT OUT INTERSECTIONS

FIGURE 6.10

May 2015

Stop
Exercise engineering judgment in determining placement of ONE WAY signs. Field experience has shown that at most 3/4 intersections the ONE WAY signs placed on the near right and far left corners of the intersection can cause confusion to motorists from the approaching cross streets and the YIELD signs in the median are angled in such a way that placing ONE WAY signs above them is not feasible. Instead of placing the ONE WAY signs on the near right, consideration could be given to installing that sign in the far right corner (mounted above the KEEP RIGHT) as shown in the above figure.
STANDARD SIGN PLACEMENT

WRONG WAY AND EXCLUSION SIGNS ON INTERCHANGE RAMPS

NOTES:

① Additional sign required on left when ramp is 3 lanes or wider.
② These signs are not installed on expressway interchange ramps.

Text Ref.: 6-5.02
WRONG WAY AND EXCLUSION SIGNS ON INTERCHANGE RAMPS

NOTES:
1. Additional sign required on left when ramp is 3 lanes or wider.
2. These signs are not installed on expressway interchange ramps.

Text Ref.: 6-5.02

May 2015

STANDARD SIGN PLACEMENT
WRONG WAY AND EXCLUSION SIGNS ON INTERCHANGE RAMPS

FIGURE 6.13
STANDARD SIGN PLACEMENT EXCLUSION SIGNS ON CLOVERLEAF INTERCHANGE RAMPS

Text Ref.: 6-5.02

FIGURE 6.14

May 2015

Page 6-88
NOTE:

1 The WATCH FOR BUSES ON SHOULDER signs shall be located beyond the ramp meter signals.

Text Ref.: 6-5.04
BYPASS LANES

Figure 6.16
ADVANCED INTERSECTION LANE CONTROL SIGNS

Single right or left turn lane

NOTE:
Signing should be based upon geometrics such as lane development and turn lane lengths and taper lengths rather than strictly on the lane configuration.

* Optional

Text Ref.: 6-5.12

May 2015
* Required if turn lane is longer than 300 feet.

NOTES:
1. Signing should be based upon geometrics such as lane development and turn lane lengths and taper lengths rather than strictly on the lane configuration.
2. An overhead structure should be installed if there are 3 or more left turn lanes.

Text Ref.: 6-5.12

May 2015 ADVANCED INTERSECTION LANE CONTROL SIGNS (2 OF 2) FIGURE 6.17B
NOTE:
① Install for acceleration lanes ≥ 1000’ in length.
NOTE:
The signing is the same for both approaches to the intersection.

* Optional

Text Ref.: 6-6.07
NOTE:
The signing is the same for both approaches to the intersection.

* Optional

500 ft min.

Text Ref.: 6-6.07

May 2015  CHANNELIZED INTERSECTION SIGNING PAINTED MEDIAN

FIGURE 6.19B
NOTE:
Intended for use where a definite need exists:
- Heavy pedestrian volumes
- Mid-block crossings, etc.

*Optional

** If used, sign should have a plaque located below denoting “AHEAD” or “XX FEET”.

Text Ref.: 6-6.09.01
NOTES:
1. The signing is the same for both approaches to the intersection.
2. Desirable location 2 - 5 miles in advance of passing lane.
3. Lane skip striping shall end approximately 50 feet beyond the Lane Reduction Transition sign.

* Optional

Text Ref.: 6-5.10, 6-6.14
PASSING LANE SIGNING
NEAR LOW VOLUME CROSS ROAD

Text Ref.: 6-5.10, 6-6.14

May 2015

FIGURE 6.21B
NOTES:
1. All sign location distances are approximate.
2. Distances between advance signs in the two-lane, two-way section to the painted gore are 500-1200 feet.
3. On high-speed roadways (45 mph and greater), the spacing should be 400-500 feet. On low speed roadways (less than 45 mph), the spacing should be 200-400 feet.
4. Do not use Divided Highway Begins and Divided Highway Ends signs when the highway is divided only at intersections or junctions.

* Optional

Text Ref.: 6-6.20

May 2015

TRANSITION SIGNING BETWEEN DIVIDED AND UNDIVIDED ROADWAYS

FIGURE 6.22

Text Ref.: 6-4.06.05

SIGNAL MAST ARM INTERSECTION SIGNING

May 2015

FIGURE 6.23A

Page 6-100
SIGNAL MAST ARM INTERSECTION SIGNING

**FIGURE 6.23B**

**RECOMMENDATIONS**

**CENTER**

Signal head location takes priority over sign location on signal mast arms. Place signs as close to center of appropriate lane as the signal head locations allow.

**E.V.P.**

Emergency vehicle pre-emption sensor must be visible to oncoming traffic. Current standard plate 8123 puts the E.V.P. at 6' from end of mast arm.

**NOTE:**

Unusual mast arm signing plans should be submitted to M-DOT signs/its section for windload analysis.
SIGNAL MAST ARM INTERSECTION SIGNING

FIGURE 6.23C

- **R1O-X12 Sign:** Install to the immediate right of the signal head.
- **E.V.P.** Emergency Vehicle Pre-Emption Sensor must be visible to oncoming traffic. Current standard plate 8123 puts the E.V.P. at 6 feet from end of mastarm.

**Directional Guide Sign with Left Arrow:** Ideally centered.

- **Left Turn Yield in Lane:** The guide sign is placed as close as possible to its ideal location.

**NOTE:** Unusual mast arm signing plans should be submitted to MnDOT signals/ITS Section for windload analysis.
E.V.P.
Emergenc vehicle preemption sensor
must be visible to oncoming traffic.
Current standard plate 8123 puts
the evp at 6' from end of mastarm.

* In this case,
the sign is too wide to
fit between the signal head
and the evp sensor, so it was
placed as close as possible to
center of THRU lanes
without blocking the evp sensor

NOTE: UNUSUAL MAST ARM SIGNING PLANS SHOULD BE SUBMITTED TO MnDOT SIGNALS/ITS SECTION FOR WINDLOAD ANALYSIS.
E.V.P.
Emergency Vehicle Pre-emption Sensor
Must be visible to oncoming traffic.
Current standard plate B123 puts
the E.V.P. at 6' from end of mast arm.

Directional Sign
With up arrow
Center the sign
Over the thru lanes

Directional Sign
With right arrow
Sign is centered over
Approaching right turn lane

E.V.P.
West 90

EAST
90

Centered

Signal head location takes priority
Over sign location on signal mast arms.
Place signs as close to center of appropriate
Lane(s) as the signal head locations allow.

Exit from EB TH 90
Entrance ramp
to EB Fm 90

NOTE:
Unusual mast arm signing plans should be submitted to
MnDOT Signals/ITS section for windload analysis.
T INTERSECTION SIGNING (2-LANE, 2-WAY)

NOTES:

1. This sign(s) shall be installed prior to a left turn lane or a bypass lane.
2. If a Stop Ahead sign is not required, install signs 300 ft. apart.
3. Install sign 500 ft. from the intersection if there is no left turn lane.

* Optional

RECOMMENDED SPACING DISTANCES

May 2015

“T” INTERSECTION SIGNING (2-LANE, 2-WAY) FIGURE 6.24A
RECOMMENDED SPACING DISTANCES
"T" INTERSECTION SIGNING (DIVIDED HIGHWAY)

NOTES:
1. See Figures 6.4 thru 6.9 for other regulatory signs.
2. If Stop Ahead sign is not required, install signs 300 ft. apart.
3. If there is no turn lane, install these signs 500 ft. from the intersection.

Text Ref.: 6-4.08, 6-7.01, 6-7.04

May 2015
4-LEG INTERSECTION SIGNING

NOTES:
1. The signing is the same for both approaches to the intersection.
2. Install this sign 500 ft. from the intersection if there is no turn lane.
3. This sign shall be installed prior to the beginning of the taper if a right turn lane is present.

* Optional

RECOMMENDED SPACING DISTANCES

Text Ref.: 6-4.08, 6-7.01, 6-7.04

May 2015

FIGURE 6.25
NOTES:
1. The signing is the same for both approaches to the intersection.
2. The Resort & Camping signs may be combined with the road name sign location.
3. Install sign 500 ft. from the intersection if there is no turn lane.

Text Ref.: 6-4.08, 6-7.01, 6-7.04, 6-7.06.03, 6-7.09.02, Appendix A - Resorts

May 2015

LOCAL ROAD/STREET INTERSECTION SIGNING

FIGURE 6.26
NOTES:

1. Consider these factors for placement: visibility, skew, and geometrics.
2. Optional where posted speed limit is ≤ 40 mph. See Chart 6.5 for sign placement distance.
3. If used, mounting height to be 1 foot.
4. If there is no junction route marker assembly, then install the roundabout plaque above the roundabout warning sign.
5. Use the R6-4b sign for speed zones ≥ 45 mph and/or multi-lane approaches.

   Use the R6-4a sign for speed zones < 45 mph and single lane approaches.
6. Diagrammatic sign shall be installed for speed zones ≥ 55 mph. Signs may be installed at District Traffic Engineer’s discretion for speed zones 40-50 mph.
7. Guide signs may be installed in either location.

Text Ref.: 6-7.01, 6-7.04

* Optional
DO NOT ENTER

YIELD

ONE WAY

DO NOT ENTER

ALL RIGHTS MUST

RIGHT TURN

④

③

③

③

REDUCED CONFLICT INTERSECTION

> 1000 FT

Install signs if turn movement is also to a cross street.

1. Signs may be installed in either location.
2. Exercise engineering judgment in determining placement of ONE WAY signs. Field experience has shown that at most 3/4 intersections the ONE WAY signs placed on the near right and left corners of the intersection can cause confusion to motorists from the approaching cross streets. Consider installing the ONE WAY signs on the far right (mounted above the KEEP RIGHT in place of the near right in the median (mounted above the YIELD sign) as shown in the above figure.

3. Install sign 1000 feet in advance of left turn lane taper.

NOTES:

Optional

FIGURE

6.28A

Text Ref.: 6-7.01, 6-7.04
* Optional

NOTES:

1. Install signs if turn movement is also to a cross street.
2. Signs may be installed in either location.
3. Exercise engineering judgment in determining placement of ONE WAY signs.

Field experience has shown that at most 3/4 intersections the ONE WAY signs placed on the near right and far left corners of the intersection can cause confusion to motorists from the approaching cross streets. Consider installing the ONE WAY signs on the far right (mounted above the KEEP RIGHT in place of the near right in the median (mounted above the YIELD sign) as shown in the above figure.

Text Ref.: 6-7.01, 6-7.04
NOTE:
The signing is the same for both approaches to the intersection.

Text Ref.: 6-7.01, 6-7.04, 6-7.06.03
SINGLE LANE CROSSROAD SIGNING
FOR DIAMOND INTERCHANGES

NOTES:
1. Destinations should not be used in urban areas.
2. This sign should be installed prior to a turn lane. If there is no turn lane, install sign(s) 300 ft from the intersection.
3. Mast arm signs are supplemental.

* Optional

Text Ref.: 6-7.01

May 2015

FIGURE 6.30
MULTI-LANE CROSSROAD SIGNING
FOR DIAMOND INTERCHANGES

NOTES:
1. Destinations should not be used in urban areas.
2. This sign should be installed prior to a turn lane. If there is no turn lane, install sign 300 ft. from the intersection.
3. Do not install if destinations are on advance guide signs.
4. Mast arm signs are supplemental.

Text Ref.: 6-7.01

May 2015

FIGURE 6.31

Traffic Engineering Manual
Chapter 6

Page 6-115
MULTI-LANE CROSSROAD SIGNING
FOR FOLDED DIAMOND INTERCHANGES

Notes:
1. Destinations should not be used in urban areas.
2. This sign should be installed prior to a turn lane. If there is no turn lane, install sign 300 ft. from the intersection.
3. Do not install if destinations are on advance guide signs.
4. Mast arm signs are supplemental.

Text Ref.: 6-7.01

May 2015

FIGURE 6.32
NON-FREEWAY CROSSROAD SIGNING
FOR CLOVERLEAF INTERCHANGES

NOTES:
1. Destinations should not be used in urban areas.
2. Install 200 feet past the end of the taper.
3. Do not install if destinations are on advance guide signs.
4. Ground mounted.
5. Bridge mounted.

Text Ref.: 6-7.01
SIGNING FOR AUXILIARY LANE ON FREEWAY
LANE LESS THAN 1/2 MILE WITHOUT ESCAPE LANE

NOTES:
1. This type of auxiliary lane is located either between loops at a cloverleaf interchange or between two closely spaced interchanges.
2. Install a MERGE sign (W4-1) in the gore of the entrance ramp located at the beginning of the auxiliary lane.
3. Install a standard Exit Direction sign (overhead mounted) at the location where the exiting lane begins to diverge from the through roadway.

* These signs are not installed at cloverleaf interchanges.
SIGNING FOR AUXILIARY LANE ON FREEWAY
LANE LESS THAN 1/2 MILE WITH ESCAPE LANE

NOTES:

1. This type of auxiliary lane is located either between loops at a cloverleaf interchange or between two closely spaced interchanges.

2. Install a MERGE sign (W4-1) in the gore of the entrance ramp located at the beginning of the auxiliary lane.

3. Install a standard Exit Direction sign (overhead mounted) at the location where the exiting lane begins to diverge from the through roadway.

* This sign not installed at cloverleaf interchanges.

Text Ref.: 6-7.01

May 2015  FIGURE 6.34B
SIGNING FOR AUXILIARY LANE ON FREEWAY LANE 1/2 MILE OR GREATER WITHOUT ESCAPE LANE

NOTES:
1. Install an Added Lane sign (W4-3) in the gore located at the beginning of the auxiliary lane.
2. Install an EXIT ONLY Advance Guide sign (overhead mounted) 1000 ft. preferred, 800 ft. minimum, ahead of the EXIT ONLY Exit Direction sign.
3. Install a RIGHT LANE MUST EXIT sign (R3-33) 500 ft. ahead of the EXIT ONLY Exit Direction sign.
4. Install an EXIT ONLY Exit Direction sign (overhead mounted) at the location where the exiting lane begins to diverge from the through roadway.

Text Ref.: 6-7.01

FIGURE 6.34C

May 2015
SIGNING FOR AUXILIARY LANE ON FREEWAY LANE 1/2 MILE OR GREATER WITH ESCAPE LANE

NOTES:
1. Install an Added Lane sign (W4-3) in the gore located at the beginning of the auxiliary lane.
2. Install an EXIT ONLY Advance Guide sign (overhead mounted) 1000 ft. preferred, 800 ft. minimum, ahead of the EXIT ONLY Exit Direction sign.
3. Install an EXIT ONLY Exit Direction sign (overhead mounted) at the location where the exiting lane begins to diverge from the through roadway.

Text Ref.: 6-7.01

FIGURE 6.34D
TYPICAL MOUNTING

SIGN PANEL ATTACHMENT DETAIL

U-POST MOUNTING

5/16 inch stainless steel bolt with nylon insert lock nut.

SQUARE TUBE MOUNTING

5/16 inch stainless steel bolt with nylon insert lock nut.

Oversize stainless steel washer with nylon washer (next to sign face).

May 2015

COMMUNITY RECOGNITION SIGNING

Text Ref.: 6-7.07.02

FIGURE 6.35
DIAGRAM A

Trunk Highway Intersection QB is adjacent to the Trunk Highway.

DIAGRAM VARIATION A

Trunk Highway Intersection QB on a Grid System.

If the QB is located on the city street system OFF the Trunk Highway, signs are permitted on Trunk Highway Y if the QB has effective off R/W directional advertising signs inplace on Trunk Highway X, as "trailblazing".

DIAGRAM B

Interstate

Cannot be used on the Interstate. Sign on Trunk Highway X would be straight ahead signing.

DIAGRAM C

Diagram C signing is considered "straight ahead" on both Trunk Highways, no signing is permitted.

LEGEND: OK - Permissible Sign Location
        QB - Qualifying Business
        City
        Specific Service Sign(s)

Text Ref.: 6-7.09.02, Appendix A Specific Service Signs
SPECIFIC SERVICE SIGNING
TYPICAL CLARIFICATION DIAGRAMS

DIAGRAM D
Trunk Highway X southbound qualifies for signs for QB-1 and QB-2 since it intersects Trunk Highway Y. Section 6-7.09.02, Installation 1c applies to straight ahead signing.

One sign for each QB qualifies. A second sign may be purchased.

DIAGRAM E
Trunk Highway X southbound qualifies for a sign for QB-2 and Trunk Highway Y qualifies for a sign for QB-1. Section 6-7.09.02, Installation 1c applies to straight ahead signing.

DIAGRAM F
Bypass

Diagram F is addressed in Appendix A, Specific Service Signs Criteria #7.

DIAGRAM G
Trunk Highway and Local Road Intersection.

LEGEND:  OK - Permissible Sign Location
           QB - Qualifying Business
           City - Qualifying Business
           Specific Service Sign(s)

Text Ref.: 6-7.09.02, Appendix A Specific Service Signs.

May 2015

FIGURE

6.36B
WAYSIDE REST SIGNING

NOTES:
1. The signing is the same for both approaches to the intersection.
2. Install prior to the point of turn.

Text Ref.: 6-8.06.03

May 2015

Figure 6.37
COMMONLY USED OBJECT MARKER

Types and Installation

**Use Type 3 Object Markers** to mark hazards adjacent to the roadway such as bridge abutments, piers and rails within the width of the approaching shoulders. Right is shown.

**Use Type 4 Object Markers** to mark the end of the roadway.

**Use snowplow marker** to mark guardrail for snowplowing operations.

Typical Marker Placement

- **Edge of Traffic Lane**
- **Typical Marker Placement**

Interchange Gore Marker (X4-4 C 12" x 24")

May 2015
GUARDRAIL

Structural plate beam type guardrail:
Where inplace, mount delineators on steel or plastic post sections fastened to wood posts 4 ft. above the edge of pavement.

3 cable type guardrail:
1. Where inplace on tangent approaches, mount delineators same as above at spacing indicated.
2. Where approach is on a curve, mount same as above but at reduced spacing based on MN MUTCD, Table 3F-1.

Greater than 18 feet but less than the approach roadway width (not including shoulders).

NOTE: Treatment is based on ideal conditions with a tangent approach, good sight distance, etc.

Text Ref.: 6-9.03.02

May 2015

NARROW BRIDGE SIGNING AND DELINEATION

FIGURE 6.39
ONE LANE BRIDGE SIGNING AND DELINEATION

GUARDRAIL
Structural plate beam type guardrail:
Where inplace, mount delineators on steel or plastic post sections fastened to wood posts 4 ft. above the edge of pavement.

3 cable type guardrail:
1. Where inplace on tangent approaches, mount delineators same as above at spacing indicated.
2. Where approach is on a curve, mount same as above but at reduced spacing based on MN MUTCD, Table 3F-1.

NOTE: Treatment is based on ideal conditions with a tangent approach, good sight distance, etc.
UNPROTECTED LARGE CULVERT AND CATTLE PASS MARKING

**Figure 6.41**

- Shoulder
- Roadway
- Flexible Post or 2 lb./ft. Steel Post
- Back-to-Back Type 2 Object Markers (Yellow)
- Shoulder P.I.
- 0 - 8 ft.
- End of Culvert

Text Ref.: 6-9.03.03
COMMONLY USED DELINEATOR TYPES

ONE-TENTH MILE (X4-8)
4 in. x 4 in.

GUIDE (X4-6)
8 in. x 24 in.

CYLINDER STYLE (X4-13)
6-8 inch diameter tube
9-12 inches tall

TYPES OF DELINEATORS

TYPICAL DELINEATOR PLACEMENT

Text Ref.: 6-10.0

May 2015

COMMONLY USED DELINEATOR TYPES
AND INSTALLATION

FIGURE 6.42
NOTE: Corners to be handled as shown in MN MUTCD Figure 3F-2.

Text Ref.: 6-10.04.04
DIAMOND INTERCHANGE - RAMP DELINEATION

PARTIAL AND FULL LIGHTING

Plan A

RAMP DELINEATION

The District Traffic Engineer will determine if guide delineators are required on the outside of any subsequent curves. The approximate spacing shown in MN MUTCD, Table 3F-1 should be used.

NOTE: Where there is guardrail, the guide delineators are mounted either above or immediately behind the guardrail.

Location of Guide Delineators

Text Ref.: 6-10.04.02, 6-10.04.03

May 2015

DIAMOND INTERCHANGE - RAMP DELINEATION

Figure 6.44
DIAMOND INTERCHANGE - RAMP DELINEATION

UNLIT

Text Ref.: 6-10.04.02, 6-10.04.03

The District Traffic Engineer will determine if guide delineators are required on the outside of any subsequent curves.

The District Traffic Engineer will determine if guide delineators are required on a Deceleration Lane or Taper at ramp exits. If installed, use white guide delineator (X4-6). Begin at the point of taper and carry past the gore nose.

Spacing: 100 ft. on center.

**NOTE:** Where there is guardrail, the guide delineators are mounted either above or immediately behind the guardrail.

Plan A

Minimum of 3 white guide delineators (X4-1) (X4-6).
Spacing: 100 ft.

Begin opposite first yellow guide delineator.

Minimum of 4 yellow guide delineators (X4-6).
Spacing: 80 ft.

Begin at exit sign or 100 ft. maximum from paved gore.

Minimum of 5 guide delineators on the outside of the curve. The approximate spacing shown in MN MUTCD Table 3F-1 should be used.

Delineate all of the curve. Terminate at the back of the concrete nose or at the Merging Traffic sign (W4-1).

**PLAN A**
RAMP DELINEATION

Lorem ipsum
At unlit interchanges, the District Traffic Engineer will determine if guide delineators are required on a Deceleration Lane or Taper at ramp exits. If installed, use white guide delineator (X4-6). Begin at the point of taper and carry past the gore nose. Spacing: 100 ft. on center.

Minimum of 4 yellow guide delineators (X4-6). Spacing: 80 ft.

Minimum of 3 white guide delineators (X4-1) (X4-6). Spacing: 100 ft.

Minimum of 5 yellow guide delineators (X4-6). Spacing: 50 ft.

Minimum of 3 white guide delineators (X4-1) (X4-6). Spacing: 100 ft.

Location of Guide Delineators

NOTE: Where there is guardrail, the guide delineators are mounted either above or immediately behind the guardrail.

Plan A
RAMP DELINEATION

Plan B
LOOP DELINEATION

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

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Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A

Plan B

Plan A
At unlit interchanges, the District Traffic Engineer will determine if guide delineators are required on a Deceleration Lane or Taper at ramp exits. If installed, use white guide delineator (X4-6). Begin at the point of taper and carry past the gore nose.

Spacing: 100 ft. on center.

**NOTE:** Where there is guardrail, the guide delineators are mounted either above or immediately behind the guardrail.

**Plan A**
- Minimum of 4 yellow guide delineators (X4-6).
- Spacing: 80 ft.
- Begin at exit sign or 100 ft. maximum from paved gore.
- Minimum of 3 white guide delineators (X4-1)
- Spacing: 100 ft.

**Plan B**
- Minimum of 5 yellow guide delineators (X4-6).
- Spacing: 50 ft.
- Begin at exit sign or 50 ft. maximum from paved gore.

Use the same signing for the opposite direction.

**RAILROAD CROSSINGS WITH TRUCK STOPPING LANE**

May 2016

May 2016

FIGURE 6.46

FIGURE 6.47

Text Ref.: 6-5.15
Community Wayfinding Signing

SAMPLE RESOLUTION

BE IT RESOLVED that the City of _________________________ agrees to comply with the guidelines adopted by the Minnesota Department of Transportation (MnDOT) for Community Wayfinding Signing to be located within the rights of way of state (trunk) highways and city streets/local roads. The city agrees that it is solely responsible for the construction, installation and maintenance of all sign structures and sign panels at its own expense and that if the community wayfinding signs are not properly maintained, the city will remove the signs, at its sole expense, upon request by MnDOT. The city also agrees that if the signs are not removed within 30 days of notification by MnDOT, MnDOT forces will remove the signs at the sole cost and expense of the city.

CERTIFICATION

State of Minnesota
County of ____________________
City of ______________________

I hereby certify that the foregoing Resolution is a true and correct copy of a resolution presented to and adopted by the Council of the City of ______________________ at a duly authorized meeting thereon held on the _____ day of ________, 20__, as shown by the minutes of said meeting in my possession.

________________________________
City Administrator/Clerk
## Ball Banking Form

**Driving Speed**

<table>
<thead>
<tr>
<th>Safe Ball Bank Reading</th>
<th>* See Note 4</th>
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<td>35 MPH and Higher</td>
<td>12 Degrees or under</td>
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<tr>
<td>25-30 MPH</td>
<td>14 Degrees or under</td>
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<tr>
<td>20 MPH or Less</td>
<td>16 Degrees or under</td>
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<th>Date</th>
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<td>IF AVAILABLE</td>
<td>IF AVAILABLE</td>
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**Notes:**

1) If curve is on a multi lane roadway, ball bank readings should be taken from the inside lane. (tightest curve)

2) Degree readings are read using the approximate center of the black bubble rather than the bubbles leading or trailing edge

3) Slope Meter should be securely fastened to vehicle’s dash board (Velcro and Duct tape are acceptable.) **DO NOT PLACE OVER AIRBAGS**

4) Safe reading numbers come from Section 2C.8 of 2011 MN MUTCD.

**Comments:**

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

May 2015

Ball Banking Form

FORM 6.2
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<th>Conventional Roads</th>
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<td>Multiline</td>
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<td></td>
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<td>Arrow Size</td>
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<td>18 x 18</td>
<td>24 x 24</td>
</tr>
<tr>
<td>3 Digit</td>
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<td>30 x 24</td>
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<tr>
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<td>24 x 24</td>
<td>24 x 24</td>
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<td>3 Digit</td>
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<td>5 or 14 head</td>
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</table>

*Ground Mounted signs for Expressways interchanges use Chart 6.1B, US & MN Highways column. All overhead signs use Chart 6.1B Overhead Mounted Signs column.

Notes:
1. Letter fonts are E Modified unless otherwise noted.
2. In urban areas there may be limited horizontal space in which to place a sign. It is then permissible to reduce the size of the letters of a sign by one step. Modified cardinal directions may be used on mast arm signs if load restrictions exist.
3. These minimum and recommended sizes are shown in inches.
4. For signing on freeway and expressway ramps use the sizes shown under the speed 45-60 mph, single lane heading.
5. When a sign includes both destination and supplemental information, and letter sizes stipulated above are different for each, upsize the supplemental legend to the destination legend size.

Text Ref.: 6-4.05.04, 6-7.09, 6-7.09.11, page 6-60
### Guidelines for Freeway Guide Sign Font Size

<table>
<thead>
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<th>Sign Type</th>
<th>Overhead Mounted Signs</th>
<th>Ground Mounted Signs</th>
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<td><strong>Exit Direction</strong></td>
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<td><strong>Overhead Guide Signs</strong></td>
<td>Aux/Alt Route Legend</td>
<td>12</td>
</tr>
<tr>
<td><strong>Route Marker</strong></td>
<td>2 Digit</td>
<td>36 x 36</td>
</tr>
<tr>
<td></td>
<td>3 Digit</td>
<td>45 x 36</td>
</tr>
<tr>
<td><strong>City/Street Name</strong></td>
<td>16-12</td>
<td>20-15</td>
</tr>
<tr>
<td><strong>Arrow Size</strong></td>
<td>17-36</td>
<td>17-36</td>
</tr>
<tr>
<td><strong>EXIT ONLY</strong></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Diagonal Upward Pointing Arrow</strong></td>
<td>8-25</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Down Arrow</strong></td>
<td>22-32</td>
<td></td>
</tr>
<tr>
<td><strong>Distance</strong></td>
<td>Numeral</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Fraction Numerals</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Word</td>
<td>10</td>
</tr>
<tr>
<td><strong>Supplemental</strong></td>
<td><strong>Generic</strong></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Proper Name</td>
<td>13.3-10</td>
</tr>
<tr>
<td><strong>Action Message</strong></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Word</strong></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Numeral</strong></td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>Exit Panel</strong></td>
<td><strong>Word</strong></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Numeral</strong></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><strong>Letter</strong></td>
<td>15</td>
</tr>
</tbody>
</table>

*Ground Mounted signs for Expressways interchanges use Chart 6.1B, US & MN Highways column. All overhead signs use Chart 6.1A.*

**Notes:**
- Overhead Guide Signs: Exit Panel
- Overhead Signs: Supplemental
- Non Standard
- Distance
- Cardinal Direction
- Route Marker
- 2 Digit
- 3 Digit
- City/Street Name
- Arrow Size
- EXIT ONLY
- Down Arrow
- Diagonal Upward Pointing Arrow
- Numeral
- Fraction Numerals
- Word
- Cardinal Direction
- Proper Name
- Action Message
- Word
- Numeral
- Letter

---

**Text Ref.: 6-4.05.04**

**May 2015**

**GUIDELINES FOR GUIDE SIGNS**

**CHART 6.1B**
TYPES OF GUIDE SIGNS

Destination Signs

- Roscoe → Cold Spring ←
  D1-2

- Alexandria ↑ St Cloud →
  D1-2

- Amity ← Twin Falls →
  D1-2d

- Remer ↑ Aitkin ←
  Grand Rapids →
  D1-3

- Foreston 7 ←
  Gilman 3 →
  D1-2a

- Albany 15 ←
  D1-1a

Directional Signs

- Interstate 94 WEST Alexandria
  NORTH SOUTH
  MINNESOTA M 23
  D1-1a

- Interstate 94 WEST St Cloud
  EAST
  MINNESOTA M 23
  MINNESOTA M 120 Century Ave
  D1-1a

- Interstate 94 WEST Duluth 90
  EAST 5
  MINNESOTA M 1 Virginia 25
  Duluth 90
  D1-2

Distance Signs

- France Ave 1/2
  Normandale Blvd 1 1/2
  E Bush Lake Rd 2
  Interchange Sequence Sign

- Osakis 4
  Alexandria 16
  Moorhead 116
  Post Interchange Distance Sign

- Askov 8
  Duluth 65
  D2-2

Text Ref.: 6-4.05.04

May 2015

TYPES OF GUIDE SIGNS

CHART 6.1C
Junction Signs

![Junction Signs Diagram]

Signal Mast Arm Mounted Signs

![Signal Mast Arm Mounted Signs Diagram]

Supplemental Signs

![Supplemental Signs Diagram]
Interchange Advance and Exit Guide Signs

Interchange Advance Guide Sign Type A
Jasper Pipestone
3/4 MILE

Interchange Exit Direction Sign Type A
Jasper Pipestone

Interchange Advance Guide Sign Type OH
EXIT 52 B
EAST
Stillwater
1 MILE

Interchange Exit Direction Sign Type OH
EXIT 52 B
EAST
Stillwater

Interchange Advance Lane Drop Guide Sign Type OH
EXIT 193
Buffalo Monticello
1 MILE
EXIT ONLY

Interchange Exit Direction Lane Drop Guide Sign Type OH
EXIT 193
Buffalo Monticello
EXIT ONLY

Text Ref.: 6-4.05.04

May 2015
Type "A" Signs with Breakaway I-Beams
(signs falling above lined area)

Legend
U = Vertical U-post
A = Knee Brace

Panel Height
Panel Width

Text Ref.: 6.4.08.01
May 2015
<table>
<thead>
<tr>
<th>PANEL WIDTH (inches)</th>
<th>POST SPACING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 POSTS (inches)</td>
</tr>
<tr>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>42</td>
<td>30</td>
</tr>
<tr>
<td>48</td>
<td>30</td>
</tr>
<tr>
<td>54</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>36</td>
</tr>
<tr>
<td>66</td>
<td>42</td>
</tr>
<tr>
<td>72</td>
<td>42</td>
</tr>
<tr>
<td>78</td>
<td>54</td>
</tr>
<tr>
<td>84</td>
<td>54</td>
</tr>
<tr>
<td>90</td>
<td>54</td>
</tr>
<tr>
<td>96</td>
<td>54</td>
</tr>
<tr>
<td>102</td>
<td>60</td>
</tr>
<tr>
<td>108</td>
<td>66</td>
</tr>
<tr>
<td>114</td>
<td>66</td>
</tr>
<tr>
<td>120</td>
<td>72</td>
</tr>
<tr>
<td>126</td>
<td>78</td>
</tr>
<tr>
<td>132</td>
<td>78</td>
</tr>
<tr>
<td>138</td>
<td>78</td>
</tr>
<tr>
<td>144</td>
<td>90</td>
</tr>
<tr>
<td>150</td>
<td>90</td>
</tr>
<tr>
<td>156</td>
<td>90</td>
</tr>
<tr>
<td>162</td>
<td>96</td>
</tr>
<tr>
<td>168</td>
<td>96</td>
</tr>
<tr>
<td>174</td>
<td>102</td>
</tr>
<tr>
<td>180</td>
<td>108</td>
</tr>
</tbody>
</table>

Use this chart if punch codes cannot be found in the Standard Signs and Markings Manual.

Text Ref.: 6-4.08.01
### Advance Placement Distance

<table>
<thead>
<tr>
<th>Posted or 85th Percentile Speed (mph)</th>
<th>Condition A: Speed reduction and lane changing in heavy traffic</th>
<th>Condition B: Deceleration to the listed advisory speed (mph) for the condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>25</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>35</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>40</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>45</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>55</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>60</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>65</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>70</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>75</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**NOTES:**

1. The distances are adjusted for a sign legibility distance of 180 feet for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 feet, which is the appropriate distance for an alignment warning symbol sign. For Condition A and B, warning signs with less than a 6-inch legend or more than 4 words, a minimum of 100 feet should be added to the advance placement distance to provide adequate legibility of the warning sign.

2. Typical conditions are locations where the road user might use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2004 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 180 feet for the appropriate sign.

3. Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are based on the 2004 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second², minus the sign legibility distance of 180 feet.

4. Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PRT, a vehicle deceleration rate of 10 feet/second², minus the sign legibility distance of 250 ft.

5. No suggested distances are provided for these speeds, as placement location is dependent on site conditions and other signing. An alignment warning sign may be placed anywhere from the point of curvature up to 100 feet in advance of the curve. However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other sign.

6. The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.
<table>
<thead>
<tr>
<th>Ball Bank Indicator Limiting Values in Degrees</th>
<th>Recommended Speed of Turn or Curve in MPH</th>
<th>Sign Drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Degrees</td>
<td>20 MPH or less</td>
<td>W1-1(R)</td>
</tr>
<tr>
<td>14 Degrees</td>
<td>25 - 30 MPH</td>
<td>W1-1(R)</td>
</tr>
<tr>
<td>12 Degrees</td>
<td>35 MPH and higher</td>
<td>W1-2(R)</td>
</tr>
</tbody>
</table>

Use this sign when two turns are connected by a tangent of less than 600 feet. The lesser of the recommended speeds for the two turns will prevail.

Use this sign when two curves are connected by a tangent of less than 600 feet. The lesser of the recommended speeds for the two curves will prevail.
Table 1: Initial Sign Structure and Sign Panel

<table>
<thead>
<tr>
<th>Sign Size</th>
<th>Total Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Cost</td>
<td>Cost per sq ft</td>
</tr>
<tr>
<td>up to 20 sq ft</td>
<td>$799.00</td>
<td>$15.90</td>
</tr>
<tr>
<td>20 - 50 sq ft</td>
<td>$927.00</td>
<td>$15.90</td>
</tr>
<tr>
<td>50.1 - 90 sq ft</td>
<td>$1,060.00</td>
<td>$15.90</td>
</tr>
</tbody>
</table>

Notes:
(1) Includes structural materials, equipment, and installation labor costs.
(2) Includes aluminum, sheeting materials, and panel fabrication costs.

Table 2: Replace Sign Panel Only

<table>
<thead>
<tr>
<th>Sign Size</th>
<th>Total Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Cost</td>
<td>Cost per sq ft</td>
</tr>
<tr>
<td>up to 20 sq ft</td>
<td>$306.00</td>
<td>$15.90</td>
</tr>
<tr>
<td>20.1 - 50 sq ft</td>
<td>$356.00</td>
<td>$15.90</td>
</tr>
<tr>
<td>50.1 - 90 sq ft</td>
<td>$406.00</td>
<td>$15.90</td>
</tr>
</tbody>
</table>

Notes:
(1) Includes structural materials, equipment, and installation labor costs.
(2) Includes aluminum, sheeting materials, and panel fabrication costs.

Table 3: Sign Relocation Costs

<table>
<thead>
<tr>
<th>Sign Size</th>
<th>Cost to move inplace sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 20 sq ft</td>
<td>$450.00</td>
</tr>
<tr>
<td>20.1 - 50 sq ft</td>
<td>$500.00</td>
</tr>
<tr>
<td>50.1 - 90 sq ft</td>
<td>$550.00</td>
</tr>
</tbody>
</table>

Table 4: Specific Service Sign Costs

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Sign Structure and Panel Installation</td>
<td>$943.00</td>
</tr>
<tr>
<td>Replace Sign Structure and Sign Panel</td>
<td>$677.00</td>
</tr>
<tr>
<td>Replace Sign Structure or Relocate</td>
<td>$534.00</td>
</tr>
<tr>
<td>Replace Sign Panel</td>
<td>$449.00</td>
</tr>
</tbody>
</table>

Tech Memo 17-06-T-01

June 2017

REQUESTER PAY SIGNING COSTS

CHART

6.6
### Table 3-1. Stopping Sight Distance on Level Roadways

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Brake Reaction Distance (m)</th>
<th>Stopping Sight Distance Calculated (m)</th>
<th>Design Speed (mph)</th>
<th>Brake Reaction Distance (ft)</th>
<th>Stopping Sight Distance Calculated (ft)</th>
<th>Design (m)</th>
<th>Design (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>13.9</td>
<td>18.5</td>
<td>15</td>
<td>55.1</td>
<td>21.6</td>
<td>76.7</td>
<td>80</td>
</tr>
<tr>
<td>30</td>
<td>20.9</td>
<td>31.2</td>
<td>20</td>
<td>73.5</td>
<td>23.8</td>
<td>111.9</td>
<td>115</td>
</tr>
<tr>
<td>40</td>
<td>27.8</td>
<td>46.2</td>
<td>25</td>
<td>91.9</td>
<td>30.0</td>
<td>151.9</td>
<td>155</td>
</tr>
<tr>
<td>50</td>
<td>34.8</td>
<td>63.5</td>
<td>30</td>
<td>110.3</td>
<td>36.4</td>
<td>197.0</td>
<td>200</td>
</tr>
<tr>
<td>60</td>
<td>41.7</td>
<td>83.0</td>
<td>35</td>
<td>128.6</td>
<td>41.6</td>
<td>246.2</td>
<td>250</td>
</tr>
<tr>
<td>70</td>
<td>48.7</td>
<td>104.9</td>
<td>40</td>
<td>147.0</td>
<td>48.3</td>
<td>300.6</td>
<td>305</td>
</tr>
<tr>
<td>80</td>
<td>55.6</td>
<td>129.0</td>
<td>45</td>
<td>165.4</td>
<td>54.3</td>
<td>359.8</td>
<td>360</td>
</tr>
<tr>
<td>90</td>
<td>62.6</td>
<td>155.5</td>
<td>50</td>
<td>183.8</td>
<td>60.8</td>
<td>423.8</td>
<td>425</td>
</tr>
<tr>
<td>100</td>
<td>69.5</td>
<td>184.2</td>
<td>55</td>
<td>202.1</td>
<td>66.4</td>
<td>492.4</td>
<td>495</td>
</tr>
<tr>
<td>110</td>
<td>76.5</td>
<td>215.3</td>
<td>60</td>
<td>220.5</td>
<td>71.9</td>
<td>560.0</td>
<td>570</td>
</tr>
<tr>
<td>120</td>
<td>83.4</td>
<td>248.6</td>
<td>65</td>
<td>238.9</td>
<td>77.5</td>
<td>644.4</td>
<td>645</td>
</tr>
<tr>
<td>130</td>
<td>90.4</td>
<td>284.2</td>
<td>70</td>
<td>257.3</td>
<td>84.0</td>
<td>727.6</td>
<td>730</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>275.6</td>
<td>89.3</td>
<td>799.8</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td>294.0</td>
<td>94.3</td>
<td>898.3</td>
<td>910</td>
</tr>
</tbody>
</table>

**Note:** Brake reaction distance predicated on a time of 2.5 s; deceleration rate of 3.4 m/s² [11.2 ft/s²] used to determine calculated sight distance.

### Table 3-2. Stopping Sight Distance on Grades

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Stopping Sight Distance (m)</th>
<th>Design Speed (mph)</th>
<th>Stopping Sight Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Downgrades 3%</td>
<td>6%</td>
<td>9%</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>30</td>
<td>32</td>
<td>31</td>
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<td>40</td>
<td>50</td>
<td>45</td>
<td>44</td>
</tr>
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<td>50</td>
<td>66</td>
<td>61</td>
<td>59</td>
</tr>
<tr>
<td>60</td>
<td>87</td>
<td>80</td>
<td>77</td>
</tr>
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<td>80</td>
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<td>90</td>
<td>164</td>
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<td>120</td>
<td>263</td>
<td>234</td>
<td>223</td>
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<td>130</td>
<td>302</td>
<td>267</td>
<td>254</td>
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<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80</td>
</tr>
</tbody>
</table>

Traffic Engineering Manual

Calculated (m)  Design (m)  Calculated (ft)  Design (ft)
20 13.9 4.6 18.5 20 15 55.1 21.6 76.7 80
30 20.9 10.3 31.2 35 20 73.5 38.4 111.9 115
40 27.8 18.4 46.2 50 25 91.9 60.0 151.9 155
50 34.8 28.7 63.5 65 30 110.3 86.4 197 200
60 41.7 41.3 83.0 85 35 128.6 117.6 246.2 250
70 48.7 56.2 104.9 105 40 147.0 153.6 300.6 305
80 55.6 73.4 129.0 130 45 165.4 194.4 359.8 360
90 62.6 92.9 155.5 160 50 183.8 240.0 423.8 425
100 69.5 114.7 184.2 185 55 202.1 290.3 492.4 495
110 76.5 138.8 215.3 220 60 220.5 405.5 566.0 570
120 83.4 165.2 248.6 250 65 238.9 405.5 644.4 645
130 90.4 193.8 284.2 285 70 257.3 470.3 727.6 730

<table>
<thead>
<tr>
<th>Degree of Curve</th>
<th>Distance “M” feet</th>
<th>Distance “M” inches</th>
<th>Radius feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°30’</td>
<td>.44’</td>
<td>5 5/8”</td>
<td></td>
</tr>
<tr>
<td>1°00’</td>
<td>.87’</td>
<td>10 7/8”</td>
<td>5730</td>
</tr>
<tr>
<td>1°30’</td>
<td>1.31’</td>
<td>15 7/8”</td>
<td>3820</td>
</tr>
<tr>
<td>2°00’</td>
<td>1.75’</td>
<td>21”</td>
<td>2865</td>
</tr>
<tr>
<td>2°30’</td>
<td>2.18’</td>
<td>26”</td>
<td>2292</td>
</tr>
<tr>
<td>3°00’</td>
<td>2.62’</td>
<td>31 1/2”</td>
<td>1910</td>
</tr>
<tr>
<td>3°30’</td>
<td>3.06’</td>
<td>36 1/4”</td>
<td>1637</td>
</tr>
<tr>
<td>4°00’</td>
<td>3.49’</td>
<td>42”</td>
<td>1432</td>
</tr>
<tr>
<td>4°30’</td>
<td>3.93’</td>
<td>47 1/4”</td>
<td>1273</td>
</tr>
<tr>
<td>5°00’</td>
<td>4.37’</td>
<td>52 1/2”</td>
<td>1146</td>
</tr>
<tr>
<td>5°30’</td>
<td>4.81’</td>
<td>57 3/4”</td>
<td>1042</td>
</tr>
<tr>
<td>6°00’</td>
<td>5.25’</td>
<td>63”</td>
<td>955</td>
</tr>
<tr>
<td>6°30’</td>
<td>5.69’</td>
<td>68 3/4”</td>
<td>881</td>
</tr>
<tr>
<td>7°00’</td>
<td>6.13’</td>
<td>73 3/4”</td>
<td>819</td>
</tr>
<tr>
<td>7°30’</td>
<td>6.57’</td>
<td>78 3/4”</td>
<td>764</td>
</tr>
<tr>
<td>8°00’</td>
<td>7.02’</td>
<td>84 3/4”</td>
<td>716</td>
</tr>
<tr>
<td>8°30’</td>
<td>7.46’</td>
<td>89 3/4”</td>
<td>674</td>
</tr>
<tr>
<td>9°00’</td>
<td>7.90’</td>
<td>94 3/4”</td>
<td>637</td>
</tr>
<tr>
<td>9°30’</td>
<td>8.35’</td>
<td>100 3/4”</td>
<td>603</td>
</tr>
<tr>
<td>10°00’</td>
<td>8.79’</td>
<td>105 3/4”</td>
<td>573</td>
</tr>
</tbody>
</table>

STOPPING SIGHT DISTANCE
LEVEL ROADWAYS AND GRADES
CHART


DEGREE OF CURVE RELATED TO “M” FOR A 200 FOOT CHORD

Take a 200 foot tape, chain, or rope and stretch it between two points on a curve. At the center (100 foot mark), measure the distance in feet and inches between the chord and the arc.

DEGREE OF CURVE RELATED TO “M” FOR A 200 FOOT CHORD

<table>
<thead>
<tr>
<th>Degree of Curve</th>
<th>Distance “M” feet</th>
<th>Distance “M” inches</th>
<th>Radius feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°30’</td>
<td>.44’</td>
<td>5 5/8”</td>
<td></td>
</tr>
<tr>
<td>1°00’</td>
<td>.87’</td>
<td>10 7/8”</td>
<td>5730</td>
</tr>
<tr>
<td>1°30’</td>
<td>1.31’</td>
<td>15 7/8”</td>
<td>3820</td>
</tr>
<tr>
<td>2°00’</td>
<td>1.75’</td>
<td>21”</td>
<td>2865</td>
</tr>
<tr>
<td>2°30’</td>
<td>2.18’</td>
<td>26”</td>
<td>2292</td>
</tr>
<tr>
<td>3°00’</td>
<td>2.62’</td>
<td>31 1/2”</td>
<td>1910</td>
</tr>
<tr>
<td>3°30’</td>
<td>3.06’</td>
<td>36 1/4”</td>
<td>1637</td>
</tr>
<tr>
<td>4°00’</td>
<td>3.49’</td>
<td>42”</td>
<td>1432</td>
</tr>
<tr>
<td>4°30’</td>
<td>3.93’</td>
<td>47 1/4”</td>
<td>1273</td>
</tr>
<tr>
<td>5°00’</td>
<td>4.37’</td>
<td>52 1/2”</td>
<td>1146</td>
</tr>
<tr>
<td>5°30’</td>
<td>4.81’</td>
<td>57 3/4”</td>
<td>1042</td>
</tr>
<tr>
<td>6°00’</td>
<td>5.25’</td>
<td>63”</td>
<td>955</td>
</tr>
<tr>
<td>6°30’</td>
<td>5.69’</td>
<td>68 3/4”</td>
<td>881</td>
</tr>
<tr>
<td>7°00’</td>
<td>6.13’</td>
<td>73 3/4”</td>
<td>819</td>
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<tr>
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<td>100 3/4”</td>
<td>603</td>
</tr>
<tr>
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<td>8.79’</td>
<td>105 3/4”</td>
<td>573</td>
</tr>
</tbody>
</table>

Text Ref.: 6-10.04.02

FINDING THE DEGREE OF CURVE FOR A HORIZONTAL CURVE

CHART 6.8

May 2015

Page 6-149
In order for a facility to receive supplemental guide signing, the sign location must meet engineering standards and the facility or business must meet the criteria set forth in this appendix.

Engineering standards involve the design and placement of signs. The main purpose of signing is to inform motorists of regulations such as speed limits and stops, warn them of any impending dangers such as sharp curves and steep grades, and help them find their destination by clearly marking routes and cross streets. Signs must be properly spaced so that motorists have time to perceive the information on signs and make the appropriate driving maneuver. For example, on a freeway, guide signs should be spaced approximately 800 feet apart. Furthermore, different types of signs (regulatory, warning, and guide) cannot be combined. For example, mixing a golf course sign with a speed limit sign is not allowed. This leaves limited space for supplemental guide signs.

There is tremendous demand for signing along our highway system. Many businesses, organizations, and agencies feel that they need and deserve signing to advertise, inform and/or aid the motorist in locating their establishment. As discussed under engineering standards, it is necessary to limit all signing to only that which is sufficient to aid drivers in safely arriving at their destination. As such, MnDOT policy and state law set out criteria that a facility must meet in order to be eligible for signing.

This appendix is an alphabetized list of various facility types falling into several different signing programs available for signing on MnDOT trunk highways if engineering standards can be met. Unless otherwise indicated, the General Criteria listed below apply to all facilities. In addition to the General Criteria, each facility type is listed with additional details regarding sign design, location from the intersection/interchange, roadway type allowed, and facility specific criteria.

A list of ineligible facilities is at the end of this appendix.

Contents
General Criteria ........................................................................................................................................A-1
Facility Type, Sign Design, Sign Program and Specific Criteria .................................................................A-4
Logo Signs..................................................................................................................................................A-37
Specific Services Signing Program...............................................................................................................A-38
Ineligible Facilities.....................................................................................................................................A-41
GENERAL CRITERIA

Unless specifically noted under a particular signing program, the following general criteria apply to all of MnDOT’s signing programs.

1. MnDOT shall fabricate, install, and maintain signs on trunk highways unless otherwise specified by the District Traffic Engineer.

2. The cost of fabrication, installation, and maintenance shall be paid by the requester.

3. Appropriate trailblazing signs shall be the responsibility of the facility and approved by the road authority. If appropriate trailblazing cannot be installed, signing on trunk highways shall not be installed. The color and design of trailblazing signs should match that of the signing installed on the trunk highway.

4. Signs shall not be allowed from intersections or interchanges that do not provide the closest or most direct route from a trunk highway to a facility.

5. MnDOT retains the authority to specify message content (including abbreviations), size of sign, sign location, and combination of messages, in accordance with standards for acceptable signing practice. The sign design, including message and logos if applicable, shall be identical on ramp and mainline signs at an interchange.

6. Location and placement of signs is dependent upon space availability as determined by the District Traffic Engineer. Sign installations shall meet sign spacing guidelines for the type of roadway on which they are allowed. No sign installations shall be placed at a location that will interfere with other necessary signing as determined by the District Traffic Engineer. If space is unavailable, requests shall be denied.

7. Mainline signs shall not be installed for a facility if there is no space available to install signs on the ramp and vice versa.

8. All sign installations on trunk highways shall conform to MnDOT’s current sign design and sign sheeting standards.

9. Signs not meeting MnDOT’s current criteria shall be removed through attrition. If mainline signing is removed, ramp signing and any trailblazing on trunk highways shall also be removed.

10. Only one sign per facility may be installed in each direction along a trunk highway.

11. The criteria for installing logos (business panels) on Specific Service and LOGO signs are specified in Section 6-7.09.01 and 6-7.09.02, respectively.
12. Pictographs are defined as a pictorial representation used to identify a governmental jurisdiction, an area of jurisdiction, a governmental agency, a military base or branch of service, a governmental approved university or college, a toll payment system, or a government approved institution. They are allowed on certain signs as specifically designated in the MN MUTCD. The following are examples of such facilities allowed:

- Casinos
- Educational Institutions (post-secondary)
- National Parks, National Monuments
- State Parks
- Trail Access

If used, pictographs shall meet the following guidelines:

a. Pictographs shall not resemble a traffic control device.

b. Inappropriate pictographs shall not be permitted.

c. There shall be only one pictograph per sign.

d. The pictograph shall supplement the text message.

e. The pictograph shall not exceed 33 percent of the size of the sign panel.

f. The pictograph shall fit within the border of the sign panel. Pictographs shall not be a separate attachment outside the limits of the sign panel.

g. The pictograph designs shall be reviewed and approved by the District Traffic Office prior to fabrication.

h. The pictograph shall be fabricated on sheet aluminum conforming to MnDOT specification 3352 and installed as an overlay.

13. Signs may be considered on trunk highways that intersect with local roads which serve as logical, primary routes for motorists approaching from other directions.

14. Signs shall not be provided if the facility is readily visible or if effective off right-of-way directional signing is present or can be provided.

15. MnDOT retains the authority to deny requests for signing where acceptable standards cannot be met, including locations where other supplemental guide signs are already in place. At the discretion of
the District Traffic Engineer, signing requests denied based on MnDOT policy may be appealed to the External Sign Variance Committee. Requests denied based on Minnesota statutes or engineering standards (i.e. insufficient space and design standards found in the MN MUTCD) may not be appealed.

16. If a district traffic office decides that a contract for signing a minor traffic generator is required, the following process shall be used:

   a. The requester should obtain proposals from at least three consulting engineering firms to prepare the signing contract.

   b. The requester evaluates the proposals and enters into a contract with one of the consulting engineering firms to provide all of the following:

      ▪ A complete design of a signing plan (including field cross sections if necessary), assembly of special provisions, and proposal. Technical assistance is available from the State Signing Engineer, Office of Traffic, Safety, and Technology (OTST).

      ▪ Submit the plan and proposal to the signing contractors. Typically allow 10 days for the contractor to review and submit bids.

      ▪ Review the bids and award the contract to the signing contractor.

      ▪ Inspect the signing contractor’s work with technical assistance provided by MnDOT’s district staff.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Equipment</td>
<td>D9-X6</td>
<td><img src="image" alt="RAPIDAN FEED STORE" /></td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td></td>
<td>D1-X4</td>
<td><img src="image" alt="AIRPORT" /></td>
<td>15 15</td>
<td>• Freeway • Expressway • Conventional</td>
<td>In addition to the general criteria for all signing programs, all of the following criteria apply to the Airport Signing Program. In order to be considered for signing, the following criteria shall be met by the requesting facility: 1. Private airports requiring owner’s permission to use shall not be eligible for signing. 2. Signing from one trunk highway onto a second trunk highway may be allowed if the airport is located within: 10 miles for an Air Carrier/Commercial Service airport, and 7.5 miles for a General Aviation airport. 3. These guidelines may also be applied to heliports. Signs should be installed in accordance with the following: 1. Individual airport names may be used on signing, as necessary, to ensure adequate identification for motorists. 2. The AIRPORT (D1-X4) sign with arrow will be adequate for most intersections at which airport signing is permitted. 3. At interchanges, a green version of the E10-3 sign design (with the word AIRPORT or proper name replacing the word HOSPITAL) shall be installed on the mainline. The (D1-X4) sign, or custom guide sign if proper name is used, shall be installed on ramp(s). The message on the ramp sign shall match the message on the mainline sign. 4. Trailblazing signing on local roads, when needed, shall utilize the Airplane Symbol sign (I-5) with appropriate arrow.</td>
</tr>
<tr>
<td>Airports</td>
<td>I-5</td>
<td><img src="image" alt="AIRPORT EXIT 134 A" /></td>
<td>15 15</td>
<td>• Freeway • Expressway • Conventional</td>
<td>Signs should be installed in accordance with the following: 1. Signing from one trunk highway may be allowed if the AMTRAK station is located within 10 miles. 2. At interchanges, a green version of the E10-3 sign design (with the word AMTRAK replacing the word HOSPITAL) shall be installed on the mainline. 3. Ramp signing should be done in accordance with the following: a. If a custom guide sign is used, the message on the ramp sign shall match the message on the mainline sign. b. If a Federal passenger station symbol sign panel (I-7) is used, it shall have a plaque including the word AMTRAK mounted below it. 4. Trailblazing signing on local roads, when needed, shall utilize the Federal passenger station symbol (I-7) with a plaque including the word AMTRAK mounted below it.</td>
</tr>
<tr>
<td>AMTRAK/Train Stations</td>
<td>I-7</td>
<td><img src="image" alt="AMTRAK EXIT 134 A" /></td>
<td>1 1</td>
<td>• Freeway • Expressway • Conventional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E10-3*</td>
<td><img src="image" alt="AMTRAK EXIT 134 A" /></td>
<td>15 15</td>
<td>• Freeway • Expressway • Conventional</td>
<td></td>
</tr>
</tbody>
</table>

* Modified according to #3 under installation guidelines.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amusement Park</td>
<td>D9-X6</td>
<td>PAUL BUNYAN LAND</td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Tourist Oriented Business</td>
</tr>
<tr>
<td>Brown Custom Design</td>
<td>Valleyfair FOLLOW 101</td>
<td>10 10</td>
<td>• Freeway • Expressway • Conventional</td>
<td>See Major Traffic Generator</td>
<td></td>
</tr>
<tr>
<td>Antiques/Gift Shops</td>
<td>D9-X6</td>
<td>AUNT ADDIE'S ANTIQUES</td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Tourist Oriented Business</td>
</tr>
<tr>
<td>Arboretum</td>
<td>Brown Custom Design</td>
<td>University of Minnesota Landscape Arboretum</td>
<td>3 3</td>
<td>• Expressway • Conventional</td>
<td>In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply. The facility should provide: 1. Parking for at least 50 vehicles. 2. Walking or driving trails along with viewing facilities. 3. An interpretive program, and/or audio/visual self-guiding presentations.</td>
</tr>
<tr>
<td>Archery Range</td>
<td>D9-X6</td>
<td>ARCHIE'S ARCHERY</td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Tourist Oriented Business</td>
</tr>
<tr>
<td>Bait and Tackle</td>
<td>D9-X6</td>
<td>MINNOW'S LIVE BAIT</td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Tourist Oriented Business</td>
</tr>
<tr>
<td>Bed and Breakfasts</td>
<td>D9-X6</td>
<td>HOMETIME B&amp;B</td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Motel</td>
</tr>
<tr>
<td>Boat Launch</td>
<td>D7-X7</td>
<td>Lobster Lake</td>
<td>1 10</td>
<td>• Expressway • Conventional</td>
<td>See Public Access to Lakes/Rivers</td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
<td>Sign Program and Facility-Specific Criteria</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>-------------</td>
<td>-----------------------------------------------</td>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Bookstore</td>
<td>D9-X6</td>
<td><img src="image" alt="GOOD READS Sign" /></td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Tourist Oriented Business</td>
</tr>
<tr>
<td>Bus Station</td>
<td>I-6</td>
<td><img src="image" alt="Bus Sign" /></td>
<td>1 1</td>
<td>• Expressway • Conventional</td>
<td>See Minor Traffic Generator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>This facility is a bus terminal with staffed ticket counters and public waiting rooms providing inter-city and inter-state motor coach bus services.</td>
</tr>
<tr>
<td>Business District</td>
<td>D1-X1</td>
<td><img src="image" alt="BUSINESS DISTRICT Sign" /></td>
<td>N/E 3</td>
<td>• Expressway • Conventional</td>
<td>See Downtown</td>
</tr>
<tr>
<td>Camping</td>
<td>E10-1</td>
<td><img src="image" alt="Camping Sign" /></td>
<td>N/E 10</td>
<td>• Freeway • Expressway</td>
<td>In addition to the criteria under the General Motorist Service Signing Program, the business shall meet the following requirements: 1. Have a State Department of Health license as required by Minnesota Statutes, Chapter 327.15. 2. Provide at least 20 spaces available for camping and parking. 3. Provide modern sanitary facilities (flush, chemical, or incinerator toilets). 4. Provide services 24-hours per day, seven days per week. 5. Be located within ten miles of the interchange via an all-weather road with adequate trailblazing signing provided by the operator to enable the traveler to reach the site. See Resorts for the Resort and Camping Signing Program defined by <a href="http://www.rentachamber.com/services/membership/">Minnesota Statute 160.283</a></td>
</tr>
<tr>
<td></td>
<td>D9-X4</td>
<td><img src="image" alt="Camping Sign" /></td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Recreational Camping Area See Resorts</td>
</tr>
<tr>
<td></td>
<td>D9-X6</td>
<td><img src="image" alt="Camping Sign" /></td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Recreational Camping Area See Resorts</td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
<td>-------------</td>
<td>-----------------------------------------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary</td>
<td>N/E = Not Eligible</td>
<td>Expressway &amp; Conventional</td>
<td></td>
</tr>
<tr>
<td>Camps, Private</td>
<td>Brown Custom Design</td>
<td>N/E</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This facility is generally a specialized, rural summer camp. It is operated or sponsored by church, fraternal, scouting, or similar organizations and is not open to the general public for overnight camping. The facility generally accommodates prearranged sessions of several days duration and is oriented toward recreation, education, training, or combinations thereof. Visitors are usually not familiar with the camp location.

In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply. The facility shall:
1. Provide full-time staff on site to accommodate clientele.
2. Be a private operation.
3. Accept prearranged accommodations only.
4. Not allow public, overnight camping.

For a seasonal camp, MnDOT may incorporated signing indicated periods of closure where appropriate.

Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casinos</td>
<td>Brown Custom Design</td>
<td>Treasure Island Casino</td>
<td>10 10</td>
<td>Freeway, Expressway, Conventional</td>
<td></td>
</tr>
<tr>
<td>Churches</td>
<td>D9-X6</td>
<td>NEW LIFE CHURCH LUTHERAN</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sign Program and Facility-Specific Criteria**

Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.

In order to be considered for signing, the following criteria shall be met by the requesting facility:

1. Events or activities shall be held continuously throughout the year.
2. Events or activities shall be non-local in scope and draw visitors from outside the local area.
3. The facility shall provide adequate on-site parking or parking in the immediate area of the facility.
4. The facility shall provide seating for at least 200 people.

The facility should be located within ten miles of the trunk highway intersection or interchange where signs are requested. Casino signs should be installed in accordance with all of the following:

1. Distances to casinos located two miles or more from the trunk highway intersection or interchange shall be shown on the sign.
2. Signs shall only be allowed from the nearest trunk highway and signs shall not be provided if the facility is readily visible or if effective off right-of-way directional signing is present or can be provided.
3. Additional proposed signing locations on other trunk highways are to be processed with MnDOT in accordance with the following procedures (developed and concurred with the Indian Affairs Council in 2003):
   a. The Tribe assembles the proposed signing package (road system map, locations of proposed signing, and casino business local panel design).
   b. The Tribe assembles the proposed signing package to the MnDOT District Engineer for evaluation (including field review of roadway network and existing signing). This may include coordination with local road authorities (county, city) if any proposed signing is to be installed on local roads.
   c. In order to assist in the decision making process, the MnDOT district office will contact the State Traffic Engineer and State Signing Engineer to field review the proposed signing locations.
   d. After completion of the field review and evaluation, MnDOT staff shall assemble a response package (sign panel designs, private sign company contracts, sign fabrication specifications) and meet with the Tribe to present MnDOT's proposed sign locations.
   e. Upon concurrence of acceptable sign locations by the Tribe, the Tribe shall submit completed application form(s) and business logo panel design to the District Traffic Engineer for review and approval.
   f. After approval by MnDOT, the Tribe shall submit sign panel designs, business logo panel design, and fabrication specifications to a private sign company(ies) for bid(s).
   g. The private sign vendor will invoice the Tribe and fabricate and deliver sign panel(s) to the Tribe.
   h. The Tribe coordinates with the MnDOT district office to arrange for installation of signs. Sign installation costs are to be paid for by the Tribe.
4. In place casino signs shall be replaced through attrition in accordance with both the general and above criteria. Existing casino signs should remain eligible for signing.

See Places of Worship
### Facility Type | Sign | Sign Design | # of Miles from an Intersection or Interchange | Roadway Type | Sign Program and Facility-Specific Criteria
--- | --- | --- | --- | --- | ---
Civic/Convention Centers | Green Custom Design | ![Sign Design](image) | 1 1 | • Expressway • Conventional | This facility accommodates various types of activities and is primarily oriented toward conventions, meetings, expositions, and performances. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply. The facility shall: 1. Hold events or activities that are non-local in scope and draw visitors from outside the local area. 2. Hold events or activities continuously throughout the year on an average of at least once a month (rural environment) and three times a month (urban environment). 3. Provide adequate on-site parking or parking in the immediate area of the facility. 4. Provide seating for at least 1000 people (urban environment). |
Colleges |  |  |  |  | See Educational Institutions |
Commodity Storage/Elevators | D9-X6 MINNESOTA GRAIN AND CORN | ![Sign Design](image) | N/E 15 | • Expressway • Conventional | See Specific Services - Rural Agricultural Business |
Community Centers |  |  |  | • Conventional | See Multi-Purpose Facilities |
Community Wayfinding | Custom Design | ![Sign Design](image) |  |  | Signs shall comply with the Community Wayfinding Signs section of the Minnesota Manual on Uniform Traffic Control (MN MUTCD), Part 2D.50 and the MnDOT policy found in Section 6-8.03 of the Traffic Engineering Manual (TEM). |
Correctional Institutions | Green Custom Design | ![Sign Design](image) | 3 3 | • Expressway • Conventional | This facility may be a state or federal penal institution that generates a significant number of non-local visitors. The general criteria for the Minor Traffic Generator Signing Program apply to this type of facility. |
County Fairgrounds | D7-X16 COUNTY FAIRGROUND | ![Sign Design](image) | 1 5 | • Expressway • Conventional | The general criteria for the Minor Traffic Generator Signing Program apply to this type of facility. |
Demolition Landfills |  |  |  |  | See Sanitary Landfills |
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
</table>
| Disc Golf Course              | D7-X22 | DISC GOLF COURSE             | N/E                                          | 10           | In addition to the general criteria for the **Minor Traffic Generator Signing Program**, all of the following criteria apply. The facility shall:  
1. Be its own entity located on its own property (not located on or in another facility that can be signed as a minor traffic generator).  
2. Have at least 18 holes.  
| Downtown                      | D1-X1  | BUSINESS DISTRICT            | N/E                                          | 3            | Signing may be provided to direct motorists to the primary business district of a rural city when a conventional highway does not pass through it.  
In addition to the general criteria for the **Minor Traffic Generator Signing Program**, all of the following criteria apply.  
1. Signing is allowed to designate the primary business center, NOT to designate any other business or shopping area.  
2. The signs shall use either the legend "DOWNTOWN" or "BUSINESS DISTRICT", based on the preference of the city administration.  
See also **Business District** |
| Drivers License/ Road Test Exam Stations | D1-X1a | DOWNTOWN                    | 1                                            | 3            | This facility shall be a permanent site.  
In addition to the general criteria for the **Minor Traffic Generator Signing Program**, all of the following criteria apply. The facility shall:  
1. Provide a complete staff, including road testing of drivers.  
2. Be an official facility operated or designated by the Minnesota Department of Public Safety. |
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Institutions</td>
<td>Pine Technical - Comm College</td>
<td>5</td>
<td>Freeway</td>
<td>All of the following criteria apply to the Educational Institution Signing Program.</td>
</tr>
<tr>
<td>(post secondary schools)</td>
<td>EXIT 169</td>
<td>10</td>
<td>Expressway</td>
<td>1. The school grants two or four-year degrees and is accredited by the North Central Association of colleges and schools. Examples are the University of Minnesota, state universities, state community colleges, private two and four-year colleges, private professional schools, private vocational schools, and technical colleges.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
<td>2. The minimum on-campus average daily student enrollment for credit shall be 400 students except in the Metro District where the minimum enrollment shall be 1500 students.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. In rural districts, schools which front directly on trunk highways may be allowed signs to assist the motorist in making proper entrance turns.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4. In the Metro District, signs shall only be allowed from the nearest trunk highway intersection. Signs directing motorist from one trunk highway to another trunk highway shall not be allowed.</td>
</tr>
<tr>
<td>Educational Institution signs</td>
<td></td>
<td></td>
<td></td>
<td>Educational Institution signs should be installed in accordance with the following:</td>
</tr>
<tr>
<td>should be installed</td>
<td></td>
<td></td>
<td></td>
<td>1. Signs on freeways shall have the institution name on the top line and EXIT XXX on the bottom line if the exit is numbered. If the exit is not numbered, the bottom line shall read NEXT (or SECOND) RIGHT.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Signs on freeway ramps shall display the institution name and appropriate arrow without extraneous legend.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Distances to schools located two miles or more from the trunk highway intersection or interchange shall be shown on the ramp or intersection sign.</td>
</tr>
<tr>
<td>Electric Vehicle (EV) Charging</td>
<td>EV-CHARGING</td>
<td>N/E</td>
<td>Freeway</td>
<td>EV charging stations must meet the following requirements:</td>
</tr>
<tr>
<td>Charging</td>
<td></td>
<td>2</td>
<td>Expressway</td>
<td>1. High powered charging station.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Located within 2 miles of the interchange.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Available to the public 12 hours per day 7 days per week.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>4. The route leading to the EV charging station and the charging station itself should be clearly identified with EV charging station signs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5. Parking spaces identified with regulatory signs for electric vehicle charging only.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>6. The EV charging station and parking facilities are lit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7. Installation and maintenance of trailblazing signs beyond the exit ramp and on site facility signing will be the responsibility of the local road authority and requester.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8. Trailblazing signs located on local roads may use either white legend on blue background or the D9-11b (alternate) symbol.</td>
</tr>
<tr>
<td>Fairgrounds</td>
<td>D9-X6</td>
<td>N/E</td>
<td>Expressway</td>
<td>See County Fairgrounds</td>
</tr>
<tr>
<td>Farm Implement Dealers</td>
<td>D9-X6</td>
<td>15</td>
<td>Conventional</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td>Feed, Seed, Fertilizer Stores</td>
<td>Logo Sign</td>
<td>N/E</td>
<td>Expressway</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>Conventional</td>
<td></td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
</tr>
<tr>
<td>---------------</td>
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<td>-------------</td>
<td>----------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Food</td>
<td>E10-1</td>
<td><img src="image" alt="E10-1" /></td>
<td>N/E 2 • Freeway • Expressway</td>
<td>Freeway • Expressway</td>
</tr>
<tr>
<td>Food</td>
<td>E10-6</td>
<td><img src="image" alt="E10-6" /></td>
<td>N/E 15 • Expressway • Conventional</td>
<td>Expressway • Conventional</td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Sign Program and Facility-Specific Criteria</td>
</tr>
<tr>
<td>---------------</td>
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<td>-------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Gas, Diesel, LP Gas, E85, Gasoline Service Stations</td>
<td>Logo Sign</td>
<td><img src="image" alt="Logo Sign" /></td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>E10-1</td>
<td><img src="image" alt="E10-1" /></td>
<td>N/E</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>E10-5</td>
<td><img src="image" alt="E10-5" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E10-10</td>
<td><img src="image" alt="E10-10" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E10-11</td>
<td><img src="image" alt="E10-11" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E10-12</td>
<td><img src="image" alt="E10-12" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D9-X6</td>
<td><img src="image" alt="D9-X6" /></td>
<td>N/E</td>
<td>15</td>
</tr>
</tbody>
</table>

- **Freeway**
- **Expressway**

For the **Logo Sign Franchise Program** refer to TEM 6-7.09.01 and [http://www.dot.state.mn.us/logosigns/](http://www.dot.state.mn.us/logosigns/)


Refer Applicants to: Dave DeSutter of Minnesota Logos, Inc.
- Toll Free: 800-769-3197, Phone: 952-895-8079
- Email: ddesutter@interstatelogos.com
- Website: [http://www.minnesota.interstatelogos.com/state/](http://www.minnesota.interstatelogos.com/state/)

In addition to the criteria under the **General Motorist Service Signing Program**, the business shall meet the following requirements:
1. Provide vehicle services including fuel and oil.
2. Provide restroom facilities and drinking water.
3. Provide continuous staffed operation for at least 12 hours per day, 7 days per week.
4. Provide public access to a telephone.
5. Be located within two miles of the interchange.

See **Specific Services - Gasoline Service Station**
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Motorist</td>
<td>E10-1</td>
<td><img src="image" alt="Sign Design" /></td>
<td>N/E</td>
<td>Freeway</td>
<td>General Motorist Service signs may be provided for all of the following (see each facility type for specific criteria): 1. Gas, Diesel, and/or alternative fuels (LP Gas, E85) 2. Food 3. Lodging 4. Camping 5. Hospitals In addition to the general criteria for all signing programs, the following criteria apply. 1. Signs may be installed at rural freeway and expressway interchanges. 2. Cost of fabrication, installation, and maintenance of the signs shall be paid by MnDOT. 3. If a business or effective advertising is visible at an interchange and the business requests signing, that service (gas, food, lodging or camping) will be signed based on the following: a. If there are in place General Motorist Service signs, the service will be added to in place signs if the service is not currently displayed. b. If there are no in place General Motorist Service signs, and there is space available, signs will be installed for only that type of service. Design of the mainline sign (font sizes and series for services and action line message) will be based on Standard Sign D9-18c E10-1.</td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange N/E = Not Eligible</td>
<td>Roadway Type</td>
<td>Sign Program and Facility-Specific Criteria</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>-------------</td>
<td>---------------------------------------------------------------</td>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Geological Markers</td>
<td>D7-X1</td>
<td>GEOLOGICAL MARKER 1/2 MILE ON LEFT</td>
<td></td>
<td>• Expressway • Conventional</td>
<td>The Geological Society of Minnesota (GSM), a non-profit corporation, has constructed and maintained geological markers throughout the state for many years. The markers consist of descriptive bronze plaques, approximately 24&quot; x 36&quot; mounted on stone work pedestals or walls. Many geological markers exist in MnDOT rest areas, wayside rests, scenic overviews, and/or wayside historical marker sites. The markers detail the geological significance of the area near their location. Signing of the sites began in 1997 and continues in accordance with the following guidelines. <strong>Criteria:</strong> 1. Sites shall be approved by the GSM. 2. Sites shall be easily accessible as part of a wayside development such as wayside rests, scenic overlooks, historical marker sites, adjacent city parks, or similar sites. 3. Sites within state parks shall not be signed. <strong>Signing Method:</strong> 1. Sites with geological markers only: a. Install advance sign D7-X1 GEOLOGICAL MARKER 1/2 MILE on RIGHT/LEFT. b. Install sign D7-X2 GEOLOGICAL MARKER with arrow at the entrance road or turnoff. 2. Sites located in other facilities (as listed above): a. Install sign D5-X1c beneath the in place advance sign. b. If there is no advance sign in place for the facility, install sign D5-X1c below the directional sign. 3. Sign fabrication, installation, and maintenance costs will be paid by MnDOT.</td>
</tr>
<tr>
<td></td>
<td>D7-X2</td>
<td>GEOLOGICAL MARKER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D5-X1c</td>
<td>GEOLOGICAL MARKER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gifts, Crafts, Art Sales</td>
<td>D9-X6</td>
<td>CRAFT KLATCH</td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See <strong>Specific Services - Tourist Oriented Business</strong></td>
</tr>
<tr>
<td>Golf Courses (public)</td>
<td>D7-X21</td>
<td>GOLF COURSE</td>
<td>3 10</td>
<td>• Expressway • Conventional</td>
<td>In addition to the general criteria for the <strong>Minor Traffic Generator Signing Program</strong>, all of the following criteria apply. The facility shall: 1. Have at least nine holes. 2. Be open to the public. See also <strong>Miniature Golf/Driving Ranges</strong>, and <strong>Disc Golf Course</strong>.</td>
</tr>
<tr>
<td>Brown Custom Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
<td>Sign Program and Facility-Specific Criteria</td>
</tr>
<tr>
<td>--------------</td>
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<td>-----------------------------------------------</td>
<td>-------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Great River Road Amenity Sites</td>
<td>M1-X1 Brown Custom Design</td>
<td><img src="image" alt="Paul Bunyan Logging Museum" /></td>
<td>1 3</td>
<td>• Expressway • Conventional</td>
<td>This facility includes parks, boat/canoe access sites, picnic areas, campsites, historic sites, and other points of interest that are directly related to the officially designated national Great River Road (GRR) route. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply for a GRR amenity site: 1. Only those sites directly tied to the national GRR system and identified on GRR maps or brochures may be signed. 2. The sign format and size shall be determined by MnDOT’s Office of Traffic Engineering. 3. The district traffic office should coordinate sign requests with the Office of Environmental Services.</td>
</tr>
<tr>
<td>Greenhouses</td>
<td>D9-X6</td>
<td><img src="image" alt="GREENHOUSE PLANTING" /></td>
<td>N/E 15</td>
<td>• Expressway • Conventional</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td>High Schools</td>
<td>D7-X19</td>
<td><img src="image" alt="HIGH SCHOOL" /></td>
<td>1 3</td>
<td>• Expressway • Conventional</td>
<td>This is a multi-purpose facility which hosts a variety of activities throughout the year. Some of these facilities may have a remote stadium or athletic complex which generates traffic and also qualifies for signing. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply. The facility shall: 1. Hold events or activities that are non-local in scope and draw visitors from outside the local area. 2. Provide adequate on-site parking.</td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
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<td>-----------------------------------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Historic District</td>
<td>D7-X11a Brown Custom Design</td>
<td>1 10</td>
<td>Expressway  Conventional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sign Program and Facility-Specific Criteria**

Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.

Listing in the National Register of Historic Places means that the district has been judged by professional historians to be worthy of preservation because its significance speaks to the broad themes of human history and because it retains enough integrity to accurately document that experience. Historic Districts so listed are worthy of public attention and serve the useful purpose of cultural heritage education.

In addition to the general criteria for the **Minor Traffic Generator Signing Program**, the following criteria apply:

1. Requests for signs will be accepted from a local government agency.
2. Requests for directional signage shall include:
   a. Location: Historic District boundaries must be distinguishable through local street signage. The application must include a map of the district and photographic evidence of distinguishing signage.
   b. Interpretation: Historic Districts shall provide information regarding the district in a publicly accessible location within the district such as a self-service kiosk or welcome center. A copy of that information must be included with the application. The information must supplement the National Register nomination with new information.
3. Requests for signing of Historic Districts shall be submitted to the State Signing Engineer, OTE. These requests shall be forwarded to the Minnesota Historical Society (MHS) for recommendations. The MHS recommendations shall govern MnDOT’s approval or denial of requests.
4. The Historic District shall be listed in the National Register of Historic Places, a federal program of the National Park Service. The MHS will confirm whether a district is listed.

**Signing Method:**

1. A city could potentially qualify for a Downtown or Business District sign and a Historic District sign. The Historic District may or may not include the whole city. Therefore, directions to different locations may be required. Signing for both would be accepted if both qualify and there is space. If spacing is an issue, both requests could be combined on the same sign if signed at the same trunk highway intersection.
2. Three sizes of Historic District signs have been developed and included in the Standard Signs and Markings Manual.
3. Optional guide signs (other than the standard sign design) may be used:
   a. “[City Name] Downtown & Historic District”
   b. “[City Name] Historic & Business District” with directional arrow(s)
### Historical Markers and State Monuments

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Urban</th>
<th>Rural</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1. Minnesota Historical Society (MHS) sites and monuments:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a. Requests for signing to State historical markers and monuments maintained by the MHS shall be submitted to the State Signing Engineer, OTE.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>b. All costs for MHS historical marker and monument signs shall be paid by MnDOT.</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td>2. Non-MHS sites and monuments:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a. Requests for the signing of non-MHS historical markers and monuments shall be submitted to the State Signing Engineer, OTE. These requests shall be forwarded for the MHS for recommendations. The MHS recommendations shall govern MnDOT’s approval or denial of the request.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>b. A historical marker or monument shall:</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>I. Document a topic with historical significance. Fifty years is a general rule of thumb of the time required to develop historical perspective and to establish significance. Topics that explain the recent past shall be exceptionally significant to be considered for approval. To establish significance, requesters should explain why a topic played a role or why it made a difference in the context of local, regional, or state history. Requesters shall provide a copy of the text and a photograph of the historical marker. As a general rule, signing shall not be approved for historical markers or monuments that represent ubiquitous historical phenomena or places that were common everywhere. Examples of these places include: the sites of towns, communities, or settlements that no longer exist; the birthplaces or grave sites of significant individuals; and cemeteries.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>II. Be located on public land and accessible to the public.</td>
</tr>
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<td>III. Be legible using letters at least 5/8 inches high (typically a font size 22 or greater).</td>
</tr>
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<td>c. The requester shall be responsible for maintaining and ensuring access to the historical marker or monument.</td>
</tr>
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<td></td>
<td>d. There shall be at least three year-round parking spaces located off the road or street. Within city limits, parking spaces may be located on-street.</td>
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<td></td>
<td>e. All costs shall be paid by the requester.</td>
</tr>
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<td></td>
<td>f. See National Monuments as applicable.</td>
</tr>
</tbody>
</table>

- **D5-X1b**
  - **Sign Design**: HISTORICAL MARKER
  - **# of Miles from an Intersection or Interchange**: 1
  - **Urban**: 10

- **D7-X5**
  - **Sign Design**: HISTORICAL MARKER 1/2 MILE ON RIGHT

- **D7-X6**
  - **Sign Design**: HISTORICAL MARKER
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary</td>
<td>N/E = Not Eligible</td>
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<td>Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.</td>
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</table>

- **Historic Sites**
- **D7-X5a**
  - **Sign Design**: Historic Site 1/2 Mile On Right
  - **# of Miles from an Intersection or Interchange**: 1
  - **Urban**: 1
  - **Rural**: 10
  - **Roadway Type**: Expressway, Conventional
  - **Sign Program and Facility-Specific Criteria**: In addition to the general criteria for the **Minor Traffic Generator Signing Program**, requests for signing of historic sites shall be submitted to the State Signing Engineer, OTE. These requests shall be forwarded to the Minnesota Historical Society (MHS) for recommendations. The MHS’s recommendations shall govern MnDOT’s approval or denial of the request.
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<tr>
<th>Facility Type</th>
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<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th># of Miles from N/E = Not Eligible</th>
<th>Roadway Type</th>
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</table>

In addition to the general criteria for all signing programs, the following criteria apply.

1. Hospitals requesting signing shall meet all of the following criteria:
   a. Accept all emergency cases without discrimination for any reason (including ability to pay).
   b. Be readily accessible from the nearest intersection or interchange (normally within a ten mile radius).
   c. Provide 24-hour emergency medical care with a physician on the premises (metropolitan area) or on-call (rural areas).
2. The costs of fabrication, installation, and maintenance of signs shall be paid by MnDOT.
3. Signing directing motorists from one trunk highway onto another may be allowed if the facility is within ten miles of the intersection of the two trunk highways. Signs directing motorists from one freeway to another freeway shall not be allowed.
4. In place EMERGENCY HOSPITAL signs shall be removed through attrition and replaced with HOSPITAL signs. Mainline signing and ramp signing at an interchange shall be replaced at the same time.
5. HOSPITAL signs should be installed in accordance with the following:
   a. Interchange signs E10-1, E10-3, E10-4, and E10-8
      I. General Motorist Service signs (E10-1) in place, the word HOSPITAL (E10-1 Supplement) may be included on the General Motorist Service sign if the word CAMPING is not displayed.
      II. At urban or rural interchanges where General Motorist Services are not signed, the E10-3 sign shall be installed at the interchange nearest the hospital. The appropriate signing (E10-4 or E10-8) shall be installed on the ramp(s).
      III. If the hospital is located less than two miles from an interchange, the E10-8 sign shall be installed on the ramp(s). If the hospital is located two miles or more from an interchange, the E10-4 sign shall be installed on the ramp(s).
      IV. Trailblazing signs on trunk highways shall display the number of miles in one mile increments (E10-8 or E10-4 if mileage is required).
      V. Trailblazing signs (D9-2a) on local roads shall display the number of blocks from the trunk highway to the facility.
   b. At-grade intersection signs (D9-2a and D9-2b)
      I. The D9-2b sign shall be ground-mounted in advance of the intersection (or on a traffic signal mast arm at the intersection) with the road leading to the hospital.
      II. Trailblazing signing (D9-2a) on trunk highways and/or local roads shall display either the number of blocks or miles (in one mile increments) to the facility. Trailblazing signs on local roads directing motorists to the facility shall display the appropriate distance and arrow.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Sign Program and Facility-Specific Criteria</th>
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<td>Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary</td>
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<td>Facility Type</td>
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<td>These traffic generators are major regional attractions, events, or facilities which attract persons or groups from beyond a local community, city, or metropolitan area. They are significant because of their unique educational, cultural, historical, or recreational experience and public appeal. Predominately retail, business or manufacturing centers are not normally eligible for signing. The business shall meet the following criteria: 4. Parking for at least 1000 vehicles. 5. A minimum of ten events per year. 6. Average event attendance of at least 5000 persons.</td>
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<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
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<td>Mall</td>
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<td>Marina, Boat Launch, Guide Service</td>
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<td><img src="image" alt="ROUGHWATERSMARINA" /></td>
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<td>Miniature Golf and Driving Range</td>
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<td><img src="image" alt="PUTTPUTTCOUNTRYCLUB" /></td>
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</tbody>
</table>

Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.
### Facility Type
- Minor Traffic Generators

### Sign Design
- Standard Sign
- Brown Custom Design
- Green Custom Design

### Sign Program and Facility-Specific Criteria

#### Urban Environment - typical characteristics are highly developed areas having slower speeds, higher proportion of local traffic, increased difficulty in finding acceptable locations for traffic signs, and a more complicated driving environment.

#### Rural Environment - typical characteristics are relatively undeveloped or agricultural lane, higher speeds, higher proportion of non-local traffic, easy ability to find acceptable locations for traffic signs, and relatively uncomplicated driving environment. Small cities in otherwise rural areas are included in this definition.

#### Sign Program and Facility-Specific Criteria

- Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.

### Roadway Type
- Expressway
- Conventional

### # of Miles from an Intersection or Interchange
- N/E = Not Eligible

### Highway Facilities
- Sign Design
- Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th># of Miles from a Intersection or Interchange</th>
<th>Roadway Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor Traffic</td>
<td>Standard Sign</td>
<td>Varies</td>
<td>Expressway</td>
</tr>
<tr>
<td></td>
<td>Brown Custom Design</td>
<td>Varieties</td>
<td>Conventional</td>
</tr>
<tr>
<td></td>
<td>Green Custom Design</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minor traffic generators are facilities that generally attract non-local persons or groups unfamiliar with the location of the generator but do not qualify as major traffic generators. The use and installation of highway signing shall be limited to only those generators which have broad motorist appeal, serve non-familiar motorists, or are the kind of facility for which a motorist normally expects highway signing.

In addition to the general criteria for all signing programs, the following criteria apply for the Minor Traffic Generator Signing Program.

1. Minor Traffic Generator signs may be installed on conventional highways, at at-grade intersections on expressways, and on rural bypasses that have interchanges at non-trunk highways. In order to be considered for signing, the following criteria must be met by the minor traffic generator requesting signing:
   a. Unless specified otherwise, facilities shall be open at least 40 hours per week and a minimum of five days per week.
   b. For seasonal generators, MnDOT may incorporate signing indicating periods of closure where appropriate.
   c. Signing shall not be permitted within the corporate limits of one city directing motorists to a facility located in another city.
   d. Generators shall be located within specified distances from the trunk highway intersection or interchange at which signing is permitted. These distances vary depending on the type of generator and whether the signed intersection is located within an urban or rural environment.
      i. Urban Environment - typical characteristics are highly developed areas having slower speeds, higher proportion of local traffic, increased difficulty in finding acceptable locations for traffic signs, and a more complicated driving environment.
      ii. Rural Environment - typical characteristics are relatively undeveloped or agricultural lane, higher speeds, higher proportion of non-local traffic, easy ability to find acceptable locations for traffic signs, and relatively uncomplicated driving environment. Small cities in otherwise rural areas are included in this definition.
   e. The local governing body(ies) shall prioritize which facilities may be signed when MnDOT determines that the number of qualifying generators that a community is requesting signing for cannot all be accommodated on signing at the same intersection due to driver information overload and sign spacing guidelines.

2. Signs shall only be allowed from the nearest trunk highway intersection. **Signs may be allowed from two trunk highways if they serve different travel directions (i.e. north-south and east-west).** Signs directing motorists from one trunk highway to another trunk highway shall not be allowed.

3. Signing shall not be provided if the facility is readily visible or if effective off right-of-way directional signing is present or can be provided. Visibility from the approach to an intersection may be determined by adding 175 feet to Condition B (deceleration to 10 mph from the posted speed) in MN MUTCD Table 2C-4. Signing is not allowed if the facility can be readily identified or if effective off highway right-of-way directional signing is legible at or beyond this distance.

Minor Traffic Generator Signs should be designed in accordance with the following:

1. Distances to generators are to be shown in one-mile increments.
2. When designing sign panels to be installed on rural expressways for private minor generators:
   a. Use the appropriate chart (Charts 6.1A, 6.1B, or 6.1C in MnDOT’s Traffic Engineering Manual) to determine the required font size for guide signs on expressways.
   b. The next smaller font size may be used to design the sign panels for private generators if existing guide signing to other private generators on the highway section were designed with one font size smaller than that specified in the charts.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign Design</th>
<th>Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary</th>
<th># of Miles from an Intersection or Interchange</th>
<th>N/E = Not Eligible</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Urban</td>
<td>See Lodging</td>
</tr>
<tr>
<td>Multi-Purpose Facilities</td>
<td>Green Custom Design</td>
<td>COMMUNITY CENTER</td>
<td>N/E</td>
<td>3</td>
<td>Conventional</td>
<td>The general criteria for the Minor Traffic Generator Signing Program apply to this type of facility. This facility includes but is not limited to public community centers and National Guard Armories. A public community center is a public building designed for a community’s social, cultural, educational, and recreational activities. A National Guard Armory is a facility where arms and military equipment are stored and/or is used for training military reserve personnel. It is frequently used for other public purposes.</td>
</tr>
<tr>
<td>Museum</td>
<td>Brown Custom Design</td>
<td>COUNTY MUSEUM</td>
<td>1</td>
<td>4</td>
<td>Conventional</td>
<td>In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply: 1. Requests for signing shall be submitted to the State Signing Engineer, OTE. These requests shall be forwarded to the Minnesota Historical Society (MHS) for recommendations. The MHS recommendations shall govern MnDOT’s approval or denial of the requests. 2. Seasonal museums may qualify but shall have a CLOSED plaque installed on signs during the months that they are not open for business. 3. A non-profit museum is required to be a Federal Tax Exempt Organization, Internal Revenue Code [IRC] 501(c)(3).</td>
</tr>
<tr>
<td>National Monuments</td>
<td>Brown Custom Design</td>
<td>Pipestone National Monument 1/4 MI ON LEFT</td>
<td>15</td>
<td>15</td>
<td>Freeway</td>
<td>General Criteria Only</td>
</tr>
<tr>
<td>Orchards/Produce Sales</td>
<td>D9-X6</td>
<td>EVERGREEN FIELD AND FARM</td>
<td>N/E</td>
<td>15</td>
<td>Expressway</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td>Outlet Malls</td>
<td>Green Custom Design</td>
<td>Albertville Outlet Center EXIT 201</td>
<td>2</td>
<td>2</td>
<td>Freeway</td>
<td>In order to be considered for signing, all of the following criteria shall be met by the outlet mall: 1. At least 400,000 square feet of retail floor space available for lease. 2. Minimum of 100 stores. 3. Primary function of the mall is to house tenants who are manufacturers that sell their stock directly to the public. 4. Located outside of the downtown or central business district except in the Metro District.</td>
</tr>
</tbody>
</table>

Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary</td>
<td>N/E = Not Eligible</td>
<td>Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.</td>
</tr>
<tr>
<td>Urban</td>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parks (City, County, Regional)</td>
<td>D7-X10</td>
<td>CITY PARK</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1. The facility shall meet Minnesota Department of Health standards regarding water supply and restroom facilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. The facility shall be maintained in a sanitary and park-like condition.</td>
</tr>
<tr>
<td>Brown Custom Design</td>
<td>D7-X15</td>
<td>COUNTY PARK</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Conventional</td>
</tr>
<tr>
<td>Parks (National)</td>
<td>Brown Custom Design</td>
<td>Voyageurs National Park</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply. The facility shall:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1. Meet Minnesota Department of Health standards regarding water supply and restroom facilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Be maintained in a sanitary and park-like condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Have water, restrooms, and picnic areas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4. Have accommodations for at least 35 overnight camp sites.</td>
</tr>
<tr>
<td>Parks (State)</td>
<td>D7-X9</td>
<td>STATE PARK</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Expressway</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Conventional</td>
</tr>
<tr>
<td>Brown Custom Design</td>
<td>D7-X9</td>
<td>Lindbergh State Park</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Expressway</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Conventional</td>
</tr>
<tr>
<td>Places of Worship</td>
<td>D9-X6</td>
<td>NEW LIFE CHURCH LUTHERAN</td>
<td>N/E</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Conventional</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>See Specific Services - Places of Worship</td>
</tr>
<tr>
<td></td>
<td>Logo Sign</td>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Refer Applicants to: Dave DeSutter of Minnesota Logos, Inc. Toll Free: 800-769-3197, Phone: 952-895-8079 Email: <a href="mailto:ddesutter@interstatelogos.com">ddesutter@interstatelogos.com</a> Website: <a href="http://www.minnesota.interstatelogos.com/state">http://www.minnesota.interstatelogos.com/state</a></td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>-------------</td>
<td>---------------------------------------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| Public Access to Lakes/Rivers | D7-X7 | Lobster Lake | 1 | • Expressway | See Section 21.5.1 of the MN MUTCD for Public Water Access Signs including the Minnesota Department of Natural Resources (DNR) sign (DNR NRM 8.2.35).
| | D7-X7a | Lobster Lake | 10 | • Conventional |
| Local Roads | D7-X8 |  |  | |
| | D7-X8A |  |  | |
| | DNR Sign | DNR NRM 8.2.35 |  | |
| Public Office Buildings | Green Custom Design | Dakota County Government Center | 1 | • Expressway | This facility includes public administrative offices (federal, state, and local) where the general public visits on a regular basis to conduct business.
| | Recreational Rentals: Bikes, Boats, Canoes, Jet Skis, Snowmobiles | STEWART’S JET BOATS | N/E | • Conventional | See Specific Services - Tourist Oriented Business |

Note: Sign #’s refer to designation in the MnDOT Standard Signs and Markings Summary.

N/E = Not Eligible

The general criteria for the **Minor Traffic Generator Signing Program** apply to this type of facility.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
</table>
| Recycling Centers | D1-X6 | Recycling Center | 1 5 | • Expressway  
• Conventional | This facility shall comply with the permit rules of, and be officially designated by, the Minnesota Pollution Control Agency (MPCA). Reference Minnesota Statute 173.086 and 115A.555.  
In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply for a recycling center. The facility shall:  
1. Be open to receive materials at least 12 hours per week, 12 months per year.  
2. Accept at least four different types of recyclable materials.  
3. Comply with Minnesota Rule 7035.2845 regarding the permitting of recycling facilities. |
| | Green Custom Design (no symbol) | | | | |
| Regional Human Services/Treatment Centers | Green Custom Design | | 1 3 | • Expressway  
• Conventional | This is a public treatment facility operated by the Minnesota Department of Human Services. Reference Minnesota Statutes Chapters 252, 253, and 254.  
The general criteria for the Minor Traffic Generator Signing Program apply to this type of facility. |
| Regional Shopping Centers | Green Custom Design | Maplewood Mall Exit 50 | 2 2 | • Freeway  
• Expressway  
• Conventional | In order to be considered for signing, all of the following criteria shall be met by the regional shopping center:  
1. At least 600,000 square feet of retail floor space, all under one roof, available for lease.  
2. At least two major department stores owned by a national or regional chain organization.  
3. Located outside of the downtown or central business district, except in the Metro District. |
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resorts</td>
<td>D9-X3</td>
<td>← RESORTS →</td>
<td>N/E</td>
<td>Expressway</td>
<td>Resort and Camping Signing Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
<td>Signs direct the motorist to campgrounds or resorts in rural areas where the Advertising Regulation Law has restricted the installation of private advertising signs off the highway right-of-way. These signs may only be installed where resort information (or County Slat Sign Program) are in place on local roads in accordance with Minnesota Statutes 160.283-160.285. See Figure 6.26. In addition to the general criteria for all signing programs, the following criteria apply: 1. Signs may be installed in rural areas on conventional highways and at at-grade intersections on expressways. 2. Signs shall only be allowed from the nearest trunk highway intersection. Signs directing motorists from one trunk highway to another trunk highway shall not be allowed. 3. The cost of fabrication, installation, and maintenance of the signs shall be paid by MnDOT. 4. One guide sign from each direction in advance of a private road or entrance is allowed when the following conditions exist: a. The main access from the trunk highway is via a private road or entrance. b. The resort or campground is located near, but not visible from, the trunk highway. c. The sign located on private property cannot be effectively seen by approaching drivers because of the width of the highway right-of-way and/or growth of vegetation. 5. Where the access to resorts or private campgrounds is via county, township, or other public road, and the road is identified with a road name or destination sign, the sign panel or panels may be combined with the in place sign. Minimum height to the bottom of the lowest sign panel shall be seven feet. 6. Businesses signed under this signing program shall not be signed under the Specific Service Signing Program. Normally, these signs are installed where SPECIFIC SERVICE signs are not erected at intersections. 7. Resorts shall have a State Department of Health license as required by Minnesota Statute 157.16. A resort is defined in Minnesota Statute 157.15, subd. 11. 8. Private campgrounds shall have a State Department of Health license as required by Minnesota Statute 327.15, modern sanitary facilities (flush, chemical, or incinerator toilets), and no restrictions on type of camping (tent, RV, trailer, etc.).</td>
</tr>
<tr>
<td></td>
<td>D9-X4</td>
<td>← CAMPING →</td>
<td></td>
<td>Expressway</td>
<td>See Specific Services - Resorts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
<td></td>
</tr>
<tr>
<td>Riding Stable</td>
<td>D9-X6</td>
<td>← 4 PINE RESORT →</td>
<td>N/E 15</td>
<td>Expressway</td>
<td>See Specific Services - Tourist Oriented Business</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D9-X6</td>
<td>← COWGIRL RIDING STABLE →</td>
<td>N/E 15</td>
<td>Expressway</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
<td></td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
<td>Sign Program and Facility-Specific Criteria</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------</td>
<td>-------------------------</td>
<td>-----------------------------------------------</td>
<td>--------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Sanitary Landfills</td>
<td>D1-X3</td>
<td><img src="image" alt="SANITARY LANDFILL" /></td>
<td>3</td>
<td>Urban 5</td>
<td>These facilities shall be approved by the Minnesota Pollution Control Agency (MPCA). MPCA literature refers to a household hazardous waste site as a HHW Center. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply: 1. The facility shall be open to the public as well as commercial and governmental users. 2. Compost sites shall not be signed.</td>
</tr>
<tr>
<td>Solid Waste Transfer Stations</td>
<td>D1-X7</td>
<td><img src="image" alt="SOLID WASTE TRANSFER STATION" /></td>
<td>5</td>
<td>Rural 3</td>
<td>These facilities shall be approved by the Minnesota Pollution Control Agency (MPCA). MPCA literature refers to a household hazardous waste site as a HHW Center. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply: 1. The facility shall be open to the public as well as commercial and governmental users. 2. Compost sites shall not be signed.</td>
</tr>
<tr>
<td>Household Hazardous Waste Sites</td>
<td>D1-X7</td>
<td><img src="image" alt="HHW CENTER" /></td>
<td>3</td>
<td>Urban 5</td>
<td>These facilities shall be approved by the Minnesota Pollution Control Agency (MPCA). MPCA literature refers to a household hazardous waste site as a HHW Center. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply: 1. The facility shall be open to the public as well as commercial and governmental users. 2. Compost sites shall not be signed.</td>
</tr>
<tr>
<td>Demolition Landfills</td>
<td>D1-X8</td>
<td><img src="image" alt="DEMOLITION LANDFILL" /></td>
<td>5</td>
<td>Urban 5</td>
<td>These facilities shall be approved by the Minnesota Pollution Control Agency (MPCA). MPCA literature refers to a household hazardous waste site as a HHW Center. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply: 1. The facility shall be open to the public as well as commercial and governmental users. 2. Compost sites shall not be signed.</td>
</tr>
<tr>
<td>Scientific and Natural Areas</td>
<td>Brown Custom Design</td>
<td><img src="image" alt="Carpenter Nature Area" /></td>
<td>1</td>
<td>Expressway 10</td>
<td>These facilities offer various types of displays in a natural setting. They are developed by the Department of Natural Resources or other state or federal agencies. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply: 1. The facility shall provide viewing areas. 2. The facility should provide: a. Parking for at least 20 vehicles. b. An on-site explanation (audio, visual, or staff person) of the subject matter. c. Restroom facilities.</td>
</tr>
<tr>
<td>Schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>See Educational Institutions or High Schools</td>
</tr>
</tbody>
</table>

Unless otherwise indicated, the General Criteria apply for all facilities. See MnDOT’s Traffic Engineering Manual for placement of signs.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
</table>
| Ski Areas           | D7-X13 | ![D7-X13](image_url) | 5 10                                           | • Expressway  
• Conventional | This is a public or private winter recreational site which provides downhill and/or cross-country skiing.  
In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply for a ski area:  
1. The facility shall be open to the public.  
2. The facility should provide parking for at least 100 vehicles at downhill sites and at least 30 vehicles at cross-country sites.  
3. Downhill skiing facilities shall provide adequate staff in case of an emergency.  
4. Cross-country facilities shall have trails which are maintained with trail guide signs or maps placed at key locations indicating location and distances.  
5. The message on the ski area signs shall be as follows:  
a. Trunk highway signing: SKI AREA or name of ski area with left (right) arrow at an intersection or NEXT RIGHT at an interchange.  
b. Local road trailblazing signing: downhill symbol sign (D7-X13) or cross-country symbol sign (D7-X14) with appropriate arrow. |
|                     | D7-X14 | ![D7-X14](image_url) | Brown Custom Design | See Sanitary Landfills |
|                     | Brown Custom Design | ![Brown Custom Design](image_url) | | |
| Solid Waste Transfer Stations | D9-X6 Series | ![D9-X6 Series](image_url) | N/E 15 | • Expressway  
• Conventional | See the Traffic Engineering Manual, Chapter 6, for more information on the history of the Specific Signs Program in Minnesota and for definitions, sign installations, and sign panel design. See the last page of this appendix for a list of ineligible facilities. |
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star Lake or River Sign</td>
<td></td>
<td><img src="image" alt="Star Lake Sign" /></td>
<td>N/E = Not Eligible</td>
<td>• Expressway • Conventional</td>
<td>Before installing signs along county, city, or township roads, permission must be granted by the road authority. Before installing signs at boat landings or other public or private facilities, written permission must be granted by the facility owner. The requirements for installing signs on state highways are as follows: 1. Signs shall be fabricated and installed by MnDOT. 2. The cost of fabrication, installation, and maintenance shall be paid by the requester. Maintenance includes replacing damaged or missing signs, and replacement of signs that have reached the end of their useful life (expected life of a sign panel is 12-15 years). 3. One sign may be erected at each approach to a lake or river within the right-of-way of an interstate or other highway that passes over a lake or river in the Department of Transportation’s eight-county metropolitan district or near or over a lake or river in greater Minnesota. 4. Signs shall not be installed contrary to other federal and state highway sign standards. 5. The 24” X 12” sign may be installed below existing named river or lake standard guide signs on the post furthest from roadway. The Variable X 36” sign may be installed in lieu of the river or lake standard guide sign on conventional roadways. More information regarding MN Star Lakes and Rivers can be found here: <a href="http://www.starlakes.org/home.html">http://www.starlakes.org/home.html</a></td>
</tr>
</tbody>
</table>

### State Recreational Areas

See Parks (State)

### Tourist Information

<table>
<thead>
<tr>
<th>Sign</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>D9-10a</td>
<td>1</td>
<td>• Expressway • Conventional</td>
<td>In addition to the general criteria for all signing programs, Tourist Information signs may be installed on conventional highways, at at-grade intersections on expressways, and on rural bypasses that have interchanges at non-trunk highways. In order to be considered for signing, all of the following criteria must be met: 1. Only Office of Tourism sites may be signed. 2. Requests shall only be accepted from a community group (e.g. Chamber of Commerce), business association, or governmental unit. 3. Only one site in a city or area may be approved for signing. 4. A sign shall be in place on the outside of the facility, clearly stating the operator and means of contact. 5. If the facility is operated seasonally, the signs shall be removed, covered, or the closure clearly indicated.</td>
</tr>
<tr>
<td>D9-10</td>
<td>3</td>
<td>• Expressway • Conventional</td>
<td></td>
</tr>
</tbody>
</table>

### Travel Information Center

Contact MnDOT’s Office of Traffic Engineering at [www.dot.state.mn.us/trafficeng/index.html](http://www.dot.state.mn.us/trafficeng/index.html) for assistance with signing for MnDOT Travel Information Centers.
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
</table>
| Township Hall | D1-X9 | TOWN HALL | 2 Urban 2 Rural | Expressway  Conventional | In addition to the General Criteria in the Minor Traffic Generator Signing Program, the following criteria apply. The facility:  
1. Shall hold monthly meetings that are open to the public. Township halls are not required to be open eight hours per day, five days per week.  
2. Shall be primarily intended for use as a town hall.  
3. Should provide adequate on-site parking or parking in the immediate area.  
4. Shall post contact information that is visible from the exterior of the building.  
Signing Method:  
1. All costs associated with township hall signing shall be paid by the township.  
2. The sign shall have the legend “TOWN HALL” with directional arrow.  
3. If a township hall is in close proximity to another township hall, and the district traffic engineer determines that using the standard sign could be confusing for motorists, the name of the township may be included on the sign. |
|               |      | Green Custom Design | 10 Urban 10 Rural | Freeway  Conventional | Signing may be permitted for access points to major recreational trails having improved and well maintained surfaces for hiking, biking, etc. All trails shall provide complete marking or trail maps for user guidance.  
In addition to the general criteria for all signing programs, the following criteria apply:  
1. Trail Access signs may be installed on all trunk highways, except in the Metro District where signs shall not be installed on freeways.  
2. Parking shall be provided at the site or within the immediate vicinity. The parking facility shall be surfaced and maintained year-round. Parking shall be provided for at least 40 vehicles at freeway signed sites and at least 20 vehicles at other sites. Smaller lots are acceptable at remote areas with the approval of the district traffic engineer.  
3. The minimum trail length shall be five miles.  
4. All requests for signing to DNR provided public trails shall be approved by the DNR and MnDOT. Signing for other trails is at the discretion of MnDOT.  
Signing Method:  
1. Signing shall only be allowed from the nearest trunk highway intersection or interchange. Signs directing motorists from one trunk highway to another trunk highway shall not be allowed.  
2. The format of the Trail Access signs should be as follows:  
a. Freeway - the official trail name and the freeway exit number.  
b. Expressway interchanges - the official trail name and the message NEXT RIGHT  
c. At-grade intersections - the official trail name, the word ACCESS and a directional arrow. |
<p>| Trail Access  |      | Brown Custom Design | 10 Urban 10 Rural | Freeway  Conventional | See Specific Services – Tourist Oriented Business |
|               |      |                      | N/E | 15 Urban 15 Rural | Expressway  Conventional | See Specific Services – Rural Agricultural Business |
|               |      |                      | N/E | 15 Urban 15 Rural | Expressway  Conventional | See Educational Institutions |</p>
<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Sign</th>
<th>Sign Design</th>
<th># of Miles from an Intersection or Interchange</th>
<th>Roadway Type</th>
<th>Sign Program and Facility-Specific Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterans and War Memorials</td>
<td>Brown Custom Design</td>
<td><img src="image1" alt="Korean War Memorial" /></td>
<td>N/E 15</td>
<td>Urban Rural</td>
<td><strong>Expressway</strong>&lt;br&gt;<strong>Conventional</strong>&lt;br&gt;This is an independently located outdoor site built to commemorate veterans of U.S. military actions and/or the actions themselves. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply:&lt;br&gt;1. The facility shall provide adequate on-site parking or parking in the immediate area of the memorial.&lt;br&gt;2. The facility should:&lt;br&gt;a. Be of a unique size and presence.&lt;br&gt;b. Be easily available for public viewing.&lt;br&gt;c. Not be part of any other building or facility.</td>
</tr>
<tr>
<td>Veterinary Clinics</td>
<td>D9-X6</td>
<td><img src="image2" alt="PETS VETS" /></td>
<td>N/E 15</td>
<td>Urban Rural</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td>Welding and Machine Shops for Agricultural Equipment</td>
<td>D9-X6</td>
<td><img src="image3" alt="WEST WELDING" /></td>
<td>N/E 15</td>
<td>Urban Rural</td>
<td>See Specific Services - Rural Agricultural Business</td>
</tr>
<tr>
<td>Wildlife Park/Animal Park</td>
<td>D9-X6</td>
<td><img src="image4" alt="SAFARI MINNESOTA" /></td>
<td>N/E 15</td>
<td>Urban Rural</td>
<td>See Specific Services – Tourist Oriented Business</td>
</tr>
<tr>
<td>Wildlife Refuges and Wildlife Management Areas</td>
<td>Brown Custom Design</td>
<td><img src="image5" alt="Cormorant Lake Wildlife Refuge" /></td>
<td>1 10</td>
<td>Urban Rural</td>
<td><strong>Expressway</strong>&lt;br&gt;<strong>Conventional</strong>&lt;br&gt;This is a facility which is open to the public and offers viewing of a variety of wildlife. In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply:&lt;br&gt;1. The facility shall provide interpretive facilities or programs or provide viewing areas or nature trails.&lt;br&gt;2. The facility should provide:&lt;br&gt;a. Parking for at least 20 vehicles in rural areas and at least 50 vehicles in urban areas.&lt;br&gt;b. Restroom and telephone facilities.</td>
</tr>
<tr>
<td>Workforce Centers</td>
<td>D7-X18</td>
<td><img src="image6" alt="WORKFORCE CENTER" /></td>
<td>1 3</td>
<td>Urban Rural</td>
<td><strong>Expressway</strong>&lt;br&gt;<strong>Conventional</strong>&lt;br&gt;This facility is formed through a partnership between locally based community, county, and state agencies that the general public visits on a regular basis to obtain employment and training services. In addition to the general criteria for the Minor Traffic Generator Signing Program, the facility shall have adequate on-premise signing visible to the motorist.</td>
</tr>
<tr>
<td>Facility Type</td>
<td>Sign</td>
<td>Sign Design</td>
<td># of Miles from an Intersection or Interchange</td>
<td>Roadway Type</td>
<td>Sign Program and Facility-Specific Criteria</td>
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<td>--------------------------------------------</td>
</tr>
</tbody>
</table>
| Zoos          | Brown Custom Design | ![Spirit River Zoo](image) | 5 10 | Expressway Conventional | This is a zoological garden or park where a wide variety of living wild animals are kept and safely displayed for public exhibition.
In addition to the general criteria for the Minor Traffic Generator Signing Program, all of the following criteria apply:
1. The facility shall be registered and approved by the American Association of Zoological Parks and Aquariums.
2. The facility shall provide identification and explanation of displays and wildlife. |
# Logo Attraction Sign Categories and Criteria

| **Historic Sites or Districts** | Historic Sites shall have definite historical significance as determined and approved by the Minnesota Historical Society (MHS) and State Signing Engineer. Requests shall be forwarded to the State Signing Engineer. Historic District requests shall be listed on the National Register of Historic Places. Requests will be accepted from a local government agency and shall contain the following:  
- A map of the district.  
- Photographic evidence of street signage. Historic District must be distinguishable through local street signage.  
- Evidence that the district is providing information regarding the district in a publicly accessible location within the district such as a self-service kiosk or welcome center. Include the location of the kiosk, hours open to the public, and a copy of the information provided to the public, such as a pamphlet. Requests shall be forwarded to the State Signing Engineer. |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Cultural Sites</strong></td>
<td>Sites shall be limited to include any facility for the live performing arts, exhibits, or concerts. In lieu of hours of operation, the facility must have a seating capacity of 2,500 seats and hold at least 50 events per year.</td>
</tr>
</tbody>
</table>
| **Recreational Sites** | **Recreational Area**  
Areas that include recreational activities such as: hiking, bicycling, boating, fishing, kayaking, rafting, public golfing, skiing, and off-highway vehicle riding.  
  
**Amusement Park**  
A permanent area which is open to the general public for entertainment rides and foods services.  
  
**Arenas**  
A stadium, sports complex, auditorium, fairgrounds, civic or convention center or racetrack. In lieu of hours of operation, the facility must have a seating capacity of at least 2,500 seats and hold at least 50 events per year.  
  
**Natural Interest Area**  
An area of natural or scenic beauty shall be limited to a naturally occurring area of interest to the general public, including State or National Parks, forests, nature preserve, wilderness areas, or mountain ranges. A feature created by nature or naturally occurring area of outstanding interest to the general public. Examples include, but are not limited to, unusual rock formations, caves, lakes, rivers, fossil beds, waterfalls, and similar areas. |
| **Educational Sites** | **Zoo, Aquarium or Botanical Park**  
A non-retail facility in which living animals, insects, fish, or plants are kept and exhibited to the public.  
  
**Facility Tour Location**  
A facility such as a factory, institution, or plant which conducts daily public tours on a regular scheduled basis during hours of operations.  
  
**Museum**  
A museum shall be limited to facilities open to the public in which works of historic, artistic, or scientific value are cared for and exhibited. Requests for signing shall be submitted to the State Signing Engineer. These requests will be forwarded to the MHS for recommendations. The Society’s recommendations shall govern the Minnesota Department of Transportation’s approval or denial of requests. A non-profit museum is also required to be a Federal tax exempt organization [IRC (Internal Revenue Code) 501 (c) (3)]. |
1. **Gasoline Service Station or other retail motor fuel business** - defined in Minn. Stat. Sec. 160.292, Subd. 13 as “A business that provides vehicle services including fuel and oil; restroom facilities and drinking water; staff for continuous operation at least 12 hours per day, seven days per week; and public access to a telephone.”

2. **Motel** - defined in Minn. Stat. Sec. 157.15, Subd. 7 as “a building, structure, enclosure, or any part thereof used as, maintained as, advertised as, or held out to be a place where sleeping accommodations are furnished to the public and furnishing accommodations for periods of less than one week.” It shall be licensed by the State Department of Health. Bed and breakfast facilities were previously allowed signing as a tourist-oriented business that met the motel criteria, but are now eligible for signing as a motel.

3. **Resort** - defined in Minn. Stat. Sec. 157.15, Subd. 11 as “a building, structure, enclosure, or any part thereof located on, or on property neighboring, any lake, stream, skiing or hunting area, or any recreational area for purposes of providing convenient access thereto, kept, used, maintained, or advertised as, or held out to the public to be a place where sleeping accommodations are furnished to the public, and primarily to those seeking recreation for periods of one day, one week, or longer and having for rent five or more cottages, rooms, or enclosures.”

4. **Place of Worship** (no legislative definition provided) - MnDOT defines a place of worship as any church, chapel, temple, synagogue, mosque, building, area, space, plaza, or dwelling wherein or whereat respect, reverence, or devotion is paid to a Divine Being. There is no restriction on time or frequency of devotional activities. However, the place or structure should be primarily intended for such purpose, and may not be a private home or school or any other site which is not primarily a place of worship.

   Minnesota Statute 173 allows religious notices signs to be permitted in areas adjacent to trunk highway right-of-way. If this type of signing is permissible and effective, specific service signs shall not be installed.

5. **Recreational Camping Area** - defined in Minn. Stat. Sec. 327.14, Subd. 8 as “any area, whether privately or publicly owned, used on a daily, nightly, weekly, or longer basis for the accommodation of five or more tents or recreational camping vehicles free of charge or for compensation. “Recreational camping area” excludes:
   - Children’s camps
   - Industrial camps
   - Migrant labor camps as defined in Minnesota Statutes and state commissioner of health rules.
   - United States Forest Service camps
   - State Forest Service camps
   - State wildlife management areas or state-owned public access areas which are restricted in use to picnicking and boat landing, and
   - Temporary holding areas for self-contained recreational camping vehicles created by and adjacent to motor sports facilities if the chief law enforcement officer of an affected jurisdiction determines that it is in the interest of public safety to provide a temporary holding area.

   The recreational camping area shall meet the following criteria:
   I. Be licensed by the State Department of Health.
   II. Provide at least 15 camping spaces.
   III. Provide modern sanitary facilities (flush, chemical, or incinerator toilets) and drinking water.
   IV. Services available 24-hours per day.
   V. Accept all forms of campers (tent, trailer, motor home, etc.) unless restriction is included in the official name (“Smith’s Tent Camping” or “Joe’s RV Camping”).

6. **Restaurant** – defined in Minn. Stat. Sec. 157.15, Subd. 12 as “a food and beverage service establishment, whether the establishment serves alcoholic or nonalcoholic beverages, which operates from a location for more than 21 days annually. Restaurant does not include a food cart or a mobile food unit.” A restaurant shall meet the following criteria:
   a. Provide a continuously staffed food service operation open at least four hours per day, five days per week except holidays as defined in Minn. Stat. Sec. 645.44, Subd. 5, and except as provided for seasonal restaurants.
   b. Provide seating for at least 20 people.
   c. Serve meals prepared on the premises (reheated, prepackaged, ready-to-eat food is not food prepared on the premises.
   d. Possess any required state or local licensing or approval.
e. Seasonal restaurants shall provide a continuous staffed food service operation at least four hours per day, five days per week during their months of operation.

f. Coffee shops are eligible for signing as restaurants provided that they meet the same criteria with the exception of criteria c.

7. **Rural Agricultural Business** - defined in Minn. Stat. Sec. 160.292, Subd. 20, as “includes but is not limited to (1) a grain-handling facility, (2) a business providing care and well-being to animals, and (3) the sale of feed or seed.”

MnDOT further defines a rural agricultural business as any commercial activity engaged in as a means of livelihood or profit, located completely outside any urban district or suburban area or residence district or business district, which receives the major portion of its income from providing goods, services, commerce trade, or industry directly related to agriculture or providing for the care and well-being of animals. Year-round businesses shall be open a minimum of eight hours per day, six days per week, and 12 months per year. Seasonal businesses shall be open eight hours per day and six days per week during the normal seasonal period.

Agriculture is the science or art of cultivating the soil, producing crops, or raising livestock of any kind and in varying degrees preparing these products for marketing and consumer use. Rural agricultural businesses shall be located in rural areas in order to be eligible.

The following is a list of eligible rural agricultural businesses (see last page of this appendix for a list if ineligible facilities):

- Agricultural Equipment
- Commodity storage/elevator
- Farm implement dealer
- Food, seed, fertilizer store
- Greenhouse
- Humane society
- Kennel
- Orchard/produce sales
- Tree farm, nursery
- Veterinary clinic
- Welding and machine shop for agricultural equipment

8. **Tourist Oriented Business** – Minn. Stat. Sec. 160.292, Subd. 25 defines a tourist-oriented business as “(a) a business, service, or activity that receives a major portion of its income or visitors during the normal business season from motorists not residing in the immediate area of the business or activity. (b) Tourist-oriented business includes, but is not limited to (1) a greenhouse or nursery, (2) a bait and tackle shop, (3) a marina, and (4) a gift or antique shop.”

A Tourist Oriented business shall have a majority of its retail floor space dedicated to the specific type of business for which signing is being requested. Year-round businesses shall be open a minimum of eight hours per day, six days per week, and 12 months per year. Seasonal businesses shall be open eight hours per day and six days per week during the normal seasonal period.

The following is a list of businesses that are eligible for signs (see last page of this appendix for a list of ineligible facilities):

- Amusement park
- Antiques, antique shop (where greater than 50% of total inventory is 50+ years old)
- Archery range
- Bait and tackle
- Bookstore (where greater than 25% of total inventory is 50+ years old)
- Gift, craft, art sales
- Marina, boat launch, guide service
- Miniature golf
- Recreational rentals (bicycle, boat, canoe, jet ski, snowmobile)
- Riding stable
- Trap and skeet shooting range
- Wildlife park, animal park.
Specific Services Signing Program, continued.

In addition to the general criteria for all signing programs, all of the following criteria apply for the Specific Service Signing Program:

1. **Specific Service signs may be installed in rural areas at at-grade intersections on conventional highways and expressways, and on rural bypasses of outstate municipalities that have interchanges at intersections of trunk highways with local roads or with other trunk highways (Minn. Stat. Sec. 160.293, Subd. 1).**

2. A Specific Service sign is allowed on an approach to an intersection if either one or both sides of the approach meets less than four of the following factors:
   a. Within corporate limits
   b. Curb and gutter
   c. Sidewalk
   d. Street lighting
   e. Posted speed limit of 45 mph or less
   f. Zoning (commercial, industrial, retail, residential)
   g. Platted development
   h. Multi-lane divided highway
   i. Established local road system
   j. Frontage road

3. Minnesota Statutes are not perfectly clear on urban qualifying businesses to be signed from rural intersections. The general authorization for each of the four basic combinations of specific service/intersection locations is summarized as follows:
   a. Service rural, intersection rural - authorized
   b. Service rural, intersection urban - not qualified
   c. Service urban, intersection urban - not qualified
   d. Service urban, intersection rural - need consideration of the following:
      I. The environment of the rural intersection as well as municipal boundaries.
      II. Straight ahead signing if overlapping routes are involved and one route does not serve the municipality.

4. In order be considered for signing on trunk highways, the following criteria shall be met by the specific service requesting signing:
   a. Businesses shall conform with all applicable laws and rules concerning the provisions for public accommodation without regard to race, religion, color, sex, or national origin (Minn. Stat. Sec. 160.295, Subd. 1).
   b. Businesses shall be located within 15 miles of the signed intersection or interchange (Minn. Stat. Sec. 160.295, Subd. 2).

5. Signing shall not be provided if the facility is readily visible or if effective off right-of-way directional signing is present or can be provided (Minn. Stat. Sec. 160.293 Subd. 2). Visibility from the approach to an intersection may be determined by adding 175 feet to Condition B (deceleration to 10 mph from the posted speed) in MN MUTCD Table 2C-4. If the facility can be readily identified or if effective off right-of-way directional signing is legible at this distance or beyond, then signing is not allowed (Minn. Stat. Sec. 160.293, Subd. 2).

6. Signing is allowed at the number of intersections or interchanges as follows (Minn. Stat. Sec. 160.293, Subd. 3):
   a. Unless as provided in paragraph b., a facility is limited to signing at one intersection or interchange on the trunk highway system.
   b. Signing is permitted at two intersections or interchanges on the trunk highway system if the place of business is located between trunk highways and within 15 miles of each qualifying intersection or interchange.

7. When a place of business is located off a conventional highway and can be served by two intersections with a local road (e.g. a bypass), one sign may be installed at each of the two intersections to provide the shortest route for motorists on the conventional highway. See Figure 6.36B.

8. A facility that meets eligibility criteria from only one approach to an intersection or interchange shall only be signed from that approach.
Ineligible Facilities

NOTE: This list is not all-inclusive. It only contains frequently requested signs that are routinely denied or have been determined by MnDOT to be ineligible for signing.

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<th>“Fraternal” Organization” Facilities</th>
<th>Live Theater (orchestra, band concert)</th>
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</thead>
<tbody>
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<td>Lumber Yards</td>
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<tr>
<td>Barber Shops</td>
<td>Movie Theaters</td>
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<tr>
<td>Bowling Alleys</td>
<td>Nursing/Senior Citizens Homes or Centers</td>
</tr>
<tr>
<td>Butcher Shops</td>
<td>Office Buildings or Facility (Private)</td>
</tr>
<tr>
<td>Car Sales/Service/Rentals</td>
<td>Office Parks</td>
</tr>
<tr>
<td>Car Washes</td>
<td>Performing Arts Theaters</td>
</tr>
<tr>
<td>Carpet Sales</td>
<td>Pet Shops</td>
</tr>
<tr>
<td>Cemeteries (except national cemeteries)</td>
<td>Post Offices</td>
</tr>
<tr>
<td>Compost Sites</td>
<td>Recreation Equipment Sales/Service</td>
</tr>
<tr>
<td>Convenience Stores</td>
<td>Recreational Vehicle sales/rental</td>
</tr>
<tr>
<td>Correctional Facilities (local and regional)</td>
<td>Rehabilitation Centers</td>
</tr>
<tr>
<td>Dance Halls/Wedding Venues</td>
<td>Repair Business</td>
</tr>
<tr>
<td>Day Care Centers</td>
<td>Road Maintenance Facilities</td>
</tr>
<tr>
<td>Drive-In Theaters</td>
<td>RV sales/service/rental</td>
</tr>
<tr>
<td>Fish Hatcheries</td>
<td>Schools (Elementary, Junior High)</td>
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<tr>
<td>Flea Markets</td>
<td>Second Hand Stores</td>
</tr>
<tr>
<td>Forest Preserves (county, state, or federal)</td>
<td>Shopping Centers (other than regional malls)</td>
</tr>
<tr>
<td>Game Farms and Preserves</td>
<td>Softball, Baseball, Soccer Fields</td>
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<tr>
<td>Grocery Stores</td>
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<tr>
<td>Gun Shops</td>
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<tr>
<td>Half-way House/Shelter Houses</td>
<td>Swimming Beaches/Pools</td>
</tr>
<tr>
<td>Hardware Stores</td>
<td>Tennis Courts</td>
</tr>
<tr>
<td>Health Clubs</td>
<td>Veterans Homes</td>
</tr>
<tr>
<td>Ice Cream Shops</td>
<td>Wildlife Treatment Facilities</td>
</tr>
<tr>
<td>Laundromats</td>
<td>Any other predominately retail, business or manufacturing center</td>
</tr>
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</table>
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.

<table>
<thead>
<tr>
<th>Material</th>
<th>Average Daily Traffic (ADT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1500</td>
</tr>
<tr>
<td>Latex Paint</td>
<td></td>
</tr>
<tr>
<td>Epoxy (Plural Component Liquid)</td>
<td></td>
</tr>
<tr>
<td>Preformed Polymer Tape or Thermoplastic</td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Material</th>
<th>Average Daily Traffic (ADT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1500</td>
</tr>
<tr>
<td>Latex Paint</td>
<td></td>
</tr>
<tr>
<td>Epoxy (Plural Component Liquid)</td>
<td></td>
</tr>
<tr>
<td>Preformed Polymer Tape or Thermoplastic</td>
<td></td>
</tr>
</tbody>
</table>

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 inplace 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 4-6 inches.

Edge line markings shall be 6 inches (effective for applications installed in 2022 and beyond). Designers may use the range of 4-6 inches for other longitudinal lines.

A wide line is defined as at least 8 inches in width if 4-inch or 5-inch normal width lines are used and at least 10 inches in width if 6-inch normal width lines are used.

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

<table>
<thead>
<tr>
<th>85th Percentile or Posted or Statutory Speed Limit</th>
<th>Minimum Passing Sight Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPH</td>
<td>Feet</td>
</tr>
<tr>
<td>25</td>
<td>450</td>
</tr>
<tr>
<td>30</td>
<td>500</td>
</tr>
<tr>
<td>35</td>
<td>550</td>
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<tr>
<td>40</td>
<td>600</td>
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<td>45</td>
<td>700</td>
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<tr>
<td>50</td>
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<td>55</td>
<td>900</td>
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<tr>
<td>60</td>
<td>1000</td>
</tr>
<tr>
<td>65</td>
<td>1100</td>
</tr>
<tr>
<td>70</td>
<td>1200</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>85th Percentile or Posted or Statutory Speed Limit</th>
<th>Minimum Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPH</td>
<td>Feet</td>
</tr>
<tr>
<td>0-30</td>
<td>300</td>
</tr>
<tr>
<td>40-50</td>
<td>400</td>
</tr>
<tr>
<td>55 or greater</td>
<td>500</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>85th Percentile or Posted or Statutory Speed Limit</th>
<th>Minimum Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPH</td>
<td>Feet</td>
</tr>
<tr>
<td>20-39</td>
<td>500</td>
</tr>
<tr>
<td>40-54</td>
<td>650</td>
</tr>
<tr>
<td>55 or greater</td>
<td>800</td>
</tr>
</tbody>
</table>

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 6 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).
End of Solid Line White

End of Broken Line White

End of Broken Line Yellow

End of Double Solid Line Yellow

End of Double Solid Line White

No Passing Zone Markings

Figure 7-1 Spotting Symbols for Pavement Striping
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).
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](image_url)
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 and shall be six inches wide (effective for applications installed in 2022 and beyond). 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


6. Minnesota Department of Transportation, *Pavement Marking Typical Detail Sheets*.
# CHAPTER 8 - TEMPORARY TRAFFIC CONTROL

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8-1.00 INTRODUCTION

8-1.01 Purpose
This chapter is intended to show applications of basic principles of temporary traffic control and assist in developing temporary traffic control plans including Transportation Management Plans, plan sheets, specifications, special provisions, etc.

8-1.02 Scope
This chapter has been written to supplement, not to replace, the MN MUTCD. This chapter includes guidelines varying from planning traffic control to fit the needs of a particular activity to the reasons for keeping accurate records. The guidelines should be useful to any qualified individual involved with planning, designing, installing, maintaining, and inspecting temporary traffic control zones. Individuals are qualified by means of training in temporary traffic control practices, having a basic understanding of the principles of traffic control in work zones, or having experience in applying traffic control in work zones.

Other road authorities are encouraged to review the MN MUTCD and establish guidelines to meet their needs.

8-1.03 Relation to Other MnDOT Standards and Guidelines
As stated, this chapter is to supplement, not to replace, Part 6 Temporary Traffic Control of the latest edition of the MN MUTCD. The MN MUTCD includes the Field Manual for Temporary Traffic Control Zone Layouts (See Chapter 6K).

The guidelines contained in this chapter and in temporary traffic control plans should conform to, or be of higher standards than, the MN MUTCD and other MnDOT technical standards and guidelines. Adequate protection of the workers, traveling public, and other road users (including pedestrians and bicyclists) is the primary goal of any traffic control.

8-1.04 Chapter Organization
This chapter is divided into nine major sections:

8-1.00 Introduction
8-2.00 Glossary
8-3.00 Responsibility
8-4.00 Temporary Traffic Control Planning and Implementation
8-5.00 Temporary Traffic Control Strategies and Controlling Criteria
8-6.00 Temporary Traffic Control Devices
8-7.00 Temporary Traffic Control Plans
8-8.00 Temporary Traffic Control Reviews
8-9.00 References
8-2.00 GLOSSARY

Refer to the MN MUTCD (including the Field Manual) for definitions of common temporary traffic control (TTC) terminology. Definitions of terms found within this manual and other resources that are not included within the MN MUTCD are listed below.

Alternate Pedestrian Route (APR)
A temporary pedestrian facility created to replace an existing pedestrian facility impacted by a work zone. The APR needs to be at the same level of accessibility as the pre-existing pedestrian route.

Barricade Mounted Signs
Traffic control signs that are mounted on barricades.

Intelligent Work Zone
A system of devices that provides motorists and/or workers “real-time” information for improved mobility and safety through a work zone.

Occupied Work Space
A work space is considered to be occupied when workers are present within the work space. Temporary Traffic Control (TTC) devices should continuously be reviewed by workers and adjustments made as needed.

Pavement Markings

Final Pavement Marking
The pavement marking that will be installed until the next time the pavement marking is scheduled to be renewed (typically one or more years). Final markings would include full length centerline markings, edge lines, and messages.

Temporary Pavement Marking
The pavement marking that will be installed in staged, long-term temporary traffic control zones. The purpose of temporary pavement markings is to communicate the temporary traffic control condition that is different from prior or final conditions. This type of pavement marking is at least of the same dimensions as final pavement markings. The temporary markings will either be removed or covered with another pavement surface prior to the application of the final markings. The temporary markings would include full-length centerline markings, edge lines, and messages. All temporary pavement markings shall be in conformance with the MN MUTCD Parts 3 and 6F. Temporary pavement markings shall also follow the specifications of final pavement markings. Temporary pavement markings typically possess wet retroreflective/recoverable properties.

Interim Pavement Marking
Interim pavement markings are those that are allowed to remain in place until the earliest date when it is practical and possible to install pavement markings that meet the MN MUTCD Part 3 standards for pavement markings (temporary or final pavement markings). In other words, they are a thinner marking applied in order to maintain traffic until the final pavement markings can be placed. These are used for very short term staging purposes. Interim pavement markings should not be left in place for more than 14 calendar days unless they meet the requirements of temporary or final markings.

Temporary Raised Pavement Marker (TRPM)
Retroreflective pavement markers applied to the roadway surface which maintain retroreflective properties during wet weather conditions. TRPMs are used alone to substitute for pavement marking segments or to provide wet weather capabilities to other pavement markings.

Portable Support Mounted Signs
Traffic control signs that are mounted on portable sign supports.
Positive Protection
The use of devices that contain and redirect vehicles, reducing the risk of vehicle intrusion into the work space.

Public Information Plan (PIP)
In relation to Transportation Management Plans (TMPs), a plan that informs the public of the impacts on traffic and the general area during or prior to construction.

Significant Project
In relation to Transportation Management Plans (TMPs), a project that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts that are greater than what is considered tolerable based on the Minnesota Work Zone Safety and Mobility Policy and/or engineering judgment.

Temporary Pedestrian Access Route (TPAR)
A temporary, continuous, and unobstructed walkway within a pedestrian circulation path that provides accessibility.

Transportation Management Area (TMA)
An area designated by the Secretary of Transportation, having an urbanized area population of over 200,000, or upon special request from the Governor and the MPO designated for the area. There is only one TMA in Minnesota – the seven county Twin Cities area, which includes Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties.

Transportation Management Plan (TMP)
A plan that lays out a set of coordinated strategies and describes how these strategies will be used to manage the impacts of a project during construction. It includes the TTCP, TOP, and PIP (if needed). The scope of the project will dictate the level of effort and detail of the TMP. The TMP can range from the citation of a specific layout from the Field Manual that is being followed to a full report that includes a Temporary Traffic Control Plan (TTCP), a Transportation Operations Plan (TOP) (including traffic modeling), and a Public Information Plan (PIP).

Transportation Operations Plan (TOP)
In relation to Transportation Management Plans (TMPs), a plan that includes Demand Management Strategies, Corridor/Network Management Strategies, Work Zone Safety Management Strategies, and Traffic/Incident Management and Enforcement Strategies.

Zipper Merge
A method of merging traffic in a lane reduction (typically two lanes to one lane). Motorists use both lanes of traffic until reaching the defined merge area, and then alternate in “zipper” fashion into the open lane.

- In an Active Zipper Merge, detection, algorithms, and communication devices tell drivers when to use the Zipper Merge.
- In a Passive Zipper Merge, signs or portable changeable message signs (PCMSs) are used to notify drivers to use Zipper Merge when backups occur.

8-3.00 RESPONSIBILITY

8-3.01 General Responsibility
It is essential that multiple functional units within the districts be involved in providing input into the Transportation Management Plan for each temporary traffic control situation. Further information can be found in Section 8-4.00 Temporary traffic control Planning and Implementation.
8-3.02 Legal Responsibility

Minnesota Statute Sections 169.06 and 169.07 provide that: (1) traffic signs shall be placed only by the authority of a public body or official having jurisdiction, for the purpose of regulating, warning, or guiding traffic; and that (2) no traffic sign or its support shall bear any message that is not essential to traffic control. Any unauthorized sign placed on the highway right-of-way by a private organization or individual without authority constitutes a public nuisance, and all such unofficial and nonessential signs should be removed.

Minnesota Statute Sections 169.06, Subd. 1-4 and 169.07 establishes 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, object markers, and delineators are all normally within highway, road, or street rights-of-way and therefore, should never be installed except under public authority.

Minnesota Statute Sections 326.02 and 326.03 requires that engineering work wherein the public welfare or the safeguarding of life, health, or property is concerned or involved, such as the development of Temporary Traffic Control Plans, be performed or supervised only by Professional Engineers trained in the relevant subject.

Construction contractors and public utility companies are permitted to erect temporary construction and maintenance signs and place temporary pavement markings at work sites to protect the public, equipment, and workers provided that such signs and markings conform to the standards of the MN MUTCD and the proper authority has been given by MnDOT.

Minn. Stat. Sec. 169.14, Subd. 5d allows the establishment of a Workers Present Speed Limit. Refer to the document “Speed Limits in Work Zones Guidelines” located on the Speed Limits in Minnesota website for additional information.

8-4.00 TEMPORARY TRAFFIC CONTROL PLANNING AND IMPLEMENTATION

8-4.01 Temporary Traffic Control Goals

During planning for temporary traffic control (TTC) zones, the greatest payoff in terms of safety and convenience at a cost commensurate with the hazards and problems involved should be the goal. A properly installed temporary traffic control zone will allow traffic to pass through or around a work zone safely. It requires time and effort for planning, installation, and maintenance.

Work zone traffic control planning is based upon analysis of the work activity as it relates to the provision of adequate safety and capacity. Questions to consider include: What is the likelihood of motorists failing to negotiate the work zone safely? What are the consequences of such action on workers, traveling public, and other road users (including pedestrians and bicyclists)?

Planning for traffic control through a construction work zone may be more involved than for maintenance or utility zones because of the differences in traffic disruption and duration of the work. The exposure of traffic to potential hazards is a function of the traffic volume and the length of time that the closure will be in effect. The goals common to all temporary traffic control zones are to:

- Protect the workers,
- Minimize crashes and crash severity, and
- Minimize inconvenience and conflicts as a result of the work.

Federal regulations also require that workers are as safe as practicable through the use of:

- Exposure control measures such as road and ramp closures, median crossovers, detours, and accelerated construction techniques,
- Positive protection devices such as barrier, truck/trailer mounted attenuators, and vehicle arresting systems,
• Other traffic control measures such as credible signing, portable changeable message signs, arrow boards, rumble strips, pilot cars, etc.

8-4.02 Transportation Management Plans ( TMPs)

A Transportation Management Plan is a plan that lays out a set of coordinated strategies and describes how these strategies will be used to manage the impacts of a project during construction. It includes the:

1. Temporary Traffic Control Plan (TTCP),
2. Transportation Operations Plan (TOP), and
3. Public Information Plan (PIP), if needed.

The scope of the project will dictate the level of effort and detail of the TMP. The TMP can range from the citation of a specific layout from the Field Manual that is being followed, to a full report that includes a TTCP, TOP (including traffic modeling), and PIP.

The development of the TMP will take into consideration the safety and mobility of workers and all users of the transportation system (motorists, pedestrians, and bicyclists). The TMP process is detailed in Technical Memorandum 12-03-T-02 Minnesota Work Zone Safety and Mobility (WZSM) Policy. This process includes a Work Zone Mobility Impact Assessment that will identify the appropriate level of TMP for the project. The level of TMP will then dictate the necessary documentation for the project. This could be as little as identifying the appropriate layout from the Field Manual, to a full Temporary Traffic Control Plan, a Traffic Operations Plan (possibly including traffic modeling), and a separate Public Information Plan. These components of the TMP are listed in the Tech Memo, as well as overall guidance in the development of each of the components. Each district should develop templates and procedures to develop these components to meet their district needs and characteristics.

The following is additional guidance that may be used as the TMP is being followed through the project development process.

Responsibility

Involvement from each of the functional areas is needed to insure that adequate consideration is given to proper temporary traffic control for all operations. In order to assure that this commitment is met, it will require early involvement by all parties including project management, pre-design, design, traffic, maintenance, and construction. Typical guidelines have been developed for the various stages.

Scoping and Environmental Documentation

During the scoping/preliminary design development phase, the Project Manager should review the scope of the project with staff from Traffic, Construction, and Detail Design to determine traffic control concepts for the proposed construction. Construction staging should be determined by the traffic carrying capacities of the roadway under construction, bypasses, or detours. Consideration should be given for other construction work in the proposed highway corridor or general vicinity by other than MnDOT forces such as cities and counties.

Metro District has created a TMP Scoping Worksheet that allows the documentation of possible work zone mobility impacts. Districts are encouraged to develop their own version of this worksheet so that impacts to traffic are considered in the Scoping phase. The TMP Scoping Worksheet can be found at the Metro District Traffic Engineering Work Zones and Pavement Marking page.

The Federal Highway Administration (FHWA) also requires that traffic control considerations and effects be mentioned in the environmental documentation. Traffic operations analyses (such as modeling) may need to be performed to assess the mobility of the proposed temporary traffic control, depending on the level of TMP for the project. Commitments made to stakeholders that impact the mobility of road users should be entered into the TMP which is initiated in this phase.

Detail Design

The Detail Design staff should involve staff from Traffic, Construction, and appropriate FHWA personnel as
the final detail plans are being developed so that the necessary details for traffic control are worked into the 
TMP. This may range in scope from a very detailed plan (or proposal) designed solely for a specific project, to 
a reference to a standard specification, a section of the MN MUTCD, or a standard agency manual. The TMP 
requirements shall be incorporated into the plans, specifications, and estimate (P.S. & E). If the complexity of 
a project warrants, a traffic control layout may be prepared by the District Traffic Engineer and be included in 
the P.S. & E.

On some projects it may be appropriate to provide broad TTC Plan parameters in the P.S. & E., and then 
permit the successful bidder to develop a detailed TTC Plan and use it if MnDOT and FHWA find it acceptable.

The Detail Design staff should involve staff from Traffic, Construction, and the District Work Zone Safety 
Coordinator personnel to develop detailed time and traffic provisions.

The pay items to be included in the plans must be determined by the district during design. Individual projects 
may have varying pay items depending on size, complexity, and location. Districts are encouraged to use 
appropriate pay items to the fullest practical extent.

**Construction**

During the construction stage, the resident/project engineer will generally be the MnDOT person responsible 
for implementing the TMP and reviewing the temporary traffic control. The resident/project engineer may 
delegate this authority. This should be done at or before the pre-construction conference.

The responsible person should have the following duties:

- Develop a familiarity with the **MN MUTCD**, the contract plans and special provisions, the current 

- Coordinate MnDOT personnel assigned to the project relative to proper techniques of traffic safety 
  and traffic operations prior to beginning construction and specifically how they relate to the TTC Plan. 
  The District Traffic Engineer and others shall be available to assist in this task.

- Ensure that all affected agencies such as State Patrol, local Police, fire departments, sheriff’s office, 
  hospital, ambulance services, local government, post office, school districts, etc., are informed of the 
  scope of the project and how it may affect their individual needs and services. The Public Information 
  Plan (PIP) of the TMP is extremely critical in the case of a total detouring of traffic. The District Public 
  Affairs Coordinator and/or the Office of Communications may be of help in this responsibility.

- As identified in the PIP, notify the major local news media (TV, radio stations, newspapers, etc.), 
  local tourism associations, AAA, local legislators, etc. of the scope of the project prior to beginning 
  operations. Cooperation with the Contractor and any involved local government agencies is advised. 
  All items of interest should be included:

  - Type of work to be performed.
  - Hours the highway will be fully opened to traffic.
  - Hours of restricted usage.
  - Type and place delays can be expected.
  - Suggested alternate routes.
  - Duration of the project.
  - Location of the detour, if applicable.
  - Anticipated completion date of project.
  - A name and phone number the public can contact for information or to make comments about 
    the project.

At appropriate times during the life of the project the responsible person should update the information 
mentioned above so that the public is kept current on the status of the project. The Public Affairs 
Coordinator may be of help in this responsibility.
• Update 511 at the start of construction, listing details on how traffic is affected.
• Monitor the Contractor's operations with regard to traffic and safety operations and enforce the requirements of the contract. On some projects, it may be necessary to change the TTC Plan during construction, depending on the contractor's schedule, progress of utility work, etc. If this is done, the TMP needs to be modified as well.
• Review traffic operations through the project limits, including the condition of all traffic control devices on a regular basis.

8-5.00 TEMPORARY TRAFFIC CONTROL STRATEGIES AND CONTROLLING CRITERIA

8-5.01 Lane Width
For temporary traffic control purposes, a minimum lane width of 10 feet shall be provided. The lane width should be no less than 11 feet on multi-lane roads. Reduced widths should be analyzed for the off-tracking of the design vehicle. AutoTurn within MicroStation, or other comparable methods, may be used for the analysis.

When shoulders are provided, the minimum width should be no less than one foot. When barrier is used, a lateral buffer of at least two feet should be provided.

8-5.02 Crossovers and Bypasses (Diversions)
A crossover is a construction staging technique used to shift traffic from one side of a divided roadway onto a portion of roadway not under construction, typically sharing the remaining roadway with opposing traffic. A specific type of crossover, known as a bypass (or diversion), moves traffic onto a temporary alignment constructed either in the median or adjacent to the original alignment. Crossovers are an effective method for completing construction of a roadway by replacing or repairing the roadway or a structure while maintaining traffic in both directions.

As mentioned in Section 8-4.01 Temporary Traffic Control Goals, recent federal regulations highlight the importance of worker safety through a variety of methods, one of which is exposure control measures. Crossovers and bypasses are an effective means for providing long-term positive separation between workers and live traffic. Strong consideration should be given to this exposure control method.

Crossovers are typically used on freeways, but may be used on divided highways with limited at-grade accesses. Lane closures and traffic shifts are typically used on multi-lane divided expressways, but crossovers are an option for long-term stationary work.

Construction of a bypass typically consists of a temporary roadway alignment (possibly construction of a temporary structure as well). The limits of the bypass extend from the initial reverse curve leaving the existing roadway to the final reverse curve tying the alignment back into the existing roadway.

8-5.02.01 Design Speed for Crossovers and Bypasses
As stated in the MN MUTCD Part 6, design speed for the reverse curves used in a crossover or bypass should be no less than 10 miles per hour below the posted speed prior to work starting. If unusual site conditions require that a lower design speed be used, the signing should reflect an advisory speed determined by engineering judgment or study.

8-5.02.02 Roadway Lighting for Crossovers and Bypasses
On long term projects, the use of roadway lighting may be beneficial and should be considered especially when there are unusual site conditions that would require a lower design speed.

8-5.02.03 Crossed-Over Two-Lane, Two-Way Traffic on One Side of Divided Facility
Once the traffic has been crossed over to the roadway not under construction, how to divide traffic must be considered. There are a few options available:
• Pavement Markings
  The use of pavement markings alone should only be used on low speed facilities.

• Surface Mounted Delineators (see MN MUTCD, Part 6F.65.1)
  These are used to supplement pavement markings and should be used on higher speed facilities such as expressways or freeways.

• Temporary Barrier
  Temporary barrier is a consideration where a physical barrier is desired between the traffic flows. Traffic volume, travel speed, geometrics, and duration are all factors to consider when evaluating the use of barrier.

One design element to be aware of is to protect hazards from both directions of travel – the TTC design should incorporate protection measures (barrier, attenuation, etc.).

8-5.03 Closures and Detours
As mentioned in Section 8-4.01 Temporary Traffic Control Goals, recent federal regulations highlight the importance of worker safety through a variety of methods, one of which is exposure control measures. Temporary road closures and detours are an effective method of exposure control. Strong consideration should be given to this exposure control method.

Temporary road closures are being used more commonly even on major freeways where parallel routes exist. These closures should generally take place during off peak travel times, such as nights and weekends.

8-5.03.01 Establishing and Maintaining Detours
A traffic detour can be a very effective traffic control measure. By closing the road to live traffic, positive protection for workers is maximized. Detours can also allow for improved finished products as contractors can work in a single work space without the need to construct the project in multiple smaller pieces. Possible considerations for establishing a detour follow:

• The physical work area cannot support live traffic and construction activities concurrently.
• When the accelerated completion of a project is desired, having uninterrupted use of the entire work site can facilitate a time-critical schedule.
• Construction constraints (e.g. vehicle weight or size restrictions) require specific vehicle classes to be precluded from the work zone.

Effective detour designs must consider, address, and incorporate the following:

• Detour routes must accommodate height, width, weight, length, off-tracking, and other physical characteristics of the design vehicle (the largest vehicle expected to use the detour). The designer of the temporary traffic control plan should coordinate with the Office of Freight & Commercial Vehicle Operations Overdimension Permits.

• Appropriate and adequate detour signing for the entire route in both directions.
• For conditional or periodic detours, using multiple portable changeable message signs (PCMSs) can provide real-time advance warnings or notifications.
• Coordination with the Regional Traffic Management Center (RTMC) for considerations with 511 traveler information.
• Coordination with local road agencies for proposed detour route(s). This should look at proposed work that the local road agency is performing that may impact the detour route.
• Agreements with local road agencies regarding the payment for the road life used by the detour, and if MnDOT or the local road agencies will maintain the roadway during the life of the detour.

8-5.03.01.01 Governing Laws Regarding Temporary Roads and Detours
Applicable laws for establishing and maintaining detours are found in Minn. Stat. Sec. 160.12, 160.16, Subd. 2, 160.2715, 161.24, Subd. 3, and 161.25.

8-5.03.01.02 Detailed Detour Procedures

The following information provides a general overview of the process for establishing and maintaining detours. Details on establishing a detour or haul road can be found in the:

- MnDOT Right of Way Manual, Sections 115.6 and 115.7, and

Details on detour agreement procedures can be found at:

- Cost Participation and Maintenance Responsibilities with Local Units of Government Manual, Section III.B.2 Detour,
- Technical Memorandum No. 13-19-MAT-01, Detour Restoration Road Life Analysis using the Equivalent Overlay Method, and
- Technical Memorandum No. 10-09-TS-03, Revised Detour Restoration Road Life Formula for the Gas Tax Method.

8-5.03.01.03 Selection of a Detour Route and Detour Agreement Development

When a route is to be selected for a detour, the appropriate personnel should be consulted as soon as possible for review of the proposed route. The district should designate a person to coordinate this review. The review team may include the District Traffic Engineer, District State Aid Engineer, District Design Engineer, Project Engineer, Area Maintenance Engineer, as well as the local road authorities of the road(s) which will be affected. The information obtained in this review should include a detailed surface condition report, recommendations for reinforcement or modification of the proposed route, and recommendations for traffic control and signing on the proposed route.

**Detour Agreement**

A Detour Agreement is required to compensate the local road authority for the road life consumed by the detoured traffic. The district will write simple detour agreements. The Cooperative Agreements Unit of the Office of Project Management & Technical Support will author complex detour agreements. See MnDOT’s iHUB Project Management and Technical Support - Cooperative Agreements website for Detour Agreement Boiler Plates.

**Detour Traffic Control Devices**

Once the detour route has been established and the Detour Agreement initiated, the Traffic Engineer and the Area Maintenance Engineer should work together to develop the signing layout and have the necessary signs prepared. The Project Engineer should consult with the Traffic and Area Maintenance Engineers to determine the advance notice needed before the detour is to go into effect. The advance notice should allow enough time to have all signing and other traffic control devices properly installed and reviewed before traffic is diverted onto the detour. Traffic control devices (particularly signing and pavement markings) along the detour should be brought to State Highway standards – this work is usually performed by the contractor of the construction project.

The detour will become a temporary trunk highway on the date the trunk highway markers are erected and will remain in effect until the markers are removed and the local road authority has been compensated per the terms of the Agreement.

**Detour Documents**

The detour documents (primarily the map of the detour) will be kept by the Project Engineer for the duration of the detour. A copy of the document is sent to the permit office at CO, Rm 153, Mailstop 420. The Project Engineer will notify the local road authority, by letter, when the detour signing is removed. Once the detour is released, the date of the release and the signature of the local road authority is affixed to the document. The
District Engineer or designee will also sign the document. The documents are then submitted to the Legal Descriptions/Commissioner’s Order Unit (Mailstop 632) of the Office of Land Management for a Commissioner’s Order to be assigned and entered into the permanent record.

When a detour is found to be necessary after actual construction has begun and is requested by the contractor, the above procedure is followed except that generally the Project Engineer coordinates the route review. In addition, a Supplemental Agreement will have to be written documenting the change from the original contract.

8-5.03.01.04 511 Notification of a Detour

For construction projects, district staff (either Construction or Public Affairs) should notify 511 staff of the detour through the use of a faxed-in lane closure form. Currently each district has their own form. The 511 Traveler Information Protocol Website contains more detailed information. More formal 511 notification methods will be forthcoming.

8-5.03.01.05 Maintenance of a Detour

Unless other arrangements are made in the construction contract, it will be assumed that the detour is to be maintained by state forces (see MnDOT Maintenance Manual, Chapter 11, Section 4.02 Maintenance Work on Detours). However, if conditions make it advisable to have local authorities maintain their own roads, such arrangements are made in the Detour Agreement at the time the route negotiations are conducted. See the MnDOT Maintenance Manual, Chapter 11, Section 4.0 Detour Agreement, for specific instructions on maintenance agreements.

8-5.03.01.06 Unofficial Detours

Unofficial detours are when a portion of traffic is not found to follow the official detour and local roads are being used – this can lead to degradation of the local roads. An unofficial detour agreement is written with a local unit of government, most often a township, to allow MnDOT to compensate them for increased maintenance costs, over and above the average expenditures associated with local or through-traffic using local roads rather than an official detour route that was established as part of a construction or reconstruction project. Increased costs of maintenance on the local roadway, not including improvement costs, are documented by the local road authority and submitted to the MnDOT district for payment consideration.

If the district concurs with the additional costs, an unofficial detour agreement is written to provide payment to the local road authority. If MnDOT and the local road authority cannot agree upon the amount of additional maintenance costs that should be paid, the “Gas Tax Method” (Technical Memorandum No. 10-09-TS-03) may be used for determining payment for a detour placed on paved roadways. An agreement or payment will not be written for less than $500. Unofficial Detour Agreements are written by the district or the Cooperative Agreements Unit in the Office of Project Management & Technical Support.

8-5.03.01.07 Haul Roads

Follow the guidance and procedures found on the Construction Tools - Haul Roads and Detours website.

8-5.03.01.08 Emergency Detours

Follow the guidance stated in the MnDOT Maintenance Manual, Chapter 11, Section 5.0 Emergency Detours.

8-5.03.02 Road Closed, Open to Local Traffic

When the ROAD CLOSED, LOCAL TRAFFIC ONLY sign or the ROAD CLOSED TO THRU TRAFFIC sign is used, the portion of road beyond that sign is still open to the residents and businesses beyond. The road needs to meet the overall standards and guidelines of safe travel.
The ROAD CLOSED sign on barricades across the road width indicates a full closure point beyond which construction activities may proceed without interference from traffic. Traffic control devices may not be necessary in this area.

8-5.04 Delay Time

In general, traffic should not be delayed by more than 15 minutes. If it is expected (through traffic flow modeling or experience) that traffic will be delayed more than this, the TMP will need to consider additional public information efforts and demand management strategies (see Technical Memorandum No. 12-03-T-02 dated February 6, 2012 - Minnesota Work Zone Safety and Mobility Policy).

8-5.04.01 Detour Delay Time

In long term work zones, the overall travel time due to detours may exceed 15 minutes; however, additional public information efforts should be identified in the TMP and implemented. Unless the travel time is exceedingly high, demand management strategies are not necessary.

8-5.04.02 Maximum Flagger Hold Time

Flagging operations should limit the hold time to 15 minutes and should coordinate to reduce the delay.

8-5.05 Flagging Operations (Updated December 2018)

Flagging procedures, when used, can provide positive guidance to the motorist traversing the work area. Part 6 of the MN MUTCD contains methods, procedures, and specifications for flagging. Work zone flaggers have the authority to stop vehicles and hold vehicles in place until it is safe for the vehicles to proceed per MN Statute 169.06 Subd 4a. MN Statute 169.06 gives authority to other individuals to stop and hold traffic, such as over-dimensional load escort drivers, motorcycle road guards, and police officers. The requirements in this section apply only to work zone flaggers. Refer to the Minnesota Flagging Handbook which is part of the MN MUTCD, for overall state standards and procedures.

The MN MUTCD requires that high visibility clothing be worn by flaggers, though the requirement for a high visibility hat is a SHOULD statement. To enhance the visibility of flaggers on the State Highway system, MnDOT requires that a high visibility hat be worn by flaggers unless the work site requires hard hats.

The MN MUTCD recommends that every flagger be trained in flagging operations. To assure this on the state highway system, any person acting as a flagger on the state highway system is required to attend a training session taught by a MnDOT Qualified Flagger Trainer within 1 year prior to the start date of the work. A Flagger Qualification Card, signed by the MnDOT Qualified Flagger Trainer, shall be carried by the Flagger as proof of training. In addition, the latest version of the Minnesota Flagging Handbook shall be in the possession of the Flagger while flagging for the work.

8-5.05.01 Approach Lanes to Flagging Operation

Flagging operations are most effective when a single lane of traffic approaches the flagger. Due to this, multi-lane roads should include a lane reduction prior to the flagger station. At intersections with dedicated turn lanes, the flagger station should be located at the beginning of the furthest upstream taper location.
8-5.05.02 Flagger Station Lighting

As stated in the MN MUTCD, Part 6E.8, flagger stations shall be illuminated at night. The average maintained illuminance should be a minimum of 5 foot candles (54 lux). Balloon lighting or floodlights may be used; however, if floodlighting is used, it shall not produce a disabling glare condition for approaching road users, flaggers, or other workers.

Vehicle headlights shall not be used to illuminate the flagger station.

8-5.05.03 Delay Times due to Flagging Operation

As stated in Section 8-5.04.02, flagging operations should limit the hold time to 15 minutes and flaggers should coordinate to limit the delay to the traveling public.

8-5.05.04 Flagging at Signalized Intersections

When flagging a signalized intersection, the signal must be turned off or turned to flashing mode. Only a licensed uniformed law enforcement officer may override a fully operational traffic control signal system.

8-5.05.05 Flagging on Freeways

Flaggers should not be used to control traffic on a freeway due to the potential of creating a speed differential which could result in a higher risk of rear-end crashes or vehicular evasive maneuvers that result in work area intrusions.

When a full closure is needed on a freeway for a very limited time (i.e. to set bridge beams), a flagging operation may be used at night when volumes are low; however, a law enforcement officer shall be used and the duration of the operation should be less than 15 minutes. See Layout 6K-73 in the Field Manual.

8-5.05.06 Side Roads Within the Temporary Traffic Control Zone

For lengthy flagging areas that contain side roads, a flagger and/or appropriate signing for each intersecting side road within the limits of the active work area should be considered. Also consider provisions to contact and notify individual private residences along the highway within the work area of the process for entering and exiting their property.

8-5.05.07 Temporary Stop Signs Alternative to Flagging

Temporary stop signs are an acceptable alternative to flagging on roads with less than 1500 ADT and clear sight between the stop areas. See Layout 6J-12 located in Part 6, of the MN MUTCD.

8-5.05.08 Pilot Car Operations

Pilot Cars may be used in conjunction with flaggers to guide platoons of vehicles through lengthy two-way, one-lane work areas. Pilot cars may be considered when:

- Lane closures exceed ½ mile and sight distance between the flagger stations is obscured,
- Workers are immediately adjacent to the traveled lane,
- There are multiple isolated activities occurring throughout the work area.

When used, it may be worthwhile to notify residents along the corridor of the proper way to enter the highway while the pilot car is in operation. This should be considered as the public information plan of the TMP is being developed.
8-5.05.08.01 Pilot Car Maximum Speeds

Limiting the travel speed of the pilot car should be considered for the flagging operation, particularly when the pilot car is passing workers in the lane adjacent to traffic. If the travel speed of the pilot car is limited to 45 mph near workers, the project may not need to implement a Workers Present Speed Limit of 45 mph.

8-5.05.09 Automated Flagger Assistance Devices (AFADs)

The AFAD is an automated, trailer-mounted device used as an option for flagging within a two-way, one-lane work zone operation. These devices are controlled by either one or two flaggers, depending on the visibility of the queues controlled by each AFAD. An advantage of AFADs is that they remove the flaggers from the flagging stations. Two types of AFADs are available:

1) STOP/SLOW AFAD
   This type uses a STOP/SLOW sign, similar to a flagger paddle, that alternately displays the STOP face and the SLOW face, depending on the direction of the flagging operation.

2) Red/Yellow Lens AFAD
   This type displays either a steadily illuminated CIRCULAR RED lens or a flashing CIRCULAR YELLOW lens, depending on the direction of the flagging operation.

The general requirements for each can be found in Part 6E of the MN MUTCD. MnDOT also requires that a gate arm be included for either option when used on the state highway system. Compared to portable signals, AFADs may allow more flexibility to react to varying queues as they are controlled by a flagger(s).

8-5.05.10 Portable Signals

Portable signals are an alternative to a standard flagging operation. A portable signal operation requires that district traffic staff set up the timing of the signals. Compared to AFADs, portable signals require fewer employees to staff the work zone as flaggers are not necessary. Portable signals are also useful for alternating one way traffic operations in unattended work zones.

8-5.06 Speed Limits in Work Zones

There are several methods of signing available for speed control in work zones. These methods are:

- Advisory Speeds,
- Workers Present Speed Limits, and
- 24/7 Construction Speed Limits.

Under certain conditions, a Workers Present Speed Limit is required by Minnesota Statute. For additional information, details, and typical layouts, see “Speed Limits in Work Zones Guidelines” found on MnDOT’s Speed Limits in Minnesota website.

8-5.07 Positive Protection

As mentioned in Section 8-4.01 Temporary Traffic Control Goals, recent federal regulations highlight the importance of worker safety through a variety of methods, one of which is the use of positive protection devices. Strong consideration should be given to this exposure control method.

The FHWA defines “Positive Protection Devices” as devices that contain and/or redirect vehicles and meet the crashworthiness evaluation criteria contained in the National Cooperative Highway Research Program (NCHRP) Report 350 or the Manual for Assessing Safety Hardware (MASH). The determination of when to use positive protection is based on engineering judgment. Numerous products and devices can be used to provide different degrees of positive protection, devices more commonly used in Minnesota are described in this section.
**8-5.07.01 Temporary Barriers for Positive Protection**

While portable concrete barrier has historically been the primary choice in Minnesota, other options are available. The options and considerations include:

- **Portable Concrete Barrier**
  - Usually used for long-duration activities where work space is limited and either worker/traffic exposures or road user/work area hazard exposures are present on a regular basis.
  - Adequate space is required for barrier deflection or the barrier needs to be pinned to the pavement surface.
  - Adequate space is needed for equipment to install/move/remove the barrier.
  - Barrier must be placed on rigid pavement surface (bituminous or concrete) to remain crashworthy.
  - Adequate contractor ingress/egress points will be needed either at barrier ends or mid-run.
  - All exposed ends must be treated with some manner of impact attenuation or protection.

- **Steel Barrier**
  - While not widely used, steel barrier options are on MnDOT's [Approved/Qualified Products for Temporary Barrier List](https://www.mn.gov/transportation/apl) (APL). It has several advantages over portable concrete barrier - including ease and reduced cost of transport, speed of installation, durability, portability once on-site, and weight per foot to minimize bridge dead-loading.
  - When anchored, steel barrier equals concrete barrier in providing a safe and effective positive protection device with minimal deflection; however, unanchored, steel barrier has significantly higher deflection.
  - On shorter term projects, steel barrier may be more cost-effective than portable concrete barrier due to the reduced transportation costs and set up time.
  - End treatment is still necessary.

- **Water-Filled Barrier**
  - Also not widely used, water-filled barrier options are on MnDOT’s [APL](https://www.mn.gov/transportation/apl). It also has some advantages over portable concrete barrier - including ease and reduced cost of transport, speed of installation, and portability once on-site.
  - Water-filled barrier has higher deflection than portable concrete barrier and steel barrier.
  - Some types of water-filled barrier can act as its own end treatment.

- **Moveable Barrier**
  - Moveable barrier has been used successfully on a few MnDOT projects and there is an option on MnDOT’s [APL](https://www.mn.gov/transportation/apl).
  - Moveable barrier is most effective for projects where lane configurations must change regularly (e.g. reversing peak traffic flows, lane reductions during non-peak hours, multiple longitudinal work areas (e.g. micro-silica deck pours, bridge deck joint replacements)) and other locations where barrier is warranted, but the shorter duration of the activity makes placement of standard concrete barrier challenging and risky.
  - Advance coordination, communication, and project planning is needed to include in a construction project.
8-5.07.02 Protection Vehicles and Truck/Trailer Mounted Attenuators (TMAs)

Protection vehicles may be used to provide positive protection in work areas where intrusions are a concern. Protection vehicles may be equipped with a TMA; however, any protection vehicles operating totally or partially within a traffic lane should be equipped with a TMA. Protection vehicles with TMAs are primarily used for mobile and short duration activities.

Long term work zones may also benefit from the use of protection vehicles, including situations such as:

- Isolated areas of work in a long work area where workers are in the lane adjacent to traffic,
- Road closure locations where intrusions are a concern.

8-5.08 Cable Median Barrier

Forthcoming

8-5.09 Lighting

Lighting of nighttime work zones should be considered carefully as it can enhance the overall safety of the temporary traffic control area; however, the negative impacts of glare on the driver needs to be minimized. The following are some objectives of nighttime work zone lighting:

- To provide the appropriate level of lighting that allows construction work to be completed safely and effectively,
- To reinforce both the intent of the traffic control plan as well as provide better guidance for drivers traveling through the work zone, and most importantly,
- To improve the overall safety of the workers and traveling public.

8-5.09.01 Roadway Lighting

Forthcoming
8-5.09.02 Work Area Lighting

Work area lighting can enhance the safety of workers and the traveling public. NCHRP Report 498 Illumination Guidelines for Nighttime Highway Work examined this in detail and developed some recommendations. This section contains guidelines from this report that may be used if work area lighting is being considered.

Three categories were recommended based on considerations such as minimum lighting levels recommended by the Illuminating Engineering Society (IES), federal and state lighting requirements and guidelines, research, and expert opinions. Researchers found these categories to adequately account for a majority of highway and bridge-related construction and maintenance activities. Examples of work zone tasks and their associated recommended illumination levels are summarized below.

### Recommended Illumination Levels by Task

<table>
<thead>
<tr>
<th>Examples of Tasks</th>
<th>Illumination Level</th>
<th>Average Minimum Maintained Illuminance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All work operations areas; • setup of lane or road closures, • lane closure tapers, and • flagging stations.</td>
<td>Level I</td>
<td>54 lux (5 foot-candles*)</td>
</tr>
<tr>
<td>Areas on or around construction equipment; • asphalt paving, • milling, and • concrete placement/removal.</td>
<td>Level II</td>
<td>108 lux (10 foot-candles)</td>
</tr>
<tr>
<td>Pavement or structural crack/ pothole filling; • joint repair, • pavement patching/repairs, • installation of signal/electrical/ mechanical equipment.</td>
<td>Level III</td>
<td>215 lux (20 foot-candles)</td>
</tr>
</tbody>
</table>

A foot candle (fc) is defined as unit of illumination that is equal to one lumen per square foot, or 10.764 lux.

**Level I**

Level I illuminance is important in areas where the work crew is in motion, moving from spot to spot. This level of illuminance is appropriate for tasks requiring low accuracy, involving slow-moving equipment, and where there are large objects to be seen.

**Level II**

Level II illuminance is recommended for areas on or around construction equipment to provide a safer environment for the workers operating the equipment, allowing them to perform tasks that require a moderate level of accuracy, as described above.

**Level III**

Level III illuminance is appropriate for those tasks that require a greater level of visual acuity or for tasks with a higher level of difficulty.

The following types of work zones and factors should be considered when selecting the types of lighting that are best suited for the work zone.

- Mobile work zones, such as a paving operation
  
  If the work zone is mobile, the length of the work activity for one night may dictate either that the lighting plan be continuous for the length of the work zone or that a mobile system be used so that the lighting moves with the various work activities.
• **Stationary work zones**  
  Work duration would determine the type of lighting in this situation. A long-duration work zone could use roadway luminaires mounted on temporary poles, while shorter duration work zones could use trailer-mounted light towers or balloon lighting at fixed locations.

• **Glare**  
  Glare from the lighting systems should be minimized for both the workers and any adjacent motorist. Glare should be considered from each direction and on all approaching roadways and opposing lanes of traffic, even those separated by grass medians.

• **Light Trespass**  
  Trespass occurs when light spills onto private property. This could be a problem in a residential area and could require shielding as a preventative measure.

### 8-5.09.03 Vehicle Lighting for Temporary Traffic Control

Appropriate vehicle lighting is required to enhance the conspicuity of vehicles within temporary traffic control zones. This applies to both day and night time operations. All mobile equipment, operating within the limits of a TTC zone with potential exposure to passing traffic, shall be equipped with operable warning lights that meet the appropriate requirements of the SAE specifications listed below. This would include closed roads that are open to local traffic only. This also includes any vehicle that enters the traveled roadway at any time. MnDOT maintains an APL for **Vehicle Safety Lights** – all vehicle lighting packages must be from this APL.

- 360 Degree Rotating Lights - SAE Specification J845
- Flashing Lights - SAE Specification J595
- Flashing Strobe Lights - SAE Specification J1318

Lights shall be mounted so that at least one light is visible at all times from a height of 3.5 feet and from a 60-foot radius about the equipment. In order to meet the 360 degree at 60-foot radius requirement supplemental lighting may be used. All supplemental lights must be SAE Class 1 certified.

Per the MN MUTCD, vehicle warning lights shall be operating and visible when a vehicle decelerates to enter a construction work zone and again when a vehicle leaves the work zone and enters the traveled traffic lane.

### 8-5.10 Drop-offs

Drop-offs or abrupt edges are inevitable during some construction activities. Protecting or not protecting drop-offs with temporary concrete barrier within the clear zone depends on the depth of the drop, the proximity to live traffic, speeds, volumes, roadway geometry, and duration of the exposed hazard. The **Field Manual** contains longitudinal drop-off guidelines for drop-offs of less than 12 inches (See Figure 6K-7 3 Longitudinal Drop-off Guidelines).

For drop-offs of greater than 12 inches, see the **MN MUTCD**, Part 6F.85 Temporary Traffic Barriers for guidance regarding the placement of temporary barrier, particularly Table 6F-5.

When temporary barrier is used, anchorage is required if the temporary barrier is close to the drop-off. MnDOT **Standard Plan 5-297.680** covers portable concrete barrier anchoring and requires anchoring when the portable concrete barrier is within two feet of the drop-off. If steel barrier is used to protect the drop-off, consult the manufacturer’s specifications for anchoring requirements.

### 8-5.11 Zipper Merge

The Zipper Merge is a method of merging where drivers are encouraged to use both lanes up to a defined merge point and then take turns merging. This is typically used with a lane reduction in a congested work zone. Early merging is still being encouraged when drivers are traveling at highway speeds as that gives drivers a
better opportunity to find a gap in the through lane prior to the lane reduction. Districts are encouraged to incorporate the Zipper Merge TTC when volumes are expected to exceed 1500 vehicles per hour. There are two methods for implementing a Zipper Merge in a lane reduction:

1) Active Zipper Merge
   An Active Zipper Merge uses Intelligent Work Zones elements (detection, algorithms, and communication) to actively direct drivers when to use both lanes and where to merge. This type of Zipper merge is shown in the Minnesota IWZ Toolbox document in the layout Dynamic Late Merge and the templates Active Zipper Merge (Right Lane Closure & Left Lane Closure) found on OTE’s TTC – Template Sheets website.

2) Passive Zipper Merge
   A Passive Zipper Merge uses signs and/or PCMSs to notify drivers that both lanes should be used when there are backups. This leaves the decision to the driver as to whether a backup exists or not. This type of Zipper Merge is shown on Layout 6K-50 for a Mobile Lane Closure and Layout 6K-58 for a Standard Lane Closure in the Field Manual. There are also templates on OTE’s TTC – Template Sheets website for Passive Zipper Merge Right Lane Closure and Passive Zipper Merge Left Lane Closure.

The Active Zipper Merge has been found to lead to higher compliance among drivers than the Passive Zipper Merge, but both methods have been shown to be successful - particularly in longer term work zones.

8-5.12 Intelligent Work Zones

Intelligent Work Zones (IWZ) use standard system components (detection, analysis, and communication) to provide a real-time notification system to provide drivers, project personnel, and the agency with information about work zone conditions. OTE has published the Minnesota IWZ Toolbox as a guideline for selecting an appropriate IWZ System for existing work zone traffic issues and to mitigate anticipated issues on scheduled projects. The IWZ System descriptions contained in the toolbox are intended as brainstorming material and should lead to practical solutions to a project’s unique expected conditions. The layouts and examples are purposely left void of many dimensions, except where particular distances are highly recommended, and engineering judgment is required to customize the system to a project.

8-5.13 Innovative Contracting Methods

Innovative contracting methods (such as Lane Rentals, ABC, Best-Value, etc) are initiatives to reduce construction time and delivery of projects, improve quality, and develop new processes to administer projects. These supplement traditional low-bid, design-bid-build contracting. See MnDOT’s Office of Construction and Innovative Contracting website for guidelines and full descriptions of the innovative contracting methods.

8-5.14 Other Travel Mode Considerations

Temporary traffic control plans are generally focused on vehicular traffic; however, there are other modes of travel that must be considered and should be incorporated into the plan documents.

8-5.14.01 Pedestrians

Pedestrians need to be considered in the development of the TTC plan. The MN MUTCD states:

**MN MUTCD Part 6D.1 – Pedestrian Considerations**

**Standard:** If the TTC (temporary traffic control) zone affects the movement of pedestrians, adequate pedestrian access and walkways shall be provided. If the TTC zone affects an accessible and detectable pedestrian facility, the accessibility and detectability shall be maintained along the alternate pedestrian route.
MN MUTCD Part 6D.2 – Accessibility Considerations

Standard: When existing pedestrian facilities are disrupted, closed, or relocated in a TTC zone, the temporary facilities shall be detectable and include accessibility features consistent with the features present in the existing pedestrian facility.

Due to these Standard statements, the districts are highly encouraged to include a Pedestrian TTC Plan within the TMP documents (this could typically be in the overall TTC plan). If not within the project documents, contractors have difficulty implementing pedestrian routes within construction projects.

In general, the Pedestrian TTC Plan should clearly show pedestrian diversion routing and necessary traffic control devices with locations of sidewalk barricades, pedestrian channelizers, temporary curb ramps, temporary walkway surfaces, and communication devices (signing and audible/tactile devices, as needed). If a detour is provided, include signing for the detour.

Sidewalks or multi-use trails that are direct routes should be detoured as little as possible. As stated in the MN MUTCD, Part 6, Chapter 6D, “Pedestrians should be provided with a convenient and accessible path that replicates as nearly as practical the most desirable characteristics of the existing sidewalk(s) or a footpath(s).” This includes keeping the re-routing as short as is practical. The routing order of preference should be:

1. Provide the Alternate Pedestrian Route (APR) on the same side of the street as the disrupted route utilizing bypasses.
2. Where it is not feasible to provide a same side APR, provide an APR on the other side of the street.
3. Where it is not feasible to provide an APR on the other side of the street, provide an APR detour with trailblazing signs.

Recreational trails may have longer detours as these are generally used for recreation, not direct access routes.

OTE has published template sheets for Alternate Pedestrian Routes (APR) bypasses/detours and Temporary Pedestrian Access Route (TPAR) devices. These may be modified and inserted into plans or used as a reference in developing a Pedestrian TTC plan.

8-5.14.02 Bicyclists

Bicyclists need to be considered in the development of the TTC plan. The MN MUTCD states:

MN MUTCD Part 6A.1 – General

Standard: The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, or on private roads open to public travel (see definition in Section 1A.13), including persons with disabilities in accordance with the Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.

MN MUTCD Part 6G.5 – Work Affecting Pedestrian and Bicycle Facilities

It is not uncommon, particularly in urban areas, that road work and the associated TTC will affect existing pedestrian or bicycle facilities. It is essential that the needs of all road users, including pedestrians with disabilities, are considered in TTC zones.

Dedicated bike lanes should be addressed in the TTC plan. Minn. Stat. Sec. 169.18, Subd. 7(d) states:

Whenever a bicycle lane has been established on a roadway, any person operating a motor vehicle on such roadway shall not drive in the bicycle lane except to perform parking maneuvers in order to park where parking is permitted, to enter or leave the highway, or to prepare for a turn as provided in Section 169.19, Subdivision 1.

If a TTC setup directs vehicular traffic into the marked bike lane, the bike lane needs to be closed prior to this location and the bikes either need to be diverted/detoured or share the road warning signs need to be placed.
8-5.15 Clear Zones

The clear zone concept applied to work zones differs from clear zone concepts applied to permanent roadways. Due to the nature of a work zone, the amount of horizontal clearance is often limited. Further, driver awareness is often heightened. As a result, lateral clear zone requirements are generally less. Work zone clear zones do not override the permanent clear zone - meaning existing roadside features should not be removed to meet work zone clear zone requirements; however, if work activities expose hazards which were not previously in the clear zone (such as in crossovers) then protections should be provided. Engineering judgment is regularly used to determine tolerable clear zone widths in work zones. Depending on site restrictions, it may only be feasible to provide an operational clearance - often as little as two feet.

Staging needs and opportunities for positive separation between workers and traffic should be considered. Actual clear zone distances should be maximized, where possible. When clear zone distances are critical within a given project or stage, distances should be identified within the project documents.

Clear zone determinations should take into account traffic speeds, volumes, roadway geometry, available right of way, and duration of work. Any specific clear zone widths needed for construction should be documented in the project file.

Stockpiled materials and inactive construction equipment and vehicles not behind barrier should be stored a minimum of 30 feet from the traveled way for all projects. The work zone clear zone concept applies to exposed hazards in the work zone - exposed barrier ends, stored equipment, drop-offs, fixed objects, etc. For practicality purposes, the work zone clear zone concept does not apply to construction vehicles and materials being used for active construction operations.

Clear zones also apply to Drop-off conditions, see Section 8-5.10 Drop-offs for further information.

8-5.16 Business Impact Mitigation

Business impact mitigation is an important part of MnDOT’s public involvement and project development processes, and is also addressed in Minnesota Statute 160.165, Mitigating Transportation Project Impacts on Business. The purpose of business impacts mitigation is to:

- Involve businesses more in the project development process,
- Keep businesses informed regarding project issues,
- Help businesses understand a project and its potential impacts,
- Mitigate construction impacts to businesses as feasible (includes reducing and, if practical, preventing negative impacts to businesses).

Substantial business impacts is defined as “Impairment of road access, parking, or visibility for one month or longer, for one or more businesses”. If the project is expected to cause substantial business impacts, specific actions need to be performed by the Project Manager and/or identified in the TMP. See Business Impact Mitigation from MnDOT’s Highway Project Development Process for additional information and guidance.

The statute requires that one of the mitigation efforts that must be considered is signage. See “Temporary Business Signing in Work Zones” in Section 8-6.02.02 for guidance.

8-5.17 Public Information

The Minnesota Work Zone Safety and Mobility Policy, Technical Memorandum No. 12-03-T-02, requires that public information be included in the TMP for projects of certain levels of impact. Some strategies are identified in this section.

8-5.17.01 Traveler Information - 511

511 is a public service of MnDOT to help drivers access information about road conditions, work zones, traffic incidents, commercial vehicle restrictions, and weather information via the phone, the web, or handheld
devices. Most TTC projects that are expected to impact traffic are included in 511. The use of 511 satisfies the public information requirements on many projects. TTC implementations that are anticipated to impact traffic are sent to 511 staff, which then enters the data into 511. 511 notifications are generally provided to the Regional Traffic Management Center (RTMC) during the construction project.

8-5.17.02 Advance Notice of Construction

This generally consists of MnDOT Public Affairs staff notifying the public of upcoming projects using a variety of means including pre-season construction kick-offs, project website updates, constant contact emails, print media, and press releases.

When used, Public Information methods should be identified in the TMP.

8-5.17.02.01 Temporary Signing Options

One method of advance notice uses some of the Construction Information (G20) series of signs found in the MnDOT Standard Signs Summary. In particular, the following are often used:

- G20-X1 - Closure Notice
- G20-X2 - Work Zone Advance Notice
- G20-X15 - Ramp Closure Advance Notice

These are used to notify drivers that regularly use that road that construction will be starting. This may help drivers determine if alternate routes should be used once construction begins. These signs are typically installed five to seven days in advance of the actual start of construction.

8-5.17.03 Portable Changeable Message Sign (PCMS) Strategies

PCMSs may be used in addition to or instead of the advance notice signs listed above. See the 2012 CMS Manual of Practice for the appropriate use of PCMS as well as approved messages.

8-6.00 TEMPORARY TRAFFIC CONTROL DEVICES

8-6.01 General Requirements of Temporary Traffic Control Devices

All TTC devices used on MnDOT street and highway construction or maintenance work shall conform to the specifications of the latest edition of the MN MUTCD, the MnDOT Standard Specifications for Construction, and all other appropriate MnDOT technical manuals.

8.6.01.01 Crashworthiness of TTC Devices

MnDOT requires that all TTC devices used (with the exception of Category 4) are crashworthy in accordance with the National Cooperative Highway Research Program (NCHRP) Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features” or the American Association of State Highway and Transportation Officials (AASHTO) “Manual for Assessing Safety Hardware (MASH)”.

Under the NCHRP Report 350 and MASH standards for crash testing, work zone devices have been classified into four categories, each having its own testing requirements:

- **Category 1** - Low-mass devices such as channelizing devices. Devices typically self-certified for crashworthiness.
- **Category 2** - Devices with higher mass that are frequently crash tested. Examples include permanent and portable sign supports, barricade supports, and small portable (balloon) lighting.
- **Category 3** - Much higher mass and requires correct installation and protection. Mandatory crash-testing. Examples include temporary barrier and TMAs.
• **Category 4** - Devices posing the greatest risk to motorists – Examples include trailer-mounted devices (PCMS, portable signals, flashing arrow boards, large portable light plants). These are currently exempt from crash testing as the benefit of these devices generally outweighs the risk; however, they:
  - Should be shielded where possible,
  - Should be removed when not needed,
  - Must be delineated - MnDOT interprets this to require type B channelizing devices (see Field Manual, Layout 6K-7).

8-6.01.02  **Approved Product List/Qualified Product List (APL/QPL)**

The following TTC Devices have a MnDOT Approved Product List upon which only these devices are allowed to be used for MnDOT street and highway construction or maintenance work.

- **Sign Sheeting Materials**
- **Automated Flagging Assistance Devices**
- **Portable Changeable Message Signs**
- **Flashing Arrow Boards**
- **Portable Signal Systems (Trailer and Pedestal Mounted)**
- **Temporary Barrier**
- **Stationary Crash Cushions**
- **Truck/Trailer Mounted Attenuators**
- **Vehicle Safety Lights**
- **Longitudinal Pedestrian Channelizers**
- **Longitudinal Channelizing Curb (non-concrete)**
- **Temporary Rumble Strips**

**Pavement markings** have a QPL upon which only these pavement marking materials are allowed to be used on the State Highway system.

8-6.01.03  **TTC Devices Not on APL/QPL**

MnDOT does not maintain an APL/QPL for the TTC devices listed below:

- Channelizing devices - the installer of channelizers must self-certify that the device complies with all the specifications found in the **MN MUTCD** and **Standard Plate 8000J**. See Section 8-6.04 Channelizing Devices for more information.

- Portable Sign Structures - the installer of portable sign structures shall provide documentation (upon request) that the device complies with the specifications of the MN MUTCD (including crashworthiness). There are proprietary and non-proprietary crashworthy designs for barricades available. See **MN Designed Crashworthy Sign Support Structures** for designs of non-proprietary crashworthy portable sign supports.

- Temporary Pedestrian Access Route (TPAR) Devices - the installer of these devices and systems must self-certify that they comply with all the specifications found in Part 6 of the **MN MUTCD** and the **November 2005 version of the Public Right-Of-Way Accessibility Guidelines - PROWAG**. Dimensions and other requirements may be found in the **Field Manual**.

- Portable Precast Concrete Barrier (PPCB) - MnDOT has a **Standard Plate (8337C)** for portable precast concrete barrier.
8-6.01.04 Sheeting Requirements of TTC Devices
Some TTC devices (signs, channelizing devices, etc) include sheeting and there are requirements based on their use. The Sign Sheeting Materials APL includes the sheeting type requirements for each application/device.

8-6.01.05 Quality Standards of TTC Devices
The use of temporary traffic control zone devices subjects them to wear which does not occur with permanent devices. Although errant vehicles cause much of the damage to the devices, they also deteriorate in appearance from wear occurred during their storage, shipment, installation, relocation, and removal. Whenever a high number of these worn and damaged devices appear on the same project, the general appearance of the Temporary Traffic Control Zone deteriorates, reducing the level of safety provided to the workers, pedestrians, and traveling public.

Quality standards have been developed in an effort to offset the deterioration in the appearance of TTC devices. A determination of the condition of device quality should be made at several stages: while in storage, during preparation for delivery to the Temporary Traffic Control Zone, during initial set up, and periodically during the course of the work. Suppliers and contractors are encouraged to apply this standard prior to delivery of devices to the job site. Doing so will minimize agency involvement and reduce costs related to on-site replacement.

The Quality Standards section of the Field Manual includes Quality Classifications and Requirements for the majority of temporary traffic control devices, while considering the duration of the work zone. These standards are intended to address the day-to-day operations of traffic control within a Temporary Traffic Control Zone and are not meant to cover the needs of emergency situations.

8-6.02 Signs
The primary means by which the agency communicates with road users is through the use of signs. In order to be effective, there needs to be some distance between signs for the driver to be able to read, understand, and if necessary, react to the message communicated by the sign. Refer to the MN MUTCD Parts 2 and 6 for standards on signs.

8-6.02.01 Regulatory and Warning Signs
Regulatory signs communicate laws and warning signs communicate conditions of which the driver needs to be aware. These signs take precedence over guide signs when placing along a TTC route.

8-6.02.02 Guide Signs
The placement and revision of guide signs is important to providing traffic control through work zones. However, placement of these signs should not interfere with construction information signs or necessary regulatory and warning signs.

A. Construction Information Signs
One commonly used construction information sign is the advance notice guide sign. It is used to provide notice of when and where construction or maintenance will occur. There are two types of advance notice guide signs:

1. Signs that inform motorists of a date or a day when construction and/or closures will begin, and
2. Signs that inform motorists of exact location(s) of construction that is underway.

It is important that in-place guide signs be covered or modified to reflect actual conditions. For example if a ramp is closed, all advance guide signs should be properly modified to inform the motorist of the closure. For short term closures this signing is impractical and warning signs may be used to provide this information.
B. Temporary Business Signing in Work Zones

MnDOT construction projects have frequently caused disruption of traffic patterns in business areas and have sometimes caused difficulty and confusion for motorists attempting to reach specific businesses or groups of businesses. This has resulted in the development of temporary business signs for use in construction areas.

Temporary business signs are used to improve driver guidance, create safer operations, and reduce the impact on businesses created by construction activities and detours. When temporary business signs are deemed necessary, they should be included as part of the Traffic Control Plan (TCP) for the construction project.

Properly placed and designed temporary business signing may alleviate business impacts due to the construction project. Inadequately designed signs with illegible messages may become traffic safety hazards and reflect poorly on the project and the businesses. The guidelines described in the following sections for temporary business signing have been developed with a balance between the standards utilized for permanent signing and the need for temporary supplemental signing during construction to guide motorists to businesses that depend upon the normal traffic flow for customers. Allowing a sign for a specific business during a construction project will not be justification for permanent business signing as governed by other parts of the TEM and MN MUTCD.

Location and Installation of Temporary Business Signs

Temporary business signs, classified as supplemental guide signs, shall not interfere with permanent or construction signing. As commonly practiced, when space becomes restricted, the hierarchy for sign installation is regulatory, warning (permanent and construction), and guide signs, in that order, over supplemental guide signs. All temporary business signs should conform to the MN MUTCD, this Manual, and Minnesota’s standards for guide sign design to the extent practical and possible. All temporary business signing shall be removed when the impact to traffic ends, or at such time that permanent changes in the affected area are completed.

A system of temporary business signs should be designed such that multiple sign structures are not required in a single location. However, in situations where a second structure is required, the structures should be placed a minimum distance apart along the right-hand side of the roadway as shown in Table 8-1 below. Temporary business sign structures shall not be combined with other signs on one structure and shall be installed in accordance with current practices for temporary construction signs, including all crashworthy standards.

<table>
<thead>
<tr>
<th>Posted Speed Limit</th>
<th>Minimum Distance Between Business Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45 mph</td>
<td>100 feet</td>
</tr>
<tr>
<td>45 - 55 mph</td>
<td>150 feet</td>
</tr>
<tr>
<td>&gt; 55 mph</td>
<td>300 feet</td>
</tr>
</tbody>
</table>

Table 8-1 Temporary Business Sign Structure Spacing

Business signing should not be installed on freeways except as needed to replace existing signage for major traffic generators or regional shopping centers. Refer to Chapter 6 of this Manual, Section 6-7.09 Supplemental Guide Signing Programs.

All temporary business signing that is proposed by MnDOT to guide traffic will be funded by MnDOT and installed by MnDOT or contract forces. Any additional temporary business signing proposed by the businesses and allowed by MnDOT shall be funded by the businesses. All temporary business signs shall comply with Minnesota Statutes, Chapter 173, Signs and Billboards Along Highways. Any signs installed off state right-of-way shall conform to any local ordinances for advertising and/or business signing.
Temporary Business Signing Plan Guidelines
The district should study all local businesses to estimate the extent of the work zone impact on each business and determine which should be classified as “traffic sensitive” or “regionally significant”. Traffic sensitive businesses may lose a large portion of their patrons to similar businesses with easier access. These businesses typically include fuel/convenience stores, restaurants/cafes/fast food, and lodging/camping. Other typical businesses may be those previously identified through Supplemental Guide Signing Programs. Regionally significant businesses are visited by non-local traffic, and the traveling public would be impacted if the access was reduced. These areas may include retail centers, transportation hubs, recreational centers, or geographical areas. A district may develop other uniform guidelines to determine whether a business is “traffic sensitive” and what types of “regionally significant” businesses may qualify in their regional part of the state.

Temporary business signing is an option for alleviating the project’s work zone impact on traffic sensitive or regionally significant business areas. MnDOT districts and partnering jurisdictions or organizations should work with businesses to suggest marketing plans to encourage continued customer patronage during construction. The marketing plans for individual businesses and/or business areas may include special advertisements via local media to inform customers of the appropriate directional information.

Types of Temporary Business Signs
Temporary business signing should be designed such that motorists are guided to the businesses through a series of easy decisions. Routes to the area businesses should be trail-blazed in successive steps such that the signing may remain understandable and legible. The first type of business signing to be encountered should be generic in regards to the business names and provide the most practical signage that easily directs traffic to any type of business or group of businesses. These signs are Business Access signs or Business Service signs. To provide the motorist adequate information to make route decisions, Business Identification signs to specific business (or business area) locations or entrances may be required.

BUSINESS SIGN LETTER AND STRUCTURE SIZES:
Although many signage options are available for temporary business sign structures, there are maximum allowable sign structure sizes and minimum letter size requirements. The maximum height of the temporary business sign structure is determined by the U-Post Wind-load charts for typical Type ‘D’ sign sizes without using breakaway I-Beam construction. Refer to the following tables for typical sign structure sizes based upon recommended letter sizes and maximum number of messages allowed per structure.

The lettering sizes are chosen to provide legibility based upon traffic speed and typical distances to the signs. Although standard sign series fonts shall be used, the standard word and line spacing on the temporary business signs may be reduced to help fit longer business names onto the standard sign blanks. Refer to the following tables for recommended letter sizes. The alternate smaller letter sizes should only be used when a resulting narrower sign structure is required due to lateral space restrictions.
BUSINESS ACCESS SIGNS:
The BUSINESS ACCESS (G20-X6) sign should be provided as the primary trailblazing sign option. This sign is listed in the MnDOT Standard Signs Manual G-Series, in three standard sizes, making it readily available for short term detour and business access situations.

The G20-X6 sign may be supplemented with a plaque to provide guidance to a specific business center or portion of a business area through an understandable name/designation. A business area may be designated by a larger anchor business, geographic location, recognizable business area name, or a temporary project name or logo associated with local advertising.

Refer to Table 8-2 below for sizes.

![BUSINESS ACCESS SIGN EXAMPLES](image)

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Posted Speed Limit</th>
<th>G20-X6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>width</td>
</tr>
<tr>
<td>2 Lane - 2 Way</td>
<td>40 mph or less</td>
<td>36&quot;</td>
</tr>
<tr>
<td></td>
<td>45 mph or greater</td>
<td>48&quot;</td>
</tr>
<tr>
<td>Multi-Lane</td>
<td>40 mph or less</td>
<td>48&quot;</td>
</tr>
<tr>
<td></td>
<td>45 mph or greater</td>
<td>66&quot;</td>
</tr>
</tbody>
</table>

Table 8-2  Temporary Business Access Signs
BUSINESS SERVICE SIGNS:
A BUSINESS SERVICE (G20-X8) sign may be installed indicating the types of business services that are available, with a limit of six categories per sign. The major business service types include gas, food, lodging, camping, grocery, and shopping, but when space allows, other generic types may be included such as mall or hardware. If needed for clarification the sign may include a destination. The destination may be a city name, an area designation such as SOUTH SIDE, a street name, or shopping center name.

Refer to Table 8-3 below for typical font and letter heights for various roadway types.

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Posted Speed Limit</th>
<th>Recommended Font</th>
<th>Minimum Font</th>
<th>G20-X8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Typical Panel Width (1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 column</td>
</tr>
<tr>
<td>2 Lane - 2 Way</td>
<td>40 mph or less</td>
<td>5&quot; C</td>
<td>4&quot; C</td>
<td>42&quot;</td>
</tr>
<tr>
<td></td>
<td>45 mph or less</td>
<td>5&quot; C</td>
<td>5&quot; C</td>
<td>42&quot;</td>
</tr>
<tr>
<td>Multi-Lane</td>
<td>40 mph or less</td>
<td>6&quot; C</td>
<td>5&quot; C</td>
<td>60&quot;</td>
</tr>
<tr>
<td></td>
<td>45 mph or greater</td>
<td>8&quot; C</td>
<td>6&quot; C</td>
<td>84&quot;</td>
</tr>
</tbody>
</table>

Note (1): Widths may vary. See the examples which show various combinations of messages.

Table 8-3 Temporary Business Services Signs
BUSINESS IDENTIFICATION SIGNS:
Businesses may require temporary business identification signs. These are generally needed when the business’ normal signing is not visible from the trailblazing route. These signs may be designed as either individual panels or as a single panel guide sign.

Examples of typical businesses that may be approved for identification are Major Traffic Generators such as shopping centers or recreational centers. Businesses, attractions, and other destinations currently signed through several of the “Requestor Pay” Supplemental Guide Signing Programs may be approved for signing.

Temporary Business Panel Signs:
Although the alternative font sizes and panel sizes are shown to provide flexibility when selecting a sign size, the following guidelines should be followed:

• Sign Assembly designs may inter-mix single line signs with double line signs while not exceeding the maximum assembly height.
• Business names should be listed in order of distance from sign. When arrows are used for each business, then the order should be through-left-right.
• Font sizes and series shall not be mixed on a sign assembly.

Refer to Table 8-4 on the following page for typical font and letter heights for various roadway types.
Table 8-4  Temporary Business Panel Signs

![Temporary Business Panel Signs](image)
Temporary Business Guide Signs:
A temporary business sign structure made up of individual panels may be replaced by a single panel guide sign. Although the maximum sign size remains the same as the combined panel signs, since the borders between business names may be removed, additional lines of text or a logo may be placed on the sign.

Design options may be utilized to optimize the legibility and clarity of the message. The options include but are not limited to:

- Use the business center name or refer to the anchor businesses' names.
- Use easily recognizable business center logos.
- Use a special project logo to identify business areas.
- Use horizontal lines or borders to separate names.
- Repositioning the arrow may provide for longer business names.

Refer to Table 8-5 for typical font and letter heights for various roadway types.

<table>
<thead>
<tr>
<th>Minimum Font Size and Series (5)</th>
<th>2 Lane – 2 Way</th>
<th>Multi-lane</th>
<th>Major Traffic Generator (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx. No. of Characters per Line (1)</td>
<td>ALL Speeds</td>
<td>&lt; 40 mph</td>
<td>ALL Speeds</td>
</tr>
<tr>
<td>No. of Characters per Line w/o Arrow (2)</td>
<td>6-4.5” D</td>
<td>4 – 3” D</td>
<td>6-4.5” D</td>
</tr>
<tr>
<td>Maximum No. Lines of Text Allowed</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Recommended Sign Panel Width (4)</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Approximation made using the recommended panel width with an average character width, and a standard directional arrow (left or right) included on the text line.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximation made using the recommended panel width with an average character width, and the directional arrow is placed at the bottom of the sign replacing one of the lines of text.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Businesses qualifying as Major Traffic Generators and/or Regional Shopping Centers should be trail blazed with larger font sizes (reference TEM Chapter 6).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three widths (48, 72, &amp; 96”) are standardized for typical post spacing. Larger signs may be designed if required.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refer to the Standard Signs Manual for proper arrow sizes depending upon orientation and placement.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8-5 Temporary Business Guide Signs

8-6.02.03 Sign Mounting in TTC Zones
Refer to MN MUTCD Part 6F for standards on placement and mounting post-mounted and portable mounted signs. Whenever possible, all temporary signs should be post mounted using the currently accepted crashworthy supports as detailed in Layout 20 of the TTC Plan Sheet templates.

Temporary signs that will remain in place for 30 days or less may be mounted on portable crashworthy support structures as defined in MN MUTCD Part 6F. See Minnesota Design Temporary Sign Supports passing NCHRP 350 for non-proprietary NCHRP Report 350 tested and approved temporary sign support structures.

Any portable signs placed on a sidewalk must:

- Allow a 48 inch clear walkway adjacent to the portable sign.
• Not be a tripping hazard. Any portable sign supports that extend into the walkway shall be no greater than ½ inch in height; if the support is greater than ¼ inch, then the support must be tapered between the ¼ inch and ½ inch dimensions. Alternatively, a detectable edge may be placed around the sign supports.

• Allow no portion of the sign to extend any greater than 4 inches into the clear walkway between the heights of 27 inches and 80 inches.

  ▪ If there are sidewalk intrusion issues, consider post-mounting the temporary sign or use the NCHRP 350 Compliant 5 Feet Portable Sign Stand for 48” x 48” Diamond portable sign.

Unless designed and crash tested with other ballasting systems, the ballast system for use on portable support mounted signs is sandbags. See Section 8-6.05 Ballast for more information.

8-6.02.04 Sign Overlays and Coverings

When it is necessary to cover an inplace sign, or place an overlay on an existing or work zone sign, care must be taken to preserve the sheeting on the existing sign.

Partial Sign Overlay on TTC Sign

Separate demountable plates were introduced to allow greater flexibility in some cases of rigid work zone signing. Demountable legend plates should meet all of the following standards:

• Legend plates shall have proper legend.

• The legends shall be of proper letter size and series.

• The plates shall be properly fastened to the sign face and shall have plastic spacers behind them to provide a minimum clearance of 1/8 inch from the existing legend.

• The plates shall be made from the same type of retroreflective material as the sign face.

• The sign sheeting shall be oriented the same as the sign face material.

The following signs are allowed to utilize demountable legend plates as detailed in the MnDOT Standard Signs Manual.

• Lane Reduction Transition (Right or Left) Sign (W4-2)

• MERGE w/Arrow Sign (W20-X3)

• RIGHT/LEFT TWO LANES CLOSED Sign (W20-X13)

• Vehicle Mounted Signs for Mobile Operations Sign (W21-X4M) (W21-X4)

• RIGHT/LEFT LANE CLOSED Sign (W20-X5) (W21-X5)

Signing for moving operations also allows the use of demountable legend plates.

All work zone signs not listed above shall have the legend directly applied to the sign face as detailed in MnDOT specifications 3352.2.A.5.c Screen Processed Painted Legend and 3352.2.A.5.d Pigmented Plastic Film Legend. See MnDOT Standard Specifications for Construction for details.

The sign face and partial overlay shall maintain a uniform color and brilliance when viewed during both daytime and nighttime hours.

Temporary Sign Covering

When it is necessary to cover an inplace sign, care must be taken to preserve the inplace sign since some coverings may cause permanent damage to the sign face sheeting. Burlap, ropes, wire fasteners, or strapping should not be used as they may abrade the sign sheeting surface. Tape should not be applied to the sign sheeting surface because sunlight will cause it to bond permanently. Pre-mask or application tape must be removed prior to exposure to sunlight. Paper or plastic covers should not be used as heat and moisture entrapment can cause permanent damage to the reflective sheeting on the sign face.
Sign covers shall be rigid panel (such as sheet aluminum or plywood) and provide a minimum spacing of 1/8 inch (1 inch maximum) between the overlay panel and the sign. The spacers shall be a material that will not harm the sign sheeting face (such as plastic or rubber). For more detail on rigid sign covers for smaller signs, see TTC Template Typical Temporary Sign Framing and Installation Details.

**Sign Panel Overlays**

When it is necessary to modify the legend of an inplace sign, care must be taken to preserve the sign. A legend revision, such as EXIT CLOSED, on an overhead sign should be sheet aluminum and installed with minimum 1/8 inch spacers. The spacers shall be a material that will not harm the sign sheeting face (such as plastic or rubber).

8-6.03 Pavement Markings in Temporary Traffic Control Zones (Updated May 2019)

Through many work zones, traffic is moved from one lane to another. Traffic must be given clear direction as to which pathway to follow. Pavement markings such as center lines and edge lines provide direction for the motorist. Pavement marking modifications are required in long term TTC Zones (which are in place for 3 days or more) that contain transitions or alignment change areas - see Layout 6J-1 in the MN MUTCD. All temporary pavement markings should have wet retroreflective/recoverable (WR) properties. See Section 8-6.03.03 Temporary Pavement Markings Guidelines for more details.

This section applies to all MnDOT construction and maintenance activities with TTC zones of at least 350 feet in length on tangent sections and of 50 feet in length or longer on curves of 6 degrees or greater. As stated in Section 8-6.01.02 Approved Product List/Qualified Product List (APL/QPL), pavement markings have a QPL (see MnDOT Approved/Qualified Products List) upon which only these pavement marking materials are allowed to be used on the State Highway system. This includes interim, temporary, and final pavement marking installations.

Following are the minimum requirements for pavement markings prior to opening a road to traffic (for exceptions, see Section 8-6.03.02 Interim Pavement Marking Guidelines):

- Multi-lane Undivided Roadways - all double yellow centerlines, lane lines, and broken line stripe pavement markings.
- Multi-lane Divided Roadways - all lane lines.
- Three and Five Lane Roadways with Two-Way Left Turn Lanes - all solid yellow lines with yellow, broken line stripe pavement markings and lane lines (for five lane sections).
- Two Lane Undivided Roadways - all centerlines.

8-6.03.01 Pavement Marking Definitions

See Section 8-2.00 Glossary for definitions of pavement markings used in TTC zones.

8-6.03.02 Interim Pavement Marking Guidelines

Interim pavement markings are any pavement markings that are not the final marking or are temporarily placed for staging purposes. Interim broken line stripe pavement markings shall use the same cycle length as final pavement markings (50 feet) and shall be a minimum of 2 feet in length. If the cycle length is not 50 feet and the section to be striped in greater than 350 feet in length but less than 1¼ miles in length, the interim marking shall match the cycle length at either end of the project. See Interim Pavement Marking Template Sheets and MN MUTCD Part 6, Figure 6F-8b.

Material specifications and tolerances for interim pavement markings will be the same as for final pavement markings, with the following exception. When final pavement markings are to be epoxy, and paint is used for interim solid lines, a 10-mil thick layer application of paint shall be used. In this case, beads should be applied at a rate of 6 lbs/gal. Removal of this thin layer of paint is not required prior to placing the epoxy.
Temporary raised pavement markers (TRPMs), when used as interim pavement markings, shall be installed in accordance with Section 8-6.03.04 Temporary Raised Pavement Markers (TRPMs) of this chapter.

In areas where paint or tape will not adhere to the surface (i.e. chip or sand seal operations), temporary raised pavement markers may be used to simulate a centerline as detailed in Section 8-6.03.04 Temporary Raised Pavement Markers (TRPMs) of this chapter.

The minimum required interim pavement markings shall be installed prior to opening the roadway to traffic and should not be left in place for more than 14 calendar days unless they meet the requirements of temporary or final markings. Minimum required interim pavement markings include:

- Multi-lane Undivided Roadways - all double yellow centerlines, interim lane lines, and interim broken line stripe pavement markings.
- Multi-lane Divided Roadways - all interim lane lines.
- Three and Five Lane Roadways with Two-Way Left Turn Lanes - all solid yellow lines with yellow interim broken line stripe pavement markings and interim lane lines (for five lane sections).
- Two Lane Undivided Roadways - all centerlines, turn lanes, bypass lanes, and outlines for any painted islands.

If the Average Daily Traffic (ADT) is less than 1500 and the Project Engineer determines that it is not possible or practical to install interim pavement markings on Two Lane Undivided Roadways before opening the road to traffic, Figure 6F-8a in Part 6 of the MN MUTCD may be followed, also shown in Interim Pavement Marking Template Sheets. If the ADT is greater than 400, then this layout shall be limited to three days.

8-6.03.03 Temporary Pavement Markings Guidelines

Typically, the markings placed for staging purposes on long term projects are temporary, meaning they will eventually be covered by surfacing materials or removed completely. The material used for temporary pavement markings should be selected based upon whether the marking is placed on the final surface (such as a lane shift crossing the final surface) or not, as well as how long the marking needs to last. Temporary pavement markings are to be installed to the same specifications as final pavement markings. All temporary pavement markings should include WR properties, though they are not required to be recessed. To increase pavement marking conspicuity in work zones, temporary pavement markings in tapers and transitions should be installed at a minimum of six inches in width. Removable preformed pavement marking tape, paint, or epoxy are typically used.

Temporary or final markings and all other pavement markings including edge lines, channelizing lines, lane reduction transitions, gore markings, and other longitudinal markings, and the various non-longitudinal markings (stop lines, railroad crossings, crosswalks, words, symbols, etc) should be installed within 14 calendar days.

The time limitations for installing temporary or final markings begin when construction operations first remove the inplace markings from the roadway. The time limitations restart any time temporary or final markings are restored.

Edge lines through transition and alignment change areas shall be marked with temporary pavement markings with WR properties. Transition and alignment change areas include: lane closure tapers, lane shifts, sharp curves, shifts onto temporary roadways or detours, etc.

The following systems are considered to be temporary WR pavement markings:
• Temporary WR pavement marking preformed tape lines
• Pavement marking paint or multi-component lines with WR elements
• Temporary pavement marking tape lines supplemented with temporary raised pavement markings (TRPMs)
• Pavement marking paint or epoxy lines supplemented with TRP

As with other pavement markings, there is an APL for TRPMs and a QPL for WR Pavement Markings.

There is a high risk of damage or removal of WR products by snow plowing operations. Therefore, temporary WR pavement markings should be refreshed in the next construction season (unless they were recessed).

8-6.03.04 Temporary Raised Pavement Markers (TRPMs)

TRPMs are normally used with construction zone markings. They are commonly referred to as “temporary markers” or “TRPMs”. TRPMs are glued to the roadway with a bitumen or epoxy adhesive. Most markers of this type consist of a plastic body with a reflective surface.

TRPMs are to be replaced when they become damaged or have been removed by traffic. These markers will be inspected on a routine basis and replaced as necessary. TRPMs shall not be used as an interim pavement marking between October 1 and May 1 because of snowplowing operations.

Another general type of temporary raised marker is the “peel and stick” type. These typically have a paper backing that is removed to expose a butyl/adhesive pad. The marker is then applied to the roadway and firmly pressed in place.

TRPMs may be used to simulate solid lines without the use of any other pavement marking material, or they may be used to supplement other types of pavement markings. See Interim Pavement Marking Template Sheets and Layout 6J-2 in Part 6 of the MN MUTCD for guidelines on how to use TRPMs to simulate and supplement pavement markings.

TRPMs are classified into four types as follows:

• TRPM Type 1 - These markers are acceptable for use on all roadways for short or long term projects. They may be used to supplement or simulate solid or broken lines.
• TRPM Type 2 - These markers are acceptable for use on projects with Average Daily Traffic (ADT) of less than 3000. They may be used to supplement or simulate solid or broken lines.
• TRPM Type 3 - These markers are acceptable for use on all roadways for short or long term projects. They may be used to supplement solid or broken lines. These markers are NOT acceptable to simulate solid or broken lines. If these markers do not conform to the color requirements herein they shall not be placed directly on the pavement marking line.
• TRPM Type 4 - These markers are acceptable for use on chip or sand sealing operations. These markers are designed to be placed prior to the sealing operation with a protective cover that is removed after the seal coat is applied.

As with other pavement markings, there is an APL for TRPMs.

8-6.03.05 Pavement Marking Removals

The removal of pavement markings must be done with care, especially within a TTC zone where excessive scarring can mislead drivers. See TEM Chapter 7, Pavement Markings for more information.

8-6.03.06 Final Pavement Marking Guidelines

Standard final striping plan sheets shall be included in each Project Construction Plan. Refer to TEM Chapter 7, Pavement Markings for more information.
8-6.04 Channelizing Devices

Overall channelizing device standards and guidelines can be found in the MN MUTCD, Part 6. Refer to this section for the categorization and different types of channelizing devices. More specific standards are found on Standard Plate 8000J, which shall be used in construction projects.

As with other devices, all channelizing devices need to be crashworthy. There are proprietary and non-proprietary crashworthy designs for barricades available. Documentation should be provided from the vendor/contractor to verify crashworthiness. See the MnDOT Type III Crashworthy Barricade Designs for designs of non-proprietary crashworthy Type III barricades.

8-6.05 Ballast

Ballast is important so that TTC devices have limited movement due to wind caused by weather or vehicles. It is also important that the entire system of the device and ballast is crashworthy.

Sandbags are the most common ballast for TTC devices. When sandbags are used, they should be constructed so they will not readily rot or allow the sand to leach when exposed to the highway environment. Also, the sandbag should be constructed of a material which will allow the bag to break and disperse its contents when struck by an errant vehicle. Sandbags should not be filled to the extent that they become too heavy to be readily moved when a traffic control device is relocated. The number and size of sandbags used as traffic control device ballast should be kept to the minimum needed to provide stability for the device. During freezing conditions, the sand for bags shall be mixed with a deicer to prevent the sand from freezing. Sandbags shall not be suspended from the traffic control device. For proprietary devices, check with the manufacturer for ballasting requirements.

Ballasting requirements are shown on MnDOT’s non-proprietary crashworthy portable sign support structure and barricade structure designs.

Other ballasting methods, such as the manufacturer provided weighted bases, may be used on TTC devices provided that the system is crashworthy.

8-6.06 Temporary Barriers

There are a variety of barriers available to be used for drop-off, hazard, and worker protection. There is an APL for temporary barriers, which includes moveable concrete, steel, and water-filled barriers. MnDOT also has a Standard Plate (8337C) for portable precast concrete barrier (PPCB). A discussion about the advantages and disadvantages of the various types of temporary barrier can be found in Section 8-5.07.01 Temporary Barriers for Positive Protection.

As stated in the MN MUTCD, Part 6, each type of temporary barrier (steel, water-filled, or concrete, etc.) requires a specific basic minimum length to achieve its crashworthy compliance. Refer to the barrier's crash testing results to determine the minimum length needed for predicted crash deflections. Shorter intermittent segments of temporary barrier shall not be used because they nullify the containment and redirective capabilities of the temporary barrier. The PPCB minimum length of installation shall be 200 feet.

Standard Plate (8337C) is available for PPCB. As stated in Section 8-5.10 Drop-offs, when temporary barrier is used, anchorage is required if the temporary barrier is close to the drop-off. MnDOT Standard Plan 5-297.680 covers PPCB anchoring and requires anchoring when the portable concrete barrier is within two feet of the drop-off.

8-6.06.01 Attenuation (Crash Cushions) for Temporary Barrier

This section details the general requirements for crash cushions used to protect the end(s) of temporary barrier in highway work zones. The stationary crash cushion APL contains the cushions that are allowed - installation must follow the manufacturer’s instructions.

One way to categorize crash cushions is the redirective ability. This refers to what happens to the vehicle if the attenuator is hit on the side. Non-redirective attenuators will allow the vehicle to go through the attenuator and redirective attenuators will redirect the vehicle toward the roadway. This should be considered when choosing the type of crash cushion to use.
8-6.06.02 Temporary Barrier Delineators
Temporary barrier delineators provide delineation along the barrier to assist the driver. Top mounted barrier delineators will have a minimum of 24 square inches of reflective surface area and are to be placed at 25 foot spacing on top of the barrier when the barrier is within 10 feet of traffic unless otherwise noted in the TTC plan. If the plan requires side mounted barrier delineators (such as when glare screen is used on top of the barrier), they will have a minimum of 12 square inches of reflective surface area and be placed at 12½ foot spacing.

8-6.06.03 Temporary Raised Pavement Markers (TRPMs) on Temporary Barrier
TRPMs at 12½ foot spacing may be placed on the temporary barrier to substitute for an edge line.

8-6.06.04 Glare Screen on Temporary Barrier
Glare screens can be helpful in reducing headlight glare on head-to-head traffic situations that are separated by temporary barrier.

8-6.07 Portable Changeable Message Signs (PCMS)
See the 2012 CMS Manual of Practice for the appropriate use of PCMS as well as approved messages.

8-7.00 TEMPORARY TRAFFIC CONTROL PLANS

8-7.01 General
During the roadway plan development, designers must be aware of the need for a TTC Plan. The TTC Plan will specify TTC devices and include plan sheets that indicate how and where the TTC devices are placed for each stage of the project. These devices include drums, cones, barricades, temporary signing, temporary striping, etc. and are used to direct and assist drivers in safely moving through the construction area.

To develop the TTC Plan, coordination meetings between design, construction, and traffic personnel are recommended throughout the development of the project documents. The number and extent of these meetings will vary according to the complexity, length, and duration of the project. The construction office will be a valuable resource in providing the time frames necessary for construction activities. In addition to this chapter of the TEM and the MN MUTCD, traffic office staff will develop the TTC plan using information in the TMP.

MnDOT Office of Traffic Engineering (OTE) has developed the Traffic Control Plan Development Course and Manual that goes into specific detail (particularly in Chapter 5) regarding how to develop a TTC Plan Set, including plan assembly steps, assembly checklists, common plan set issues, etc. TTC Plan Designers are encouraged to follow the process defined within the Manual.

8-7.02 Requirements for Temporary Traffic Control Plans Submitted to MnDOT
The MN MUTCD requires the development of project specific TTC Plans to facilitate travel of road users through a work zone. A TTC Plan may range from a reference to the Minnesota Temporary Traffic Control Field Manual to a detailed set of plans and specifications. Layouts from the Field Manual may be used for projects that last 3 days or less. For long-term projects (or complicated projects that last 3 days or less), Minnesota Statutes, Minnesota Rules, and the MN MUTCD require the development of a TTC Plan signed by a Professional Engineer. These requirements apply to plans submitted to MnDOT by permit applicants or TTC plans submitted to MnDOT pursuant to a MnDOT contract.

The Requirements for Temporary Traffic Control Plans Submitted to MnDOT and the Attachment A – Detour for Special Events documents detail the requirements and exceptions. These documents have also been added to the MnDOT Traffic Engineering Temporary Traffic Control Manuals and Guidelines web page. The Requirements for TTC Plans Submitted to MnDOT document is considered part of the Traffic Engineering Manual, but has been published as a separate document for easier reference by other manuals, specifications, or applications.
8-8.00 TEMPORARY TRAFFIC CONTROL REVIEWS

8-8.01 General
The TTC in work zones should be reviewed by traffic, construction, maintenance, and others to assure compliance with TTC standards and guidelines, as well as to verify that traffic is flowing safely and without confusion through the work area.

8-8.02 Project Review
For each project, an individual shall be assigned the responsibility for traffic control.

On construction projects, the Contractor should designate a specific person by name and telephone number and provide this information to the Project Engineer. On large projects, the review of traffic control should be assigned to an employee within the agency’s organization. Routine inspections of the traffic control installations should be carried out by these individuals.

On maintenance projects, after the installation of the TTC devices, a lead worker should review the TTC deployment for adequacy (i.e. drive through the work area, as needed).

The Field Manual contains a sample Project Inspection Checklist (Figure 6K-1 40) as a resource for the responsible person.

8-8.03 Temporary Traffic Control Periodic Reviews
One of the duties of the recommended District Work Zone Safety Coordinator (as stated in the Minnesota Work Zone Safety and Mobility Policy) is to make periodic reviews of maintenance and construction projects to determine the adequacy of the TTC plan and to assist project and maintenance personnel with compliance to the plan. If there is not a Work Zone Safety Coordinator established in the district, a district employee should be delegated this responsibility.

The inspector will be faced with the need to make decisions during the inspection and must exercise judgment in establishing appropriate practices.

8-8.04 Frequency of Reviews
Prior to the daily work beginning, the supervisor and/or inspector should complete a comprehensive TTC inspection including all signs, pavement marking material, and channelizing devices that are being used.

During the work shift, TTC devices should be routinely monitored and misaligned devices should be readjusted on an hourly basis.

When the devices in a short-term stationary TTC zone cannot be monitored and repaired on an hourly basis, then the requirements for an intermediate-term stationary/night time TTC layout shall be utilized.

Less frequent but periodic inspections should be performed by senior staff of the contractor (typically the superintendent) and the agency (the District Work Zone Safety Coordinator, the resident engineer, and/or the District Traffic Engineer or designee).

8-8.05 Record Keeping of Temporary Traffic Control Deployment
Good record keeping procedures suggest that the time and location of the installation and removal of traffic control devices be documented, as well as any incidents of note (e.g. vehicular crashes, intrusions). Although this can be time consuming for a moving maintenance operation, it is important to record significant traffic control actions taken by the field crew. It is desirable that this include:

1) Starting and ending time of work,
2) Location of work,
3) Type, condition, and position of traffic control devices,
4) Names of personnel,
5) Type of equipment used,
6) Any change in temporary or permanent regulatory devices, and
7) If it occurs, crash and intrusion data.

Major projects will require more detailed record keeping as they may involve higher funding amounts, outside (Federal or State Aid) funding sources, and longer distances and times of physical exposure to the workers, motorists, or pedestrians.

8-9.00 REFERENCES

1. MnDOT Temporary Traffic Control Work Zone Safety Resources
5. MnDOT, Technical Memorandum 12-03-T-02, Minnesota Work Zone Safety and Mobility (WZSM) Policy.
15. MnDOT, Minnesota Intelligent Work Zone (IWZ) Toolbox (see Work Zone - Manuals and Guidelines website).
17. United States Access Board, November 2005 version of the Public Right-Of-Way Accessibility Guidelines - PROWAG.
CHAPTER 9 - HIGHWAY TRAFFIC SIGNALS

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9-1.00 INTRODUCTION

9-1.01 Purpose
The purpose of this chapter is to present uniform guidelines, procedures, and preferred practices used in the planning, construction, revisions, and maintenance of highway traffic signals on trunk highways in Minnesota.

9-1.02 Scope
This chapter applies to all highway traffic signals that are on state trunk highways. Highway traffic signals that are installed by agencies other than the State of Minnesota and that are not on state trunk highways may utilize the guidelines in this chapter, as appropriate. There is no legal requirement for using these guidelines by local agencies.

Highway traffic signals include all power-operated (manually, electrically, or mechanically operated) traffic control devices by which traffic is warned of conflicting movements or directed to take some specific action. Highway traffic signals assign right-of-way where conflicts exist or where passive devices, such as signs and markings, do not provide the necessary flexibility to properly move traffic safely and efficiently.

Traffic control signals, flashing beacons, pedestrian hybrid beacons, pedestrian signals, hybrid beacons, emergency vehicle signals, movable bridge signals, portable traffic signals, and temporary traffic control signals are covered in this chapter. The planning, design, and operation of highway traffic signals in Minnesota must conform to the standards, limits, and alternatives provided in the “Minnesota Manual on Uniform Traffic Control Devices” (MN MUTCD). Where the standards in the MN MUTCD are broad, this Traffic Engineering Manual describes preferred practices of design and operation of signals. The standards and guidelines of the MN MUTCD and this Manual are to be a basis for engineering judgment, not a substitute for it.

This chapter is intended as an overview of guidelines and procedures for the process of highway traffic signal design and operation in Minnesota. Please refer to “MnDOT Signal Design Manual” (Signal Design Manual) and “MnDOT Traffic Signal Timing and Coordination Manual” (Signal Timing Manual) when traffic control signal design and operations training and/or detailed description is needed. This chapter may reference chapters in the Signal Design Manual and Signal Timing Manual when appropriate.

This chapter should be used together with other documents to design and operate highway traffic signals on trunk highways in Minnesota. The MN MUTCD details minimum standards for the planning, design, and operation of highway traffic signals. The National Electrical Manufacturers Association (NEMA) Standards Publication No. TS 1-1989 or TS 2-Ver 2.06, 2003, “Traffic Control Systems”, latest revision, gives specifications for traffic signal control equipment. Detailed drawings for traffic control signal construction are in the MnDOT Standard Plates Manual. The MnDOT Standard Specifications for Construction book, latest revision, governs the construction of highway traffic signals. Other applicable documents include the latest version of the National Electrical Code by the National Fire Protection Association (NFPA), MnDOT Technical Memoranda from the Office of Traffic Engineering, the signal design details found on the MnDOT Traffic Engineering Signals web site, and Minnesota Statutes.

9-2.00 ACRONYMS

<table>
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<tr>
<th>Acronym</th>
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<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
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<td>ADA</td>
<td>Americans with Disabilities Act</td>
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<td>AFMS</td>
<td>Automated Facilities Management System</td>
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<td>APL</td>
<td>Approved Products List</td>
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<td>APS</td>
<td>Accessible Pedestrian Signal</td>
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<td>AWF</td>
<td>Advance Warning Flasher</td>
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<td>CAES</td>
<td>Office of Computer-Aided Engineering Services</td>
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9-3.00 LEGALITY
For highway traffic control signals to serve any useful purpose, their indications must be clearly understood and strictly observed. To achieve these objectives, highway traffic signals should be uniform, there should be valid justification for installation, and compliance with them must be legally enforceable. National standards have been developed for the installation and operation of traffic control signals. The actions required of motorists and pedestrians are specified by statute or by local ordinance or resolution consistent with national standards. Legislation establishing the authority for installation, the meanings of the signal indications, and the required compliance to these indications by the road user, are outlined in such documents as the Uniform Vehicle Code and Minnesota Statutes.

9-3.01 Legal Authority
Legal authority is established in Minnesota Statutes Section (Minn. Stat. Sec.) 169.06, Subdivisions (Subd.) 1-4) for the Department and local units of government to place and maintain highway traffic signals, require obedience to highway traffic signals, prohibit the use of unauthorized highway traffic signals, and prohibit interference with official highway traffic signals.

Minn. Stat. Sec. 169.06 refers to specific types of signals as follows: Subd. 5 - Traffic Control Signals, Subd. 6 - Pedestrian Control Signals, Subd. 7 - Flashing Signals and Subd. 8 - Lane Direction Control Signals.

9-3.02 Jurisdiction
All highway traffic signals to be installed on Minnesota trunk highways shall have approval by the MnDOT District Traffic Engineer prior to installation.

When a highway traffic signal is to be installed for which agencies in addition to the State of Minnesota have responsibility, an agreement shall detail the responsibility of each participating agency.

9-3.03 Meaning of Signal Indications
The legal meaning of traffic control signal indications in Minnesota is found in the MN MUTCD, Part 4 and in Minn. Stat. Sec. 169.06, Subd. 5.
9-3.04 Tort Claims

Chapter 12 of this Manual discusses tort claims as they relate to highway traffic signals.

9-4.00 GENERAL DESCRIPTION OF HIGHWAY TRAFFIC SIGNALS

A highway traffic signal is a device that contains one or more indications to warn of an impending hazard or right-of-way change. Traffic signals are commonly called stoplights, semaphores, or flashers. The largest percentage of highway traffic signals are intersection traffic control signals.

Most highway traffic signals are installed in response to high vehicle and/or pedestrian volumes, or a high number of correctable crashes. A justified highway traffic signal, properly designed, installed, operated, and maintained, is an asset to the traveling public. A highway traffic signal that is unjustified, poorly designed, installed, operated, or maintained may decrease the safety or the efficiency of an intersection.

9-4.01 Types of Highway Traffic Signals

The general category of highway traffic signals includes traffic control signals, pedestrian hybrid beacons, emergency vehicle signals, pedestrian signals, flashing beacons, railroad crossing signals, freeway ramp control signals (ramp meters), lane-use control signals, in-roadway lights, movable bridge signals, portable signals, and temporary traffic control signals. See MN MUTCD Part 4 for additional detailed descriptions of highway traffic signals.

9-4.01.01 Traffic Control Signals

Intersection traffic control signals (commonly called traffic signals) are the most common type of highway traffic signal. The primary function of an intersection traffic control signal is to assign the right-of-way to different movements at intersecting streets or highways. It does this by giving to each movement, in turn, a green indication or flashing yellow arrow indication, which allows drivers to proceed through the intersection. Intersection traffic control signals allow traffic and pedestrians to cross heavily traveled roadways safely, provide for the efficient operation of intersections, and reduce right angle crashes.

The decision to install a traffic control signal should be made after an Intersection Control Evaluation (ICE) is performed for the intersection. The purpose of the ICE is to document all of the analysis that went into determining the recommended alternative. The amount of analysis will depend on each project's location and scope. Intersections which are part of larger projects and/or have significant impact to adjacent intersections will require significant analysis and documentation. Stand-alone intersections will require a safety and capacity analyses and documentation of other factors such as cost and right-of-way information. The goal is to select the optimal control for an intersection based on an objective analysis of the existing conditions and future needs.

If, as a result of the ICE, a traffic control signal for the intersection is warranted, a design using the latest standards will result in a safe operation. The signal is to be installed according to the plans and special provisions. After a signal is installed, it must be maintained to ensure safe operation.

Traffic control signals can operate under two types of control, pretimed or traffic actuated (see MnDOT Signal Timing and Coordination Manual).

1. Pretimed
   Under pretimed control, the intersection is operated using predetermined, fixed cycle lengths, splits, and offsets.

2. Traffic Actuated
   Under traffic actuated control, the intersection is operated according to traffic demands. Cycle lengths, splits, and offsets change according to traffic demands.

Two or more traffic control signals that are operated as a system are said to be coordinated. These coordinated traffic control signals are operated to permit continuous movement or minimize delay along an arterial highway or throughout a network of major streets.
Pedestrian or Mid-block Signal
A pedestrian signal is a traffic control signal installed, usually at mid-block, to allow pedestrians to cross a road. It uses a red, yellow, and green ball indication. Pedestrians can push a button to give them the right-of-way to cross the road. These signals are installed to benefit a nearby school for example or other pedestrian traffic generator.

Emergency Vehicle Hybrid Beacon
An emergency vehicle hybrid beacon is a special type of highway traffic signal system used to warn and control traffic and to assist emergency vehicles to access the roadway in a safe and efficient manner. In most cases, the beacon should be placed mid-block. Since the indications are displayed dark when in rest, it is not considered a traffic control signal.

Emergency Traffic Control Signal
An emergency traffic control signal is a traffic control signal in front of or near a building housing emergency vehicle equipment where a signal is not otherwise warranted, but is needed to allow emergency vehicles to safely enter the roadway. At mid-block locations, the traffic control signal stays green for the mainline traffic until preempted in the station. This permits the emergency vehicle to receive the right-of-way and enter the roadway immediately.

One-Lane, Two-Way Signal
A one-lane, two-way signal (commonly referred to as a portable signal system) is a traffic control signal used at a location that is not wide enough to allow traffic to flow in both directions simultaneously (for example a one lane bridge or a construction area). These signals essentially operate as a two-directional control.

Pedestrian Hybrid Beacon
A pedestrian hybrid beacon (often referred to as a High-Intensity Activated Crosswalk Beacon or HAWK) is a special type of hybrid beacon used to warn and control traffic at an un-signalized location to assist pedestrians in crossing a street or highway at a marked crosswalk. The pedestrian hybrid beacon must be ADA compliant and in most cases the pedestrian hybrid beacon should be placed mid-block. It should meet the warrants found in the MN MUTCD, Part 4. Since the indications are displayed dark when in rest, it is not considered a traffic control signal.

9-4.01.02 Flashing Beacons
Advance Warning Flashers (AWF) are highway traffic signals that alert vehicles approaching a traffic control signal that the green indication is about to terminate. This highway traffic signal uses two 12-inch yellow indications above the “PREPARE TO STOP WHEN FLASHING” sign that flashes alternatively in a wig wag operation. AWF’s are part of the intersection traffic control signal, located typically 700’ to 800’ ahead of the intersection.

Flashing beacons are highway traffic signals that draw attention to signs, pedestrian crossings, and intersections. A flashing beacon is either a red or yellow circular indication.

Warning Beacon
This type of yellow flashing beacon is used to identify obstructions in or immediately adjacent to the roadway, to supplement warning and regulatory signs, except the “STOP”, “YIELD”, and “DO NOT ENTER” signs, and to identify pedestrian crosswalks.

Speed Limit Sign Beacon
This type of yellow flashing beacon is used with fixed or variable speed limit signs. Where applicable, a flashing speed limit beacon (with an appropriate accompanying sign) may be used to indicate that the speed limit is in effect. The use with a “SCHOOL SPEED LIMIT” sign is an example.
Intersection Control Beacon

Intersection control beacons are used at intersections where traffic or physical conditions exist that do not justify the installation of a traffic signal, but where high crash rates indicate a special hazard. The installation of intersection control beacons overhead above the intersection is limited to red on all approaches (where an all-way stop is warranted). It is only used in conjunction with 4-way stop signs.

Stop Beacon

This type of red flashing beacon is located above a stop sign to emphasize and draw attention to the stop sign.

9-4.01.03 Railroad Crossing Signals

Railroad approach signals are used at highway-railroad grade crossings to give warning of the approach or presence of a train. When indicating the approach or presence of a train, the signal displays to the approaching highway traffic two red lights in a horizontal line flashing alternately. The signals may be supplemented by gates that extend across the roadway lanes and keep vehicles off the tracks while trains are present or approaching. A detailed explanation of railroad signals can be found in the MN MUTCD Part 8.

Railroad approach signals are designed and installed by the railroad companies, and reviewed and approved by MnDOT’s Office of Freight and Commercial Vehicle Operations (OFCVO). If a signalized intersection is near a railroad crossing, the traffic control signals may have a preemption system connected with the railroad approach signal system that allows vehicles to safely clear the railroad tracks, and modifies the operation of the signal to allow traffic movements that do not conflict with the train while it is present. If gates are not in place and the railroad is interconnected to a traffic control signal, contact the MnDOT Office of Freight and Rail as soon as possible to determine if gates are needed and what funding options are available. Detailed descriptions and the approved interface are discussed in the MnDOT Signal Design Manual. Traffic signals that are interconnected to railroad crossings should be equipped with battery backup systems.

9-4.01.04 Freeway Entrance Ramp Control Signals (Ramp Meters)

Freeway entrance ramp control signals, commonly referred to as ramp meters, are described in Chapter 3 of this manual, Freeway Corridor Traffic Management.

9-4.01.05 Lane-Use Control Signals

Lane-use control signals are special overhead indications that permit or prohibit the use of specific lanes of a street or highway. They are placed directly over the lane they control and have distinctive shapes and symbols. Lane-use control signals are described in this Chapter 3 of this manual, Freeway Corridor Traffic Management, and in the MN MUTCD Part 4, Highway Traffic Signals.

9-4.01.06 Movable Bridge Signals

On roadway approaches to a movable (draw, swing, or lift) bridge, traffic control signals are generally used to stop vehicular traffic when the bridge is opened. Signal heads are installed at both approaches to the bridge, often in conjunction with warning gates or other forms of protection. The traffic control signal is coordinated with the bridge control and arranged so that adequate warning time is provided in advance of the bridge opening to ensure that the bridge will be clear of all traffic.
9-4.01.07 Temporary Traffic Control Signals

A temporary traffic control signal differs from a permanent traffic control signal in that it uses wood poles and span wires to place the signal indications in the driver's line of sight. A temporary traffic control signal may also use a non-intrusive means of vehicle detection, such as microwave or video detection. In all other ways, a temporary traffic control signal is just like a permanent signal.

Temporary signals are meant to be in place for only a short time, from a few months up to a few years. Most are used as intersection traffic control signals during construction projects.

9-4.01.08 Portable Traffic Control Signals

Another type of temporary highway traffic signal is the portable traffic control signal. Portable traffic control signals have limited use in conjunction with construction and maintenance projects and should normally not operate longer than 30 days. A portable traffic control signal must meet the physical display and operation requirements of conventional traffic control signals.

9-4.02 Elements of Traffic Control Signals

9-4.02.01 Signal Indications

A traffic control signal must be seen in order for the driver to react and make the required action. The most basic part of a traffic control signal is the signal indication. This is how the traffic control signal transmits information to the driver. This information or message is portrayed by selective illumination of one or more colored indications.

A signal indication is made up of a Light-Emitting Diode (LED) array, and housing with a visor. Signal indications are 12 inches in diameter, are red, yellow, or green, and can be circular or arrows. They can be found on the MnDOT approved products list. When three to five signal indications are mounted together vertically or in a cluster, they form a signal head. In five section signal head cluster mount situations, bi-modal indications can be used with a total of six indications. Each signal head is outlined with a black background shield. Traffic signal indications and heads are covered in more detail in the MN MUTCD, Part 4. LED signal indication modules should be replaced on a cycle of every seven years not to exceed 10 years, or earlier if visual observation warrants replacement.

Signal heads for vehicular traffic are often accompanied by signal heads for pedestrian control. Pedestrian signal indication symbols are LED, are white for WALKING PERSON (WALK) and orange for HAND (DON'T WALK), with orange countdown timers. Part 4 of the MN MUTCD provides more detail regarding the design and application of countdown pedestrian signals.

Vehicle and pedestrian signal heads are attached to poles and pedestals by mounting assemblies that support the signal heads and serve as a wire way for the electrical conductors. There are two primary mounting assemblies: angle and straight mounts, as found on the MnDOT approved products list for signals. There are other possible bracketing arrangements on older existing traffic signals; shown on MnDOT Standard Plates 8110 and 8111.

9-4.02.02 Flashing Yellow Arrow for Left Turns

The installation of the flashing yellow arrow (FYA) left turn indication is required on all new traffic signal dedicated left turn lane approaches on the Minnesota trunk highway system. This includes both mainline and cross street dedicated left turn lanes. A four section head using a red arrow, yellow arrow, flashing yellow arrow, and green arrow shall be used. Any agency doing work on the trunk highway system shall install the flashing yellow arrow. The FYA can be omitted from the design for the following reasons:

1. If the left turner has limited intersection sight distance (as defined in AASHTO’s “A Policy on Geometric Design of Highways and Streets”).
2. If conflicting (i.e. overlapping) left turn paths are present such that split phase operation is the only option.

3. If it has been determined that the signal will always operate protected-only, based on engineering judgment related to multiple turn lanes, high volumes, and high speeds (all three present).

If a flashing yellow arrow is not installed based on the above criteria, the system shall be designed to easily accommodate a change to a flashing yellow arrow in the future, including length of mast arm, wiring, cabinet, and controller.

If the flashing yellow arrow is not installed at a location because it has conflicting left turn lanes or a sight distance deficiency, or if there is other information that is important for the signal operator or future signal designer to be aware of, this information shall be provided by the signal designer on the signal plan.

When operated properly by time of day, the flashing yellow arrow can be used in many situations where protected-only phasing had been the only operational option.

Sign R10-X12 (LEFT TURN YIELD ON FLASHING YELLOW ARROW) must be installed for a flashing yellow arrow on the trunk highway for a minimum of six months after installation of the indication.

Additional guidelines for the operation can be found in the MnDOT Traffic Signal Timing and Coordination Manual. FYA design guidelines can be found in the MnDOT Signal Design Manual.

9-4.02.03 Poles, Mast Arms, and Pedestals

Poles, mast arms, and pedestals are the structures that support signal heads. They are made of galvanized steel for structural strength and for protecting the wiring to the signal heads.

Mast Arm
A mast arm is a structure that is extended over the roadway. Mast arm lengths are between 15’ and 80’.
There are two designs series to the mast arms, the PA series (15’ to 55’) and the BA series (60’ to 80’). The BA series poles and mast arms have significantly higher costs.

Typical PA Pole and Mast Arm
The typical PA pole and mast arm, shown on Standard Plate 8123, (15’ to 55’ mast arms), consists of a tapered octagonal shaft positioned on a cubical transformer base. A mast arm is attached near the top of the shaft, which is actually two arms braced together to form a truss. The mast arm extends horizontally from the top of the pole shaft in 5’ incremental lengths between 15’ and 55’. Extending vertically from the top of the pole shaft is the luminaire arm extension, on which the street light (luminaire) is placed.

Typical BA Pole and Mast Arm
The typical BA pole and mast arm, detailed on Standard Plates 8133 and 8134, consists of a tapered round shaft positioned on a cubical transformer base. A mast arm is attached near the top of the shaft, which is actually two arms braced together to form a truss. The mast arm extends horizontally from the top of the pole shaft in 5’ incremental lengths between 60’ and 80’. Extending vertically from the top of the pole shaft is the luminaire arm extension, on which the street light (luminaire) is placed.

Traffic control signals on arterial highways typically use four mast arm poles per intersection.

Signal Pedestals
Signal pedestals are used on divided highways or in places where PA and BA type signal poles are not practical. Signal pedestals are shorter, do not have mast arms, and are not used for overhead signal placement. They are designed to break away from the foundation on impact in order to minimize damage to a striking vehicle. A typical signal pedestal and its base are shown on Standard Plate 8122.

Temporary Traffic Control Signal Systems
Temporary traffic control signal systems may be mounted on wood poles or suspended from span wire that is stretched over the roadway. These systems should only be installed as temporary traffic control signals and are built with the intent to remove them after road work construction is complete or after a permanent traffic control signal has been installed.
9-4.02.04  Cabinet and Control Equipment

The control equipment for the traffic control signal at an intersection is housed in an aluminum cabinet at
the intersection. The cabinets are placed close enough to the intersection so that the maintenance and or
operation technicians can observe the intersection while they are working on the cabinet, but far enough away
so that the cabinet is not likely to be struck by an out of control vehicle.

Signal Cabinet
The typical signal cabinet sits on a concrete foundation. It has a power venting fan to reduce heat buildup
on warm days. The wiring between the signal cabinet and the poles or pedestals is placed in underground
conduit.

Controller
The controller is a specialized solid-state microcomputer that is programmed to control the signal indications,
and give the right-of-way to various approaches, based on a timing plan.

MnDOT uses a NEMA fully actuated traffic controller. This traffic actuated controller varies the timing for
all controlled conflicting movements based on vehicular or pedestrian demand as determined by detectors
placed in the roadway or near the pedestrian crossing.

The typical controller is a 16, 8-phase, traffic actuated, NEMA TS2 Type 1 controller. This means it can
control many separate traffic movements, including protected left turn movements, for all approaches to
an intersection. A NEMA controller is built to the specifications of the National Electrical Manufacturers'
Association. The controller includes a time-clock to control events by time of day and a coordinator to
synchronize the operation of the intersection controller with that of other controllers in a coordinated system
of controllers or intersections.

Solid State Load Switches
Solid state load switches are devices that when activated by the cabinet’s low voltage control circuitry, turn
on and off the 120 VAC (RMS) electric power that goes to the signal heads and powers the indications.

Malfunction Monitor Unit
The malfunction monitor unit, also called a failsafe or MMU, is a device that monitors cabinet output and
internal cabinet voltages. If the MMU senses an improper signal output or internal voltage, it will put the
intersection into the all red flashing mode of operation.

Vehicle Detector Units
Vehicle detector units sense very small inductance changes as vehicles pass over coils of wire, also known
as loops, imbedded in the roadway. This change in inductance is converted to an on/off signal connected
to a controller input so that the controller can take appropriate action. Other detector technology used less
frequently by MnDOT includes video detection and microwave.

Flasher
The solid state flasher is a two circuit device that controls the signal indications when the intersection drops
out of normal operation into the all red flashing mode. It provides a backup flashing operation. When a
traffic control signal is in the flashing mode the signal indications should be flashed red for all approaches.

Other Equipment
Other equipment to be found in the cabinet includes accessible pedestrian signal (APS) control units, flash
transfer relays, and other miscellaneous equipment and wiring.

Preemption
Preemption overrides the normal operation of the traffic signal controller. When a preemption call is placed
into the controller, the preemption program will allow preference to buses, emergency vehicles, light rail,
and trains. There are three levels of preemption:

1. Railroad Preemption – This is the highest priority of preemption. Railroad preemption is
used only on trains and will override normal intersection sequencing, transit preemption, and emergency vehicle preemption. Railroad preemption will first clear the track phase, and then bring up only phases that do not conflict with the railroad crossing.

2. **Emergency Vehicle Preemption** – This preemption is used on fire trucks, police cars, and ambulances. This preemption will override all normal intersection sequencing and transit preemption and bring up greens immediately or hold a green for the approaching emergency vehicle until the preemption call is gone.

3. **Transit Preemption** – This preemption is used for buses and sometimes light rail. This preemption needs special programming beyond preemption programming and does not override operations as emergency vehicle or railroad preemptions do. Transit preemption will hold a green longer or bring up a green sooner than normal operation allowing additional green time for transit vehicles. The transit emitter call is on a lower frequency than emergency vehicle call frequency.

9-4.02.05 Detection

All new traffic signal systems on trunk highways today are traffic-actuated, which means that the intersection approaches are given right-of-way in response to actual traffic demand, rather than according to a fixed time pattern.

**Detector Types**

Detectors enable the controller to “know” which approaches to an intersection have traffic demand that must be served.

The most common type of vehicle detection device in use by MnDOT is the inductive loop. The loop is a coil of wire embedded in the pavement that carries a very low level, high frequency signal. When a conductive mass passes over the loop it creates an inductance change causing the resonant frequency to change. The frequency change is sensed by the detector and it signals the controller that a vehicle is present.

Other types of vehicle detectors include magnetic coil, microwave, radar, sonic, and video. Descriptions can be found in technical literature.

**Detector Functions**

Vehicle detectors perform a variety of functions. They can place a call to the controller to change the right-of-way at the intersection, extend the amount of time the phase is given, and can be used to count traffic.

Detector placement for most efficient operation of a traffic-actuated intersection is a complex subject and is discussed in the MnDOT Signal Design Manual and the MnDOT Traffic Signal Timing and Coordination Manual.

**Pedestrian Pushbutton**

A pedestrian pushbutton, is a pushbutton switch mounted near a crosswalk. When the button is pushed, it indicates to the controller that a pedestrian is present and wishes to cross the street.

All new traffic control signals are required to be ADA compliant. Accessible pedestrian signals (APS) are placed at all new traffic control signals that have a pedestrian indication. Accessible pedestrian signals use a button that includes a locating tone along with sound, LED confirmation light, and tactile (vibrating) information to assist users in crossing the street. When a major revision of a traffic control signal is being done, an APS must also be installed. Major reconstruction is considered work affecting poles on 3 of the 4 corners at the intersection. When other work is being done at the intersection such as a mill and overlay, the signal should be at a minimum made “APS ready”. APS ready means wires, conduit, and pedestrian stations have been placed in the intersection corner so that only the APS buttons need to be installed in the future. More information can be found in the MnDOT Signal Design Manual and the MnDOT ADA Guide.

**Installation**

The installation of saw cut inductive loop detectors is shown on Standard Plate 8130; the installation of the Rigid PVC inductive loop detectors is shown on Standard Plate 8132; the installation of Accessible Pedestrian Signals (APS) is shown on a detail sheet included in the plan set.
9-4.02.06 Source of Power and Service Equipment

Signal controller cabinets are powered by 120 volts alternating current (VAC) electricity from the local electric utility company. The cabinet is wired to a signal service cabinet. The electric utility company brings power to the meter. On the load side of the meter, the wiring and circuit breakers or fuses belong to the agency that owns the signal. The combination of meter and circuit breakers is called service equipment. The location of the service equipment is called the source of power.

Service equipment is mounted on the equipment pad along with the controller cabinet. In rare cases it can be mounted on a wood pole. MnDOT signal service cabinets are designed to accommodate a battery backup system. In the design process, a decision to use a battery backup system must be made. The cabinet can use up to four batteries and a power inverter. The cabinet can be used without a backup system and can accommodate the inverter and batteries anytime in the future, if desired.

Service equipment and the equipment pad are detailed within the plans. Signal Controller cabinets are state furnished and service equipment must be purchased off the MnDOT approved products list for signal equipment.

9-4.02.07 Conduit and Handholes

The electrical wiring between the signal cabinet and the poles or pedestals usually travels in underground conduit. Conduit can be either rigid steel conduit or non-metallic conduit whose size is determined by the application and the number of cables that it must accommodate. A grounding wire is needed if there are 120 VAC power conductors in the conduit.

Handholes must be listed on the MnDOT approved products list. They are placed in conduit runs to provide junctions for conduit, to facilitate the pulling of cables, and to provide water drainage for the conduits.

9-4.03 Timing and Coordination of Traffic Control Signals

Details for timing and coordination of traffic control signals are in the MnDOT Traffic Signal Timing and Coordination Manual.

It is often necessary to consider the movement of traffic through a system of consecutive intersections or through an entire network, rather than through a single intersection. In this case, each traffic control signal is considered a dependent part of a system. The goal is to maximize the efficiency of the whole system rather than any one intersection in the system.

A system of traffic control signals can be made up of a number of fixed-time controllers, a number of actuated controllers, or a combination of both kinds. A group of intersection controllers is usually interconnected by twisted pair copper wire or fiber optic interconnect, though sometimes time-based coordination or wireless interconnect is used.

In coordinated master or central controller systems, the entire system and all individual controllers can be controlled by a computer that receives information from detectors and adjusts the traffic control signal system according to traffic demand.

In general, two or more signalized intersections can be coordinated if they are less than one-half mile apart, or if the travel time between them is less than a cycle length. Coordination software may suggest coordination between signals that are more than one-half mile apart. Coordination between signals can be considered at any distance as long as an analysis can prove beneficial. A timing mismatch of even a few seconds between two intersections can result in considerable delay to traffic.

Software should be used to show and to help coordinate traffic signal timing at adjacent intersections.

The selection and use of specific coordination equipment should take into account the nature of the area, the traffic characteristics of the roadway, and the available capital and operating budget.
9-4.04 MnDOT Enforcement Light

An enforcement light is an additional light (blue) that is added to the back of the signal pole or indication. Proper positioning of this light allows a single police officer to see the enforcement light, the approach stop line, and the offending vehicle at the same time. The light is wired to be in sync with the red indication and therefore permits an officer to enforce violations of the red light from a strategically accommodating position near the intersection. In many cases, given conditions at the intersection, the light may not be beneficial to red light enforcement and a decision to install should be made between the signal agency and the local police department. The light should not be installed without consideration from all agencies involved. The light is only intended to be seen by the enforcement officer and should only be installed selectively on one or two of the intersection approaches to avoid confusion.

9-4.05 Standard Design/Operation for MnDOT Signals with Railroad Preemption

The circuits detailed below should be installed when railroad preemption at a traffic control signal is required. MnDOT will need to notify the railroad of the preferred design circuits. Optional circuits may depend on existing conditions such as number of tracks or traffic controller type.

Railroad Interconnection

Railroad Interconnection is the electrical connection between the railroad active warning system and the traffic signal controller assembly for the purpose of railroad preemption.

Railroad Advance Preemption and Advance Preemption Time

This is when notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly by railroad equipment for a period of time prior to activating the railroad active warning devices. This period of time is the difference in the Maximum Preemption Time required for highway traffic signal operation and the Minimum Warning Time needed for railroad operation and is called the Advance Preemption Time.

Railroad Simultaneous Preemption

This is notification of an approaching train that is forwarded to the highway traffic signal controller unit or assembly and railroad active warning devices are activated at the same time.

Railroad Maximum Preemption Time

This is the maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the Right-of-Way Transfer Time, Queue Clearance Time, and Separation Time.

Railroad Single Break Interconnect Circuit

This is a 7 - 2 wire circuit interconnection between the signal controller cabinet and the railroad bungalow equipment.

Interconnect cable from the traffic control signal cabinet to the railroad bungalow should be a 2-12/c #14 signal control cable in accordance with 3815.2C.3. The following two-wire circuits should be established within these cables:

1. Energy - 24VAC RMS

2. Advanced Preemption - Begins the railroad preemption sequence when the railroad equipment first notifies the traffic controller of an approaching train.

3. Supervisor - Additional circuit providing additional verification of the integrity of the interconnect cable between the signal cabinet and the railroad cabinet. If the circuit is broken the traffic control signal will go into all red flash.

4. Simultaneous Preemption - Activates when lights on the railroad begin to flash. Should be used to turn on blank out signs if present. Can also be used for train restart if train stops with detection area for switching.
5. **Gate Down** - Activates when the highway-rail grade crossing gate arms are lowered to near horizontal. Prevents track clearance green from terminating before the railroad crossing gates are down.

   The Traffic Health Circuit is provided by the traffic signal control cabinet unit to the railroad crossing warning system. It is connected to the controller cabinet signal flash transfer relay control circuit so that the health circuit will de-energize any time the traffic control signals are flashing or dark. If the railroad detects a signal health fault the railroad crossing gate arms will begin their decent as soon as an approaching train is detected.

7. **Advanced Pedestrian Preemption Circuit (new 2019)**
   The Advanced Pedestrian Preemption Circuit begins a sequence to terminate any active pedestrian (not vehicle) movement when the railroad equipment first notifies the traffic signal controller of the approaching train. This circuit is ideal for long pedestrian clearance times. The circuit is activated by the equipment response railroad equipment and some traffic controllers do not accommodate this preemption input.

   The railroad preempt circuit should be a single break interconnect circuit with supervision and gate down logic (gate horizontal control).

   A battery backup system should be installed and utilized on all new traffic signals that have railroad preemption.

   Turning movements toward a highway-rail grade crossing where the intersection traffic control signals are preempted by the approach of a train and are located within 200 feet of the highway-rail grade crossing should be prohibited during the preemption sequence based on criteria in Chapter 8 of the **MN MUTCD**. If the left turn is prohibited, new and reconstructed signals with left turns with an exclusive left turn lane should install a 4-section flashing yellow arrow signal head and utilize the RED arrow to prohibit this move. A blank-out sign may be needed to prohibit the left turn if there is a shared through-left turn lane. If the right turn is prohibited, blank-out signs prohibiting right turns should be used at all new and reconstructed signals to prohibit turning movements toward the highway-rail grade crossing during preemption. The approved blank-out signs are shown below in Figure 9-1.

   ![Blank-Out Signs](image)

   **Figure 9-1 Blank-Out Signs**

   An engineering study may be conducted to analyze whether or not to prohibit the turns based on a diagnostic team review. The team should consist of representatives from the MnDOT Signal Design Team, MnDOT's Office of Freight and Commercial Vehicle Operations, and any local authorities affected. This decision must be documented and kept in the signal design file. Some factors to be considered during this review include: geometrics of the intersection, turn lane capacity, design vehicle, volumes, and the speed limit of the tracks.

   Additional guidelines for the railroad preemption can be found in the [MnDOT Traffic Signal Timing and Coordination Manual](#) and the [MnDOT Signal Design Manual](#).
9-5.00 TRAFFIC SIGNAL JUSTIFICATION PROCESS

9-5.01 Engineering Studies for Traffic Signals

Intersection Control Evaluation (ICE) reports must be completed to document the process of selecting the optimal control for an intersection based on an objective analysis for existing conditions and future needs.

If traffic control signals are proposed for an intersection, enough study should be done and documented to demonstrate the need for a traffic control signal.

Studies that will be helpful in assessing and demonstrating the need for a traffic control signal include the following:

- Volume studies including approach volumes, turning movements, and peak hour detail counts.
- Pedestrian counts including any unusual numbers of children, handicapped, and elderly.
- Traffic gap studies.
- Speed studies.
- Crash studies.
- Intersection delay studies.

Procedures for doing various traffic studies are found in the Institute of Transportation Engineers, Manual of Transportation Engineering Studies.

Intersection Control Evaluations are discussed in Section 9-5.02.04 of this chapter.

9-5.02 Warrants and Justification for Traffic Control Signals and Flashing Beacons

9-5.02.01 Traffic Control Signal Warrants

Warrants have been developed to determine if an intersection needs some type of traffic control. Justification for a signalized intersection should be based on meeting one or more of the established warrants as stated in the Minnesota Manual on Uniform Traffic Control devices (MN MUTCD). Traffic control signals should not be installed unless one or more of the signal warrants in the MN MUTCD are met, but the meeting of a warrant or warrants does not alone justify the installation of a traffic control signal.

The data collected as part of the engineering studies should be used in combination with the warrants to justify the need to install the traffic control device. The ICE should show that the intersection will benefit in improved safety and/or operation.

The traffic signal warrants are stated in Part 4 of the MN MUTCD. There are 9 warrants for traffic signals. Refer to Part 4 of the MN MUTCD for definitions of each of these warrants.

The statements that follow give intents and interpretations of the warrants. Only the warrants that need clarifications are listed here.

WARRANT 1: Eight-Hour Vehicular Volume

Warrant 1 is the warrant that pertains to volume and is the most common warrant for justifying intersection control.

The same eight hour period must be used for both the Major and the Minor Streets. Either Condition A (Minimum Vehicular Volume) must be met for 8 hours or Condition B ( Interruption of Continuous Traffic) must be met for 8 hours. It does not need to be the same 8 hours for Condition A and Condition B.

MnDOT policy on the use of the speed reduction factor is that if a mainline roadway has a posted speed limit of 45 mph or above, that is sufficient evidence that the 85th percentile speed is above 40 mph, and a speed study is not required.

The population reduction factor (70%) mentioned in Warrants 1-3 states that an intersection lying “within the built-up area of an isolated community having a population of less than 10,000...”. In the seven-county
metropolitan area, it is often a judgment call whether a community is isolated or not. There is no strict criteria on this. Geometrics play an important part in determining the volume requirements.

**WARRANT 2: Four-Hour Vehicular Volume and WARRANT 3: Peak Hour**

These warrants may not be addressed by projected or hypothetical volumes, or for currently nonexistent intersections. Actual on-site studies are required.

**WARRANT 4: Pedestrian Volume**

This warrant allows the installation of a traffic signal if there are a considerable number of pedestrians. If a signal is warranted, the signal should be traffic actuated with pedestrian indications.

**WARRANT 6: Coordinated Signal System**

An ICE report addressing Warrant 6 should contain a time-space diagram of the proposed intersection and nearby signals, helping to demonstrate that a progressive system will help maintain platooning and group speed.

Signals are installed under Warrant 6 on the basis of the 85th percentile speed, so a speed study is necessary for this warrant. It is expected that any signal installed under Warrant 6 would include interconnect.

**WARRANT 7: Crash Experience**

For Warrant 7, the requirement is the 80% columns of Warrant 1, Condition A or Condition B, or 80% of the pedestrian volumes of Warrant 4.

ICE reports that address Warrant 7 are to include a collision diagram. A time-space diagram showing that the proposed signal system will not seriously disrupt progressive traffic flow should be included. Discussion of the failure of less restrictive remedies is also required by the MN MUTCD.

Current MnDOT policy is that, in general, Warrant 7 is not applicable to an intersection that is already signalized.

**WARRANT 8: Roadway Network**

Current MnDOT interpretation of Warrant 8 is that its intent is the use of a signal to pull traffic away from other intersections, “to encourage concentration and organization of traffic flow networks.” Therefore, MnDOT policy is that Warrant 8 does not apply to isolated intersections, but rather to intersections in urban grid systems.

**WARRANT 9: Intersection Near a Grade Crossing**

Warrant 9 is intended for use on an intersection approach with a STOP or YIELD sign where the proximity of a grade crossing is the main reason to consider installing a traffic control signal. This warrant should be used only where the conditions described in the previous traffic signal warrants are not met.

**9-5.02.02 Warrants for Flashing Beacons at Intersections**

Flashing beacons at intersections include intersection control beacons mounted on span wire directly over an intersection (all-way stop only), stop beacons mounted on a pedestal above stop signs (red), and warning beacons mounted on a pedestal above intersection ahead symbols signs (yellow). Both overhead and pedestal mounted beacons have advantages and disadvantages. Overhead beacons may distract the motorist from roadway signing, but they aid the motorist in locating the intersection. Pedestal mounted beacons help draw attention to stop and intersection ahead signing, but do not help locate the intersection for the mainline driver who sees only flashing yellow mounted on an intersection ahead sign, somewhere in advance of the intersection itself. In any case, any flashing beacon must be justified under one or more of the following warrants.
WARRANT 1: Limited Visibility
Where sight distance is limited, a flashing beacon may be installed if the sight distance is less than that shown in the table below for any approach to the intersection. Locations qualifying under limited visibility must have previously had adequate warning signs and pavement markings installed.

<table>
<thead>
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<th>Design Speed (mph)</th>
<th>Stopping Sight Distance (feet)</th>
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<td>820</td>
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NOTE: The distances here are to ensure the driver (3.5 ft. height-of-eye) who can not see an oncoming vehicle (3.5 ft. height-of-object) has enough time to react and make a stop. The numbers above are based on the 2011 AASHTO, “A Policy on Geometric Design of Highways and Streets”, Table 3-1: Stopping Sight Distance on Level Roadways, page 3-4.

WARRANT 2: Crash Rate
A flashing beacon may be installed where high-hazard safety improvement criteria are met or where in one year where there have been four or more crashes of the right-angle or left-turn type or of the type deemed preventable by a flashing beacon.

WARRANT 3: School Crossing
A flashing beacon may be installed at an established school crossing where, during the heavy crosswalk usage periods, there are more than 500 vehicles per hour (actual or effective rate) crossing the crosswalk, AND, insufficient usable gaps for pedestrians using the crosswalk.

WARRANT 4: Rural Trunk Highway Junctions
At or near some rural junctions of two or more high speed trunk highways, a flashing beacon may be installed to warn drivers of an unexpected crossing of another highway.

9-5.02.03 Advance Warning Flashers (AWF) Consideration
An Advance Warning Flasher (AWF) is a device that MnDOT uses to convey to the motorist information about the operation of a traffic signal. An AWF is typically found at certain high speed locations where it may be necessary to get the motorists attention through a visual indication about a pending change in the indication of a traffic control signal. The AWF assists motorists in making safer and more efficient driving decisions by informing them that they must prepare to stop. The AWF configuration, placement, and timing details can be found in Part 4 of the MN MUTCD.
An AWF should only be installed in response to a specifically correctable problem, not in anticipation of a future problem. Generally, AWF implementation is appropriate only at high speed locations. Before an AWF is installed, other remedial action should be considered.

Refer to the MnDOT Signal Design Manual and MnDOT Traffic Signal Timing and Coordination Manual for guidelines for consideration and timing of AWF’s.

9-5.02.04 Intersection Control Evaluation (ICE)

Why an ICE Report
Selecting the appropriate traffic control for an intersection is an important aspect of intersection design and should be initiated early in the design process. Previously, engineers mainly considered the installation of a traffic signal or stop signs to mitigate traffic delay and safety problems for at-grade intersections. This rationale has changed over the years and now there are many different options for intersection control including the installation of a traffic signal, all-way stop, roundabout, reduced conflict intersection, higher capacity intersections, and grade separation. To select the optimal design, an Intersection Control Evaluation (ICE) may need to be completed. The ICE process will compare the viable intersection control alternatives on an equal basis and help identify the best alternative.

Definition and Purpose
The goal of an ICE is to identify the optimal control for an intersection based on an objective analysis for existing conditions and future needs. The overall design of the intersection and multi-modal uses (pedestrian, bicycle, and transit) should also be considered. In some instances, a corridor analysis will be required depending on the intersection in relation to adjacent intersections and their respective traffic control.

There are several areas of analysis that should be evaluated through the ICE process:

• Intersection/roadway safety,
• Traffic operations,
• Intersection geometry design, and
• Identification of the appropriate traffic control device.

Based on the results of the preliminary analysis, further considerations may be needed on a case-by-case basis to investigate other factors such as an economic analysis, environmental considerations, right-of-way, and political issues. The purpose of the ICE report is to document the analysis and design considerations, and to document how these determined the study recommendations.

The scope of an ICE report can vary widely and should be determined case-by-case and be specific to address the intersection or project needs. Preliminary discussions with the governing agency should always be completed when considering the scope of the ICE. These discussions will assist in refining the scope and context of the analysis and what should be documented within the ICE.

The following provides general guidelines to help determine when an ICE should be completed:

• When any intersection or traffic control improvements are being considered on a trunk highway or NHS roadway.
• When a trunk highway intersection with a county or municipality cross-street is being considered for intersection improvements or a traffic control change.
• When existing safety or traffic operational issues exist or are expected in the future, and there is a need to identify improvements.
• As part of a state or local agency roadway reconstruction project where intersections are impacted; and there is a need to identify the appropriate lane geometrics and intersection control devices.
General Information
All intersection treatments must be considered as early in the project as possible. An ICE is not required for intersections that are determined to need minimal control such as two-way stop, yield, or no control. However, a traffic operation or safety analysis may be necessary to ensure an appropriate design. The contents of an ICE can support these traffic control decisions.

An ICE must be written under the supervision of a licensed Professional Engineer in the State of Minnesota and approved by the District Traffic Engineer before the preliminary plan is finalized. Each district can require additional review and approvals, if desired.

See the MnDOT Traffic Engineering’s Intersection Control Evaluation Guidelines for Implementation website for more information.

Intersection Control Alternatives
There are many alternatives for intersection control, each with advantages and disadvantages. Each type of control considered for an intersection design alternative should be acceptable to the public, the local governmental unit, and the local road authority. A list of common traffic control options follows. It may not always be necessary to review all options. As an example, some intersections may require more emphasis on intersection design characteristics and only require a review of one or two different traffic control options. This list is not all-inclusive and it is possible that an entirely different or unique solution may be preferred or justified at a certain location. See the MnDOT Traffic Engineering’s Intersection Control Evaluation Guidelines for Implementation website for more information.

• Traffic Signal
• Two-Way Stop Control
• All-Way Stop Control
• Roundabout
• Non-Traditional Intersections
• Access Management Treatments
• Grade Separation

The ICE Process
The process needed to complete an ICE is highly dependent on several factors: project origination and size, type of project, and the magnitude of traffic operation or safety issues to address. These factors influence the complexity and extent of the study.

The ICE process is conducted in two phases:

Phase 1
Phase 1 is completed very early in the project development process with the purpose of scoping and recommending one or more traffic control options for further development. In Phase 1, data is collected, warrant analyses are completed, and operational and safety analyses of the alternatives are performed for existing and future conditions. A decision may be reached after Phase 1 if there is only one viable alternative, but it still may be necessary to develop preliminary layouts, cost estimates, and other project development tasks to complete the ICE report.
Phase 2
The second phase, if needed, is alternative selection and development of an approved preliminary layout. In Phase 2, a more rigorous design process is needed using MnDOT’s typical design process for developing preliminary layouts. In some instances, multiple intersection alternatives will need to go through the entire design process for equal comparison. Once a preferred alternative is selected, the formal ICE report can be written documenting the design process.

Depending on the scope and size of the project, a Public Involvement Process may be needed where local stakeholders and the general public can provide input and comment on the alternatives.

![Figure 9-2 ICE Development Process](image)

Figure 9-2 ICE Development Process

Depending on the complexity of the project and scope determined with the local agency, the necessary steps to complete an ICE are as follows:

- Warrants and Justification - There are 9 warrants for traffic signals. Refer to Part 4 of the [MN MUTCD](https://www.mn.gov/tdot/plan/trafficengineering/ice/manuals/ICEManual.pdf) for definitions of each of these warrants.
- Crash Evaluation
- Intersection Capacity Evaluation
- Intersection Design and Engineering Considerations
- Right-of-Way Impacts and Project Cost
- Political Considerations and Public Involvement
- Multi-Modal Considerations
- Other Considerations

The steps are described in detail in the ICE Manual found on the [MnDOT Traffic Engineering’s Intersection Control Evaluation Guidelines for Implementation](https://www.mn.gov/tdot/plan/trafficengineering/ice/manuals/ICEManual.pdf) website.

**ICE Report/Memorandum**

Depending on the amount of the analysis, a full report may not be necessary and a memorandum will be acceptable. The ICE manual provides a detailed outline, data requirements, and a sample of a typical ICE report.
9-5.02.05 Traffic Control Signal Removal Justification Criteria

Signalized intersections that meet 80 percent of the volume requirements of MN MUTCD Part 4, Warrant 1 should be considered justified and should not be removed. Signalized intersections that do not meet 80 percent of the volume requirements of MN MUTCD Part 4, Warrant 1, but meet 60 percent of the volume requirements of Warrant 1 are in the gray area and may be considered for traffic control signal removal. Additional studies, findings, engineering judgment and documentation beyond the volume requirements will be needed to justify retaining the signal.

Signalized intersections that do not meet 60 percent of the volume requirements of MN MUTCD Part 4, Warrant 1 and meet no other Warrant are unjustified traffic control signals and should be removed. The traffic signal removal decision process should be followed as set forth in the “User Guide for Removal of Not Needed Traffic Signals”, FHWA-IP-80-12, November 1980.

In the traffic control signal removal process, the District Traffic Engineer considers all the findings and the decision is made whether or not to remove the traffic signal. The final decision concerning signal removal is a blend of analytical procedures and political considerations coupled with professional judgment. However, the technical findings from the analysis should provide a strong factual basis for reaching, supporting, and defending the final decision or recommendation. The most important factor in success for removing the traffic control signal is early and frequent contact with the community in question to outline why the traffic control signal removal is being considered (safety, delay, and cost (refurbishing and maintenance)) and to obtain the community’s feedback and concerns.

All findings of the decision process shall be summarized by the District Traffic Engineer in a signal removal justification report. As part of the traffic control signal removal justification report, a review of all-way and two-way stop warrants to determine which control solution would be the best replacement should be completed.

Convincing the community of what type of traffic control should replace the signal can be a challenge. Communities are often concerned about the speed of traffic through town, and pedestrian safety due to the absence of the traffic signal. The public perception is often that a traffic signal is a safety and traffic calming device, when in fact the signal’s sole purpose is to indicate the right-of-way.

All traffic control signals that are determined to be retained should be revised to meet current standards. These traffic control signals should be prioritized along with other traffic control signal projects and scheduled for revision as permitted.
9-6.00 TRAFFIC CONTROL SIGNAL PROJECT PROCEDURES

9-6.01 Traffic Control Signal Project Management Flowchart

Chart 9-1 below illustrates a typical state-let traffic control signal project management flowchart based on the deliverables and important milestones.

![Flowchart Image]

Chart 9-1 Typical State Let Traffic Signal Project Management Flowchart
9-6.02 Notes on Traffic Control Signal Project Management Flowchart

A. START PROJECT
The Statewide Transportation Improvement Plan (STIP) and the Program and Project Management System (PPMS) identify the project and project manager. This is the beginning of tracking of the project. Signal design projects can be characterized based upon the following parameters:

1. Contracting agency - MnDOT let versus local agency let, or force account (work by MnDOT or local maintenance forces).
2. Funding source - state federal funds, local federal funds, state funds, state funds through a cooperative agreement, state aid funds, and local funds.
3. Designer - MnDOT, consultant, design build contractor, county and city.
4. Scope - Stand alone signal project or part of larger construction project.

B. PROJECT NOTIFICATION LETTER
Early project coordination is the key to a successful review process. For MnDOT designed projects, the Project Notification Letter is sent from the MnDOT district to the affected local agencies of an upcoming project. The letter describes the project need and justification, scope, proposed letting date, expected construction duration, contact personnel (name, title, mailing address, phone, and e-mail), funding source(s), and any need for inplace plans and mapping.

For externally designed projects, the designer should send the Project Notification Letter to the MnDOT District Traffic Engineering office with similar information.

C. PROJECT KICKOFF MEETING
The designer should schedule a Project Kickoff Meeting to discuss the project scope, data collection findings and goals, and MnDOT and local agency issues and goals. The meeting’s purpose is to make all project participants fully aware of all issues so that the project management, scope, funding, and technical issues are resolved prior to the beginning of signal design activities. This meeting should include the signal designer, local agency project manager (city, county, etc.), agencies affected by the project (cost, operation, maintenance), and MnDOT District Traffic Engineering office personnel.

In preparation for the Project Kickoff Meeting, the designer will begin data collection. The data to be collected (as needed) should include: obtaining inplace signal plans (or CADD files if available), obtaining mapping if available, identifying any current problems with signal operations and/or maintenance, identifying signal design standard or geometric deficiencies, checking for other proposed projects in the vicinity including project time lines, checking crash rates, checking existing cabinet/controller condition and compatibility, and obtaining a preliminary cost estimate for state furnished materials and labor.

The following is the project Kick-off Meeting check list for each intersection affected by a project:

Project Management

• MnDOT Traffic Engineering project manager
• Project sponsor/lead (MnDOT, city, county)
• Designer (MnDOT, city, county, consultant)
• Project location (TH/Intersection)
• Project process (Permit, State Aid, local initiative/AM funding, MnDOT Programmed)
• Proposed project time line

Project Scope

• Work proposed (new signal, major/minor revision, EVP, phasing change, standard, accessible pedestrian signals, flashing yellow arrow)
• Project proposer’s specific goals (lanes, phasing, heads, EVP, etc.)
MnDOT’s specific goals (lanes, phasing, heads, EVP, etc.)
Effect/coordination with RTMC systems
Effect/coordination with lighting systems
ICE/project memo required
Operation issues
Operation issues not addressed by proposed project
Maintenance issues
Safety/crash issues
Traffic engineering construction liaison scope of responsibilities

System Operation/Management
Use Cost Participation, Operations, and Maintenance Responsibilities Worksheet

Funding/Costs
State, City, or County furnished materials and labor estimate for proposed work
Need for an agreement (signals/lighting) for this proposed work (Pre-agreement letter to follow, if necessary)
Need for a permit for this work
Funding sources and cost participation of proposed work

Technical Issues (Use Field Walk Checklist to Identify all Issues)
Field walk
Effect on inplace source of power
Battery backup system must be installed if the traffic control signal will have railroad preemption
SOP meeting and notification letter needed
Equipment pad revisions needed
EVP sight lines adequate (vertical and horizontal)
Effect on inplace interconnect - need for interconnect
Effect on inplace HH’s - need to be moved or receive replacement covers
Standards upgrades proposed/needed (LED, EVP, pedestrian indication, etc.)
Phasing review needed
Detection needs/changes
Striping/signing affected
Approach signing affected (review conflicts)/needed (coordinate)
Utility information and process/needs - notification letter and time line
Specification requirements (design, operations, CESU for EVP card delivery, etc.)
Accessible pedestrian amenities status including Americans with Disabilities Act (ADA) compliance (ramps, sidewalk, indications, PB placement, markings)

Further Contacts
Since the project scope can change as result of data review and this meeting, define what actions will be taken to inform all attendees and stakeholders of project scope changes.
References

- Refer to www.dot.state.mn.us/trafficeng for checklists, details, standards, sample special provisions, and other significant information.
- Refer to signal design manuals for processes and technical information.

D. PRELIMINARY ESTIMATE

A Preliminary Estimate will be the basis for the costs in the Pre-Agreement Letter. The Preliminary Estimate will include the preliminary construction contract cost and will additionally identify costs for state furnished materials and labor, and costs for design and construction engineering. As the project costs become better defined, the designer should update the Preliminary Estimate.

E. PRE-AGREEMENT LETTER

The District Traffic Engineering project manager will send a Pre-Agreement letter to affected local agencies and MnDOT offices identifying the following:

1. Preliminary Estimate with breakdown.
2. Project scope.
3. Funding and cost participation.
4. Time line.
5. Major/minor maintenance responsibilities.
6. Source of power supply costs and ongoing responsibilities.
7. Signal and coordination operation responsibilities.
8. State, County, or City furnished material/labor.
9. Construction engineering costs.


F. Intersection Control Evaluation (ICE) Report

An ICE Report shall be approved by the MnDOT District Traffic Engineer. This report should be completed prior to traffic control signal plan development, but only after the project scope is clearly defined. See Section 9-5.02.04 of this chapter for details of the ICE.
**PENCIL SKETCH**

A "pencil sketch" or preliminary CADD drawing (usually graphics and charts - no pole or construction notes) of the new signal should be provided to the MnDOT District Traffic Engineering office for review. This will allow MnDOT to comment on important design elements (head placement, detection, phasing) prior to signal plan development. This will eliminate significant design changes once the signal design has begun.

Signal designers should meet and confer to agree on preliminary signal design. The design topics to be discussed should include, but not be limited to the following:

1. General nature of the signal project: new installation, minor, or major revisions.
2. Phasing of the intersection, relation of proposed phasing to the traffic volumes and turning movements; use of flashing yellow arrow left-turn phasing rather than protected-only; use of overlaps.
4. Restricted movements at the intersection.
5. Lack of sight distance.
6. Determine design standards based on who will operate the system.
7. Use of 4-section heads and non-standard bracketing.
8. Head type.
9. Appropriateness of poles and pedestals for the site.
10. Placement of signal standards to ensure legal placement of all vehicle and pedestrian signal indications. See the MnDOT Signal Design Manual, for signal head placement diagrams.
11. Placement of accessible pedestrian signals relative to signal poles and inplace sidewalks and crosswalks.
12. Need for EVP and placement of components.
13. Need for battery backup.
15. Detector placement and functions. See the MnDOT Signal Design Manual for loop detector placement diagrams.
16. Placement and type of handholes.
17. Design of equipment pad.
18. Type of service equipment.
19. Discuss needs for combined pad with lighting and/or TMC.
20. Need for intersection geometric improvements.
21. For revised systems, the wording of the signal pole notes for the revision.
22. Need for AWF’s, supplemental heads, etc.
23. House moving route needs.
24. Painting of signal if required by the local agency. The cost of painting is solely the responsibility of the local agency.
25. Luminaires metered or unmetered.
26. Source of power (to determine cabinet location).

27. Interconnect (determine need and type, location of master).

G. PRELIMINARY PLANS AND SPECIAL PROVISIONS
For in house designs, the MnDOT District Traffic Engineering office project manager distributes the preliminary signal design package (as distinct from a roadway design package) for review to the MnDOT District Traffic Engineering office, District State Aid office, Cooperative Agreements, Consultant Agreements, Permits, Metro or Regional Electrical Service Unit, and other district functional offices as appropriate. The preliminary signal design package should consist of the appropriate number of copies of signal plans (hard copies), signal special provisions, Microstation CADD file, preliminary estimate, source of power letter, and power application form (if applicable). The preliminary signal design package is required for all projects. The District Traffic Engineering office project manager works directly with the designer on format and technical comments, keeping other project managers informed.

The plan should identify the Traffic Engineering (TE) number, the system ID number, the master ID number (if applicable), and the electric utility meter address.

NOTE: To expedite the signal plan review process, the signal plan should be checked by the signal designer prior to submittal. A checklist for plan reviews is available in the MnDOT Signal Design Manual.

H. TRAFFIC ENGINEERING REQUEST
A Traffic Engineering (TE) Request is a work order requesting state furnished materials and/or labor from the Central Electrical Services Unit. Signal projects let by MnDOT will utilize a state furnished traffic signal controller and cabinet. Other state furnished materials, especially for temporary traffic signal systems, may include microwave or video detection systems. In addition to the state furnished materials, a TE Request may also include a request for labor, such as modifying wiring within an existing signal controller cabinet in the field and APS installation. The District Traffic Engineering office prepares and submits the TE Request in the AFMS system and the Central Electrical Services Unit approves it.

The project special provisions should require the Contractor to contact the Central Electrical Services Unit to request the state furnished materials at least 30 days before the materials are needed. The Central Electrical Services Unit will finalize the TE Request, which ensures that the materials are correctly charged to the signal construction project.

The project special provisions should require the Contractor to again contact the Central Electrical Services Unit three days before picking up the state furnished materials.

I. SIGNAL AGREEMENT
MnDOT shall prepare a signal agreement as needed. Items typically covered within the agreement are:

1. Construction cost participation.
2. Responsibility for power cost.
3. Responsibility for major maintenance.
4. Responsibility for minor maintenance.
5. Responsibility for maintenance costs.
6. Responsibility for battery backup.
7. LED indication replacement schedule.
11. Reimbursement for State, County, or City furnished materials/labor.

12. Construction engineering costs.

The signal agreement request is often part of the final Plan Turn-In. Projects requiring signal agreements should not be let without the agreement signed by the local unit of government. The construction project should not be awarded without a fully executed agreement (signed by all parties).

J. PLAN TURN-IN

The MnDOT District Traffic Engineering office project manager ensures that all of the comments to the preliminary submittal have been appropriately addressed. Upon completion of the final review, MnDOT (either the District Traffic Engineering office project manager or the larger roadway project manager) will begin final processing of the project package. Once all the district and local signatures are obtained, the project will be submitted to the Pre-Letting Section of the Office of Technical Support for final processing.

Traffic control signal plan approvals handled by MnDOT for other agencies, with or without the state aid process, are handled differently depending on whether the project has federal funding participation, and whether or not the intersection involved is on or off the trunk highway system.

If a traffic control signal at a trunk highway intersection is being built or revised by any other agency, the District Traffic Engineer shall approve the final plans before bids are opened on the project. If a proposed signal is not at a trunk highway location, the District Traffic Engineer will indicate concurrence with the design by means of a memorandum to the State Aid office.

The project submittal package should include:

1. Hard copy and Microstation CADD files of the signal plans.
2. Hard copy and Microsoft Word files of the signal special provisions.
3. Tabulation of Quantities for the signal project.
4. Sight distance calculations.
5. ADA decisions.
6. SOP letter and checklists.
7. Project correspondence.
8. Major design decisions.

K. ENGINEER’S ESTIMATE

The Office of Technical Support prepares the final Engineer’s Estimate based upon the tabulation of quantities provided by the signal designer.

L. PRE-CONSTRUCTION MEETING

For the Pre-Construction Meeting the District Traffic Engineering office project manager should invite the MnDOT District Traffic Engineering office operations personnel as appropriate.

M. AS-BUILT PLANS

As-builtin signal plans should be forwarded to the MnDOT District Traffic Engineering office upon completion of projects administered by local agencies.

N. Global Positioning System (GPS) Component and Utility Location Data

GPS coordinates should be collected for each traffic signal pole or pedestal including pedestrian push button stations, SSB service and traffic signal cabinets, handholes, source of power, and underground cable that is either direct buried or in conduits installed. This information should be forwarded to the MnDOT Traffic Engineer to be used with the MnDOT Geographic Information System (GIS).
9-7.00 TRAFFIC CONTROL SIGNAL DESIGN

9-7.01 General Considerations

The design of a traffic control signal system is a process of balancing, among other things, the requirements of the MN MUTCD, intersection geometrics, operational characteristics of the intersection vehicle and pedestrian traffic, the nature and volume of arterial traffic, and the constraints of the construction process. Please see the MnDOT Signal Design Manual for more information.

9-7.02 Intersection Geometry

Intersection geometry is an important element of traffic control signal design. The design of traffic control signal system hardware and operation of the traffic control signal system should be preceded by a thorough evaluation and, if necessary, geometric improvement of the existing intersection.

The following geometric elements should be considered:

1. Pavement width should be adequate for anticipated traffic movements and future capacity requirements. Highway capacity analysis should be performed to get a better understanding of the capacity of the intersection.
2. If appropriate islands should be designed and constructed so that the driver has adequate reaction distance to them and they are large enough to install a standard signal foundation. Existing shoulders should always be carried through the intersection; this will usually provide enough reaction distance to the island. However, turning radii should be checked to ensure enough setback for comfortable turns.
3. Turn lanes must provide adequate storage in order to prevent turning traffic from interfering with other traffic movements and thus causing capacity breakdown.
4. When a median width is more than 30 feet between opposing through lanes, special signal design considerations are necessary (See MN MUTCD Section 4P). Extremely wide medians confuse drivers on the crossing street, prevent them from being comfortable with opposing traffic, and cause them to lose track of their path. Wide medians also cause capacity restrictions because more time is needed for vehicle movements and clearances through the intersection.
5. Sidewalks should be constructed as close to the center of the corner as possible. Pedestrian crosswalks should be in line with the sidewalk and as close to the intersection as practical. ADA guidelines must be followed for proper ramps, pedestrian access routes, and push button locations.
6. Alignment changes within the intersection should be avoided. Vehicles approaching the intersection should be directed through the intersection. Vertical alignments approaching signals must allow for proper signal visibility.
7. Driveways within an intersection should be signalized and accommodated by the intersection geometrics. Whenever feasible, the driveways should be located or relocated outside the limits of the intersection.
8. The size of corner radii is an important consideration. Excessively large corner radii may obscure intersection limits and create a hazard for bicycles and pedestrians, while very small radii may create a hazard for motorists. Corner radii at signalized intersections should not be less than 20 feet nor more than 60 feet. A turning radius guide for 58-foot vehicles should be used to determine proper corner radii. At intersections where bus routes are located, corner radii should be analyzed giving due consideration to bus maneuvers.
9. It may be necessary to relocate utilities such as manholes, catch basins, fire hydrants, overhead power and telephone lines, and power poles to obtain adequate geometrics for signalization. The existence of these utilities must not get in the way of adequate geometrics.

10. Pedestrian curb ramps are typically required at all corners. An evaluation can be done if there is question whether the curb ramp must be put in. See the MnDOT ADA website for more detailed information.

9-7.03 Operational Characteristics

The behavior of the traffic at an intersection is another highly important element of signal design. The following elements should be considered:

1. Existing 15-minute vehicle volumes, by vehicle class, and pedestrian volumes are the most basic operational consideration. Data used should represent intersection operation in peak periods.

2. Intersection capacity should be determined based on the Highway Capacity Manual and other sources.

3. The vehicle approach posted speeds should be determined for the location of advance detection.

4. Adjacent land uses should be evaluated to identify activities that may conflict with intersection operation. Items that should be considered include entrances, advertising devices, and areas of high pedestrian activity (schools, manufacturing plants, shopping centers, etc.).

5. Crashes within the intersection should be studied to determine causes and possible design solutions.

6. Pedestrian volumes and school-crossing activities should be studied to determine pedestrian routes and necessary design treatments. Pedestrian movements in and around signals should be routed into the intersection crosswalks in front of vehicles stopped for the signal.

9-7.04 System (Arterial) Considerations

In many cases, an individual traffic control signal must be considered as part of a system, either as one of a series of signals along a linear route, or as one signal in a grid network. System considerations in signal design should include, but are not limited to the following:

1. Adjacent signals should be interconnected and coordinated whenever they are less than one-half mile apart, when the travel time between adjacent signals is less than the cycle length at each signal, or when platoons leaving one intersection remain intact to the next signal.

2. Properly spaced signalized intersections greatly simplify coordination in planning new signals. Minimum spacing of one-quarter mile is recommended. Irregular signal spacing reduces the overall operational efficiency of the mainline movements and greatly complicates signal coordination.

3. Whenever possible, platoons should be kept intact to allow easier mainline coordination and minimize cross-street delay.

4. New street or roadway construction should anticipate the need for future signals and the need for handholes and conduit, particularly under the roadway.

5. Pre-timed controllers may be used in built-up urban environments, particularly central business districts. The streets are not excessively wide and the traffic patterns are quite
predictable. In this environment, a signal cycle should contain pedestrian movements. Traffic actuated controllers are most often used. The actuated controller tends to reduce the number of stops and does not cut off platoons of vehicles. In the suburban environment, the arterial streets tend to be very wide, and the volumes are usually quite high on these arterials. There are not usually many pedestrians crossing such an arterial, so an actuated controller tends to operate much more efficiently, as it is not necessary to time pedestrian intervals except when an actual demand exists. MnDOT traffic control signals are now exclusively fully actuated.

6. Splits and offsets should be carefully estimated to determine their impact on arterial flow. A split is the relative percentage of green time allocated to each of the various phases at a single intersection. An offset is the travel time between signals, usually expressed in seconds but sometimes in percent of cycle length.

7. Minimum pedestrian walk and clearance timings should be anticipated when designing coordinated signal systems.

**9-7.05 Signal Design Elements**

1. The most efficient operation of a traffic control signal system is with the fewest phases that are sufficient to move traffic without hazardous conflicts. Procedures exist to determine the optimum number of phases for an intersection. See the MnDOT Signal Design Manual for a discussion of phasing considerations.

2. The primary consideration in signal head placement is clear visibility. Drivers approaching an intersection shall be given a clear and unmistakable indication of their right-of-way assignment. The number and placement of signal faces shall conform to the requirements of Sections 4D.10 through 4D.25 of the MN MUTCD. Overheads should be located as near as practicable to the line of the driver's normal view. It is recommended that an overhead indication should be used over each lane. The size of lenses shall be as stated in section 4D.7 of the MN MUTCD. See the signal head placement charts in the MnDOT Signal Design Manual. In general, vehicle signal faces should be placed and aimed to have maximum effectiveness for an approaching driver located a distance from the stop line equal to the distance traveled while reacting to the signal and bringing the vehicle to a stop at an average approach speed. Visors, shields, or visual delimiting should be used to help in directing the signal indication to the approaching traffic, and to reduce sun phantom resulting from external light entering a signal indication lens. The Horizontal Location of Signal Faces diagram shown in MN MUTCD Section 4D.7 should be used as an aid in placing vehicle signal faces.

3. Vehicle detectors should be placed according to the detector spacing chart and the loop placement diagrams shown in the MnDOT Signal Design Manual.

4. At locations where pedestrians are expected, provisions must be made to control pedestrian activity in and around the signalized intersection. Pedestrian indications and Accessible Pedestrian Signals (APS) shall be provided if minimum pedestrian crossing time exceeds minimum vehicular green time, or if any of the conditions set out in section 4E.3 of the MN MUTCD are met. Pedestrian push buttons should be installed at locations with pedestrian activity where it is not operationally efficient to provide pedestrian timing on every cycle. Pedestrian signal indications shall be mounted, positioned, and aimed so as to be in the line of pedestrians vision, and to provide maximum visibility at the beginning of the controlled crossing. Locations of the pushbuttons in an accessible pedestrian signal are subject to placement criteria. See the MN MUTCD Part 4 and the Americans with Disabilities Act (ADA) guidelines for more details.

5. If it is determined to prohibit pedestrian movement across any approach, that prohibition must be clearly visible to pedestrians by use of Standard Sign R9-3a on each side of the prohibited crosswalk. See Part 4 and Part 2B of the MN MUTCD for further information.
6. Luminaires for roadway lighting should be installed with traffic control signals and flashing beacons. Luminaires are generally LED luminaires for use at a 40 foot mounting height, mounted in the far-right quadrants of the major street. Installing luminaires at all four quadrants should be considered to meet adequate light levels, larger intersections will require additional luminaires. Forty foot mounting heights provide even light distribution. Street lights installed on Type A signal mast-arm poles should be mounted at approximately 350 degrees clockwise from the mast arm in order to provide frontal illumination of any signs mounted on the mast arm.

Signal design must take into account the existing adjacent lighting systems and the equipment available to provide access to the luminaires for maintenance. The presence of overhead power lines must also be taken into account. These must be designed around or moved.

Use the Signal Design Review Check List that is in the MnDOT Signal Design Manual.

9-8.00 TRAFFIC SIGNAL PLANS AND SPECIFICATIONS

9-8.01 General

The end products of the pre-construction activities in signal design are the Plan, Special Provisions, and the Engineer’s Estimate. Supporting the Plans and Special Provisions are the standard design practices, the MnDOT Standard Plates Manual, MnDOT Standard Specifications for Construction, other applicable national and local standards, and any necessary agreements. Detailed information is shown in the MnDOT Signal Design Manual.

9-8.02 Traffic Signal Control Plans

The Districts are responsible for developing traffic control signal plans. If the districts desire, they may request review of the plans by MnDOT’s Office of Traffic Engineering (OTE).

9-8.03 Special Provisions

The Special Provisions for traffic control signal projects include complete detailed specifications of the traffic control signal system(s) and maintenance of traffic section which details the contract time schedule and provisions for traffic during construction. The Special Provisions are project specific specifications that supplement the MnDOT Standard Specifications for Construction book. A sample signal special provision is located on the OTE web site.

Responsibilities related to the Special Provisions are as follows:

1. District Traffic Engineer
   a. Submits to the Special Provisions Engineer of the Office of Technical Support, the Special Provisions for MnDOT designed signal system projects. The Special Provisions should be submitted in accordance with the pre-determined “Project Pre-Letting Date” deadlines.
   b. Submits to the Special Provisions Engineer in the Office of Technical Support, a completed copy of Form 21184, Contract Time Schedule Recommendations and Misc. Data, and Form 21185, Provisions for Traffic During Construction. This information should be submitted in accordance with the pre-determined “Project Pre-Letting Date” deadlines.

2. Office of Traffic Engineering Signal Unit
   a. Upon request of the District, the OTE Signal Unit reviews Special Provisions for signal system projects let by the State or other agencies involving the trunk highway system. The Office of Traffic Engineering website will maintain sample Special Provisions for district, consultant, and other agencies to access.
9-8.04 Tabulation of Quantities

The Detailed Construction Estimate (Engineer’s Estimate) for all signal system projects let by the State is prepared by MnDOT’s Office of Project Management and Technical Support. The District is responsible for providing a detailed tabulation of quantities to the Office of Technical Support as a basis for the Engineer’s estimate. The MN MUTCD provides a sample tabulation of quantities. Districts may also provide a designer estimate.

9-8.05 Standard Plates Manual


9-8.06 Standard Plan Manual

MnDOT’s Standard Plans contains a set of drawings developed by MnDOT, detailing standard construction and materials. These standards are incorporated, where applicable, into a set of road construction plans. Pedestrian curb ramp details can be found here.

9-8.07 MnDOT Standard Specifications for Construction

MnDOT Standard Specifications for Construction (“Spec Book”) contains the standard provisions to be used and referred to in signal plans and special provisions.

9-8.08 Other Standards

Other national and local standards that are applicable to traffic signal plans and specifications are as follows:

1. National Electrical Code
3. ICEA-NEMA Standards for Electrical Wire and Cable
4. ITE Standards
5. State and Local Statutes and Ordinances
7. MnDOT Signal Design Manual

9-9.00 TRAFFIC CONTROL SIGNAL CONSTRUCTION

9-9.01 State Furnished Material

It is in the public interest for MnDOT to supply both new and refurbished traffic signal equipment and to assemble and modify this equipment for federal-aid projects because of the uniformity and ability to maintain. The purchase of large quantities of materials occurs using the low bid process and then the material is supplied to the contractor for each contract. The state purchasing of material shall conform to FHWA PPM 21-6.3, Paragraph 14 and a Public Interest Finding will be completed.

When it is determined that there will be State furnished materials to be provided by the Central Electrical Services Unit (CESU):

2. The AFMS System ID and TE Request number shall be on the Traffic Signal plan.

3. One or two weeks prior to the letting of the contract, the District Traffic Office approves the TE Request on the AFMS.

4. CESU reviews the TE Request and enters the Electronic Concurrence in the AFMS.

5. The work is then assigned and completed by CESU personnel.

9-9.02 Signal Turn-On Procedure

Advance notice should be given to the public when a signal is to be activated. Those who should be present when the signal is activated include: (1) Project Engineer, (2) Contractor, (3) District Traffic Engineer (4) Regional Electrical Services Unit (RESU)/Metro Electrical Services Unit (MESU), and (5) City Police, if appropriate. The MN MUTCD describes the considerations for bringing the new signal out of flashing operation into normal stop and go operation.

9-9.03 Post Turn-On Procedures

After a signal has been activated, a copy of a memorandum of notification should be sent to the:

1. City
2. County
3. Affected power company
4. State Patrol
5. CESU & RESU/MESU

This notice should include the location, date and time of turn-on, maintenance responsibilities (including dates of warranties affecting the project), and the vertical clearances of any objects suspended over the roadways.

A sample signal turn on letter can be found on the OTE website.

9-10.00 TRAFFIC SIGNAL OPERATIONS

9-10.01 General

It is the responsibility of the District Traffic Engineer to observe the operation of all traffic signals in the district. Any timing or operation that is not correct should be corrected. Personnel in the Central Office Signal Unit can assist in the determination of the timing. Unusual hardware implementations may require the assistance of personnel from the Central Electrical Services Unit. The District Traffic Engineer shall maintain a complete timing record, including all preemption timing, in the controller cabinet and in the District Traffic Office. In the event the District Traffic Engineer determines a traffic signal is to be revised by state maintenance forces, a TE Request is to be written. The TE Request should outline the work that is to be done. Normally, the District Traffic Office will be contacted by the Central, Metro, or Regional Electrical Services Unit, as appropriate, after concurrence and before the work is done.

Each district should budget for payment of electrical power usage where the State has that responsibility.

The District Traffic Office shall keep a current maintenance log in each controller cabinet and any timing change performed to that signal shall be duly recorded on that log.

The District Traffic Office should perform an “operations check” of all district traffic control signals every 6 to 12 months. The operations check will review the operation of the traffic signal including checking all vehicle indications, pedestrian pushbuttons, detection, and other items critical for efficient operation of the traffic control signal. The cabinet filter should also be replaced once every 12 months.

A sample signal maintenance log sheet can be found on the OTE website.
9-10.02 Operational Timing Practices

Detailed information is shown in the MnDOT Signal Design Manual. It should be noted that those guidelines, procedures and practices are general and should only be used as a guide. Many other factors at each individual intersection must be considered along with engineering judgment when applying the guidelines.

9-11.00 TRAFFIC CONTROL SIGNAL MAINTENANCE

9-11.01 General

Maintenance work on traffic signal systems that is the responsibility of the State is performed by the Electrical Services Unit (ESU). ESU has three electrical service units within it as follows:

1. **Metro Electrical Services Unit (MESU)**
   The MESU performs repairs within the seven county Metro Area. MESU works primarily on high voltage type repairs and equipment including traffic control signals, street lighting, and other electrical traffic control systems. MESU only works in the Metro District and is part of the Metro District Traffic Office.

2. **Regional Electrical Services Unit (RESU)**
   The RESU performs repairs in greater MnDOT districts outside of the Metro area. RESU works primarily with high voltage type repairs and equipment including traffic control signals, highway lighting, Intelligent Transportation Systems (ITS), Variable Message Signs (VMS), and other electrical traffic systems in greater Minnesota. This group also works on control equipment and other related electronic systems when needed. They are located throughout the state and are part of the Office of Traffic Engineering.

3. **Central Electrical Service Unit (CESU)**
   The CESU performs shop and field repairs of traffic signal control equipment and other traffic related electronic systems, receives Gopher State One Call location requests, updates cabinets and prints, prepares state-furnished equipment for installation by contractors on traffic control signal projects, and provides technical field assistance. CESU works primarily with low voltage type repairs and equipment, providing service in all districts. CESU is part of the Office of Traffic Engineering.
   CESU will perform a preventative maintenance (PM) checks of all MnDOT traffic control signals every 12 to 24 months. This PM will place the signal in flash to perform a Malfunction Management Unit test. The PM will also check indications, pedestrian pushbuttons, detection, and any other items critical to efficient operation of the traffic control signal.

A municipality or county may, by resolution, request that the State, with its own forces, perform certain maintenance work assigned to the municipality or county using a separate reimbursable maintenance and operation agreement. The State is reimbursed for work through this agreement. The District and the Metro or Regional Electrical Services Unit should evaluate such requests for feasibility for the State to do this additional work. The signal agreement will define responsibilities for maintenance and monthly power cost.

9-11.02 Malfunction Repair

In the event of an equipment malfunction, the District Traffic Engineer, State Patrol, or other authorities call the Metro, Central, or Regional Electrical Services Unit to dispatch a repair crew. The District Traffic Engineer assigns each intersection a Signal Maintenance Priority that indicates the order that traffic signal malfunctions should be serviced when malfunctions are known to exist at more than one intersection. The Signal Maintenance Priorities are as follows:

1. Repair as soon as possible.
2. Repair before next peak hour.
3. Repair next scheduled workday.
4. Repair as schedule permits.
5. No State maintenance responsibility.

After hours, the call typically comes into the District Maintenance or State Patrol Dispatcher. In the Metro area the dispatcher will contact the appropriate Metro or Central Electrical Services Unit “on call” person. In greater Minnesota the dispatcher will call the appropriate district person or the Regional Electrical Services Unit person. After the dispatcher makes contact with the Metro, Central, or Regional Electrical Services Unit or the appropriate district contact, it is the responsibility of this person to follow-up on the problem.

When a traffic control signal malfunction has been reported to the District, and the local authority is responsible for the maintenance of that traffic control signal, the responsible jurisdiction should be contacted immediately to arrange for prompt repair.

**9-11.03 Signal Indication Failures**

All indication failures that are the responsibility of MnDOT shall be reported to the Metro or Regional Electrical Services Unit personnel. Indication failures that are the responsibility of other agencies shall be reported to them for correction. Any indication failure report received by the Metro or Regional Electrical Services Unit that is not the responsibility of MnDOT will be referred to the responsible agency for correction. All such reports shall be documented by the Metro or Regional Electrical Services Unit.

LED signal indications fail by gradually dimming until they no longer provide adequate output. The Institute of Transportation Engineers (ITE) provides specification for required light output of the indications. To ensure LEDs meet light output requirements, LED indications shall be replaced every 7 to 10 years. This should be considered when budgeting for maintenance.

**9-11.04 Signal Maintenance Log**

A paper signal maintenance log is present in each traffic control signal cabinet. Anyone who does any repair work, changes to controller programming, and/or modifications in the cabinet or at the intersection shall record the action in the signal maintenance log. The signal maintenance log provides a historical record of work done in the cabinet to assist personnel in diagnosing problems in the cabinet and in making operational adjustments. A copy of the signal log sheet can be found on the OTE website.

**9-11.05 Automated Facilities Management System**

In addition to the signal maintenance log contained in the intersection controller cabinets, the Automated Facilities Management System (AFMS) maintains a record of signal maintenance for each intersection for which the State has maintenance responsibility. Whenever a maintenance call is made to an intersection, the work that is done is recorded and entered into the AFMS. The AFMS provides data for analysis of such factors as maintenance time apportionment and equipment reliability. It also provides tracking for legal issues.

The AFMS contains computer records for all traffic signals and flashing beacon systems on trunk highways in Minnesota and for any additional traffic control signals or other devices for which the State has any responsibility.
9-12.00 TRAFFIC SIGNAL COMPUTER AIDS

9-12.01 General

District Traffic Offices, traffic engineers and technicians in the State of Minnesota have access to a number of computer programs that assist with the intersection or network geometry setup and/or modification, traffic signal warrant analysis and justification, design, timing and coordination plan development, operations, and management of traffic signal systems. Computer programs can also help with signal inventory and maintenance management. More information can be found in the MnDOT Signal Timing and Coordination Manual.

9-12.02 Computer Software

There are many software programs available to the traffic signal designer or operations analyst. The Highway Capacity Manual software was developed for the Federal Highway Administration and follows the capacity analysis procedures found in the latest edition of the Highway Capacity Manual.

Signal warrant analysis software, given volume, speed, and geometric data for an intersection, will produce tables and graphs, and will analyze the volume counts against traffic signal warrants defined in the Minnesota Manual of Uniform Traffic Control Devices (MN MUTCD).

There are many computer tools that users can choose from for signal timing and coordination analysis applications. A detailed introduction of the MnDOT most used software, Synchro, and a brief description of three other widely utilized programs, including, TRANSYT-7F, PASSER-II, and CORSIM are provided in the MnDOT Signal Timing and Coordination Manual. It is important to know that one cannot (or should not) simply implement the computer-generated timing and offset settings. Engineers must carefully fine-tune settings in the field based on observations of actual traffic flows.

9-12.03 Computer-Aided Drafting

MicroStation is an extremely powerful computer-aided drafting software. Training is available through the Office of Computer-Aided Engineering Services (CAES) in Central Office.

9-13.00 REFERENCES


5. Minnesota Department of Transportation, Standard Specifications for Construction.


7. Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD)


CHAPTER 10 - LIGHTING OF TRAFFIC FACILITIES

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10-1.00 INTRODUCTION

10-1.01 Purpose

The purpose of this chapter is to present MnDOT’s practice for the lighting of traffic facilities. The chapter also presents the step by step procedure for initiating, designing, and letting a contract for the construction of an electric lighting system.

10-1.02 Scope

This chapter is meant to be a guideline rather than a standard. Together with other documents, this chapter gives guidelines and procedures for lighting installations on MnDOT roadways, underpasses, tunnels, rest areas, weigh stations, parking lots, lighted signs, and bridges. Refer to the MnDOT Roadway Lighting Design Manual when a detailed lighting design description is needed. This chapter references the Lighting Design Manual when appropriate.

The principal reference for lighting design is the Roadway Lighting Design Guide published by the American Association of State Highway and Transportation Officials (AASHTO). The AASHTO Roadway Lighting Design Guide is an essential document to accompany this chapter and is a frequent reference within the chapter.

Other important documents include the American National Standard Practice for Roadway Lighting RP-8 published by the Illuminating Engineering Society, hereafter referred to as RP-8, and the National Electrical Code published by the National Fire Prevention Association. Other references are listed at the end of the chapter.

10-2.00 GLOSSARY

“A” Base
Base plate joined to the pole shaft with continuous exterior and interior welds and fastened directly to the foundation anchorages or to the top of a transformer base.

Ambient Light
Illumination at, near, or around a traffic facility, but outside of the right-of-way.

Average Initial Illumination
The average level of horizontal illumination on the pavement area of a traveled roadway at the time the lighting system is installed, when lamps are new, and luminaires are clean; expressed in footcandles (lux).

Average Maintained Illumination
The average level of horizontal illumination on the pavement area of a traveled roadway when the illuminating source is at its lowest output allowed and when the luminaire is in its dirtiest condition; expressed in footcandles (lux).

Ballast
An auxiliary device used with high intensity discharge (HID) lamps to provide proper starting and operating characteristics. It limits the current through the lamp and may also regulate the voltage.

Bent Straw Pole
A tapered pole with a straight mast arm off the top at an approximately 90 degree angle

Breakaway
A design feature that allows the lighting unit support to yield, fracture, or separate near ground level on impact.
**Breakaway Support Coupling**  
A high strength coupling specifically designed to yield quickly and cleanly on impact.

**BUG Rating**  
Backlight, uplight, and glare rating of a luminaire.

**Candela**  
The unit of luminous intensity (the force generating the luminous flux). Formerly the term “candle” was used.

**Complete Interchange Lighting**  
The lighting of the freeway through traffic lanes through the interchange, the traffic lanes of all ramps, the acceleration and deceleration lanes, all ramp terminals, and the crossroad between the outermost ramp terminals.

**Davit Pole and Mast Arm**  
A shaft that curves from vertical to horizontal.

**Edge Line**  
A line that indicates the edge of the roadway.

**Electronic Control Module (ECM)**  
A module in LED luminaires that controls dimming and monitors luminaire performance.

**Electronic Driver**  
Power supply used in LED luminaires to power the LED light modules.

**Feedpoint**  
A source of AC power that distributes AC power to individual lighting units in a lighting system.

**Fog Line**  
Also known as the right lane edge.

**Footcandles (lux)**  
The unit of illumination when the foot is taken as the unit of length. It is the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen, or the illumination produced on a surface, all points of which are at a distance of one foot from a directionally uniform point source of one candela.

**Frangible Base**  
An aluminum transformer light pole base designed to readily or easily break on impact. The frangible base is fastened with bolts to the “A” base that is welded to the light pole shaft.

**Glare**  
The brightness of a light source which causes eye annoyance, discomfort, or loss in visual performance and visibility.

**Gore**  
On a freeway or expressway, the area where the mainline of the roadway and the ramp diverge or converge.

**High Base**  
A tapered transformer base that attaches to a galvanized or stainless steel pole by slip fitting inside the pole shaft.

**High Intensity Discharge (HID) Luminaire**  
A complete lighting fixture consisting of a HID lamp together with the ballast, reflector, refractor, a photocell when required, and the housing. An example of an HID lamp type would be High Pressure Sodium (HPS) or Metal Halide (MH).
Horizontal Lux
Lux measured in a horizontal plane.

Illuminance
The density of luminous flux incident on a surface; it is the quotient of the luminous flux by the area of the surface when the latter is uniformly illuminated, expressed in lumens per square meter.

IP Rating (International Protection Rating)
Sometimes interpreted as Ingress Protection Marking, this classifies and rates the degree of protection provided against intrusion, dust, accidental contact, and water.

Isolated Intersection
The general area where two or more non-continuously lighted roadways join or cross at the same level.

Lamp
A source of light. The device within a luminaire that converts the electrical energy to light.

LED Luminaire
A complete lighting fixture consisting of light-emitting diodes (LEDs) that connect to a power supply as well as internal and external designed parts necessary for operation and distribution of light.

Light-Loss Factor (LLF)
A depreciation factor which is applied to the calculated initial average luminance or illuminance to determine the value of depreciated average illumination at a predetermined time in the operating cycle. The light loss factor reflects the decrease in effective light output of a lamp and luminaire during its life.

Lighting Unit
Includes the light pole, luminaire, lamp (if needed), wire holder, fuse holder, and all other miscellaneous equipment required for a complete lighting unit installation.

Lumen
The unit of luminous flux (time rate of flow of light). A lumen is defined as the luminous flux emitted by a point source having a uniform luminous intensity of one candela.

Luminance
The luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction, expressed in candela per square meter.

Lux
The International System (SI) unit of illuminance. One lux is defined as the illuminance incident on a surface of one square meter, all points of which are one meter from a uniform source of one candela.

Partial Interchange Lighting
Lighting consisting of a few luminaires located in the vicinity of some or all ramp terminals, intersections, or other decision making areas.

Pavement Reflection Factor (or Reflectance)
The ratio of the light reflected by a pavement surface to the light incident upon it.

Post Top Lighting Unit
A light pole with a short vertical shaft for mounting the luminaire.

Progressive-Shear Base
A high base that is riveted or spot-welded to a base plate designed to shear progressively on impact. Most commonly found on stainless steel breakaway poles.

Shoe Base
A low profile casting that connects the shaft to the pole base plate.
Slip Base
A pole base plate designed to slide off a lower plate on impact.

Tenon
A smooth tapered piece on the top end of the pole shaft or davit for slip fit mounting of the luminaire.

Transformer ("T") Base
A box-like structure with access door between the foundation and pole “A” base plate used to accommodate the wiring splice connections.

Truss Mast Arm
A horizontal bracket used to support the luminaire.

Uniformity Ratio
Average to minimum uniformity ratio is the ratio of average footcandle (lux) of illumination on the design area to the footcandle (lux) at the point of minimum illumination on the area. Maximum to minimum uniformity ratio is the ratio of the maximum footcandle (lux) value at any point on the design area to the point of lowest footcandle (lux) value.

Veiling Luminance
A luminance superimposed on the retinal image that reduces its contrast. It is this veiling effect produced by bright sources or areas in the visual field that results in reduced visual performance and visibility.

Vertical Lux
Lux measured in a vertical plane.

10-3.00 LIGHTING PROJECT PROCEDURES
This section describes the process involved in bringing a state administered lighting project from its inception to its completion. The section lists the steps involved and then describes each step separately.

For projects that utilize state funds but are not administered by the state, the MnDOT Office of State Aid will request from the District Traffic Engineer any assistance needed to handle the project. Local jurisdictions may also, with proper permits, administer lighting projects on state trunk highways at their sole expense, as when the local jurisdiction desires lighting that is determined by the state to be unwarranted. Form 2525, the utility permit application, is obtainable from the district office for this purpose. Any lighting on state trunk highways must be approved by MnDOT regardless of the agency installing it.

The district initiates state administered lighting projects. The following steps are necessary for completing a lighting project:

1. Scoping the project
2. Programming the project
3. Negotiating with local authorities and utilities
4. Implementing a work authority
5. Preparing plans
6. Preparing special provisions
7. Preparing agreements
8. Letting the project

10-3.01 Warrants
The primary purpose of warrants is to assist administrators and designers in evaluating locations for lighting needs and selecting locations for installing lighting. Warrants give conditions that should be satisfied to justify the installation of lighting. Meeting these warrants does not obligate the State to provide lighting. Conversely,
local information in addition to that reflected by the warrants, such as roadway geometry, ambient lighting, sight distance, signing, crash rates, or frequent occurrences of fog, ice, or snow, may influence the decision to install lighting. The warrants are applicable to all lighting projects where the State participates in the cost, whether the contract is administered by the State or by a local governmental agency.


The AASHTO Roadway Lighting Design Guide also contains guidelines on special considerations for roadway lighting.

The AASHTO Roadway Lighting Design Guide gives no specific warrants for continuous lighting of roadways other than freeways (roads with fully controlled access, no at-grade intersections), but does suggest some general criteria that may apply when considering the installation of lighting.

Lighting of at-grade intersections is warranted if the geometric conditions mentioned in the AASHTO Roadway Lighting Design Guide exist or if one or more of the conditions listed in the MnDOT Lighting Design Manual exists.

Intersection lighting is a strategy for reducing fatal and serious injury crashes at isolated intersections and has been recommended in the Minnesota Strategic Highway Safety Plan (SHSP) and other companion documents such as the District Safety Plans and the County Road Safety Plans. If a nighttime crash issue is identified, illuminating the intersection is a strategy that should be considered. However, if all impacted jurisdictions agree, intersection lighting can be installed proactively even though no formal crash warrants have been satisfied. Lighting may be installed in the form of full intersection lighting, meeting recommended light levels, or delineation lighting, intending to mark an intersection for approaching traffic, but not meeting light level recommendations. Intersection lighting installations should be data driven and take into consideration risk factors associated with crashes. Effort should be made to make sure that lighting deployments are not arbitrary in nature. Lighting is one of many strategies that can be used to improve safety and should be compared with other alternatives to determine what strategy is most effective for the location under consideration.

Warrants covering lighting for roundabout intersections, tunnels, underpasses, rest areas, and signs are contained in the AASHTO Roadway Lighting Design Guide.

10-3.02 Programming

The District Traffic Engineer is responsible for requesting planning and programming to encumber funds for lighting installations.

10-3.03 Negotiations

Lighting installations involve coordination with electric utility companies and may involve other agencies. The responsibility for negotiating with municipalities, counties, railroads, and electric utility companies rests with the District. The Utility Agreements Unit of the Office of Technical Support, the Office of Freight and Commercial Vehicle Operations (OFCVO), and the Central Office (CO) Lighting Unit may all be available to assist the District in such negotiations.

10-3.04 Work Authorities

Work authorities are required before design or construction is started.

Function 1 work authority is for preliminary design.

Function 2 work authority is for detail design.

Function 3 work authority is for construction.

Where the lighting design is part of the road plans, the Road Design Engineer should implement the work authority, including the lighting design work, and a separate work authority for the lighting portion of the plan is unnecessary.
10-3.05 Preparation of Plans

The District Traffic Office is responsible for the designs of the lighting system that will be installed under a State contract. Assistance may be requested from the CO Lighting Unit.

The lighting plans should include a title sheet showing the following:

1. Project location and description,
2. State and federal project number(s),
3. The area and job number(s),
4. Appropriate signature lines,
5. Roadway design values,
6. Legends and symbols,
7. A list of scales, and
8. A plan index.

When a municipality is participating in the cost for installing or maintaining the lighting system, the title sheet should include a signature line for the appropriate authority from the municipality. The District Traffic Engineer should submit a final copy of the plan to the municipality for review and approval before the project is let.

Lighting System Pay Items

The lighting system pay items may be itemized showing items for conduit, cable, light standards, etc., in which case a statement of estimated quantities is included, or, the lighting plan may be shown as a lump sum. Any notes pertaining to any of the items in the estimated quantities should be included on the estimated quantities sheet. Paying for the lighting system as a lump sum item may be more convenient than itemizing in certain situations. To simplify estimating and bidding when a lump sum pay item is used, the plans should include a tabulation of the individual items that are part of the lump sum.

Detail Sheets

Detail sheets should show pole details for each type of pole used in the project, details for mounting the service cabinets and photoelectric controls, any special anchorage details, conduit attachment to bridges for underpass lighting, and any other necessary details.

Layout Sheets

Each layout sheet should include a layout of the roadway and locations of light poles, cable, service cabinets, conduit, junction boxes, and handholes or pull boxes. All of these items should be properly labeled and identified. A tabulation should list stations, locations, and types of lighting units.

Lighting Unit Labels

Lighting units indicated in the plans should be labeled with a unique identification number. The top number, which is assigned by the CO Lighting Unit, is called the feedpoint number. The number below the feedpoint number indicates the individual lighting unit number (pole number) being serviced by that specific feedpoint. Light poles should be labeled with the entire assigned feedpoint number and the lighting unit number as stated in the plan. Tunnel and underpass luminaires should be labeled with the last letter of the assigned feedpoint number above the number indicating the lighting unit on that feedpoint. Lighting units should be numbered consecutively according to the plan.

Wiring Diagrams

The plans should include wiring diagrams to detail the wiring of the lighting circuits such as wire sizes, identification colors, splices and handholes, conduits, and type of wiring (direct buried lighting cable or single conductors).

Information sheets should be included when appropriate.
Sources of Power and Meter Address
The designer must contact the appropriate electric utility company to establish source of power(s) (SOP) and the meter address. The electric utility company may require an Application for Service, extra equipment, and have an electrical service charge. All communications with the electric utility company should be confirmed in writing.

10-3.06 Preparation of Special Provisions
The special provisions for a lighting project should give any necessary information that is not already given in the plans or in the MnDOT Standard Specifications for Construction, as well as information that is especially in need of the bidders’ attention. This information may include an explanation of the electrical distribution system, materials specifications for materials, construction requirements that are not included in the Standard Specifications for Construction, a statement of items that are to be furnished by the state, and an explanation of what is included in each pay item.

The District Lighting Designer normally prepares the Lighting Special Provisions for the project. The CO Lighting Unit may provide assistance if requested.

10-3.07 Preparation of Agreements
An agreement is a legal document detailing the responsibilities of the various parties involved regarding cost, installation, maintenance, and providing power to a lighting system. The District prepares the agreements for lighting projects that are not a part of a road construction project.

Lighting agreements that are part of a road construction project are normally prepared by the Municipal Agreements Unit of the Office of Technical Support.

An agreement may be between the State, the electric utility company, a railroad, or a municipality (city or county). There may be several agreements with different agencies. In rare instances there may be a three-party agreement. The terms of the agreement will be project specific. Information regarding agreements with a railroad, an electric utility company, and a municipality are shown below. Only general considerations are given in these descriptions.

10-3.07.01 Agreement with a Railroad
Agreements and permits may be necessary for power cables over or under railroad tracks.

10-3.07.02 Agreement with an Electric Utility Company
MnDOT typically meters all roadway lighting, therefore an agreement with the local electric utility company is not needed. Only in rare instances when MnDOT will not be metering a lighting system an agreement with the local electric utility company is required.

An agreement with an electric utility company details the method of payment and certain maintenance functions of the lighting system along with the possibility for providing electric utility owned lights. Rates for maintaining the lighting system may include maintenance such as LED luminaire replacement, luminaire and glassware maintenance and cleaning, lamp replacement, ballasts, photocells, and maintaining the above ground wiring supplying power to the luminaire in addition to supplying electrical energy. The service cabinet, direct buried lighting cable, and pole knockdowns are almost always maintained by the State and are not part of an agreement with the electric utility company. Agreements with power electric utility companies should be open ended to include additions or changes to the number and types of lighting units on the lighting system covered and may be made by processing a CADD lighting plan sheet showing the addition or changes. A flat rate is then charged for each lighting unit based on the type.

With the exception of municipal utilities, the rates charged by electric utility companies are regulated by the Minnesota Public Utilities Commission (PUC). The electric utility company must set forth these conditions in a letter to the PUC when filing a new proposed rate schedule or when filing a change of the rate schedule. The
rates set forth in the schedule may be put into effect by the utility 30 days after the letter is filed with the PUC. Municipal utilities are not regulated by the PUC, but rather by the residents of the municipalities that own and operate them.

On the rare occasion that local electric utility company owned lights are to be provided, the District Traffic Office should prepare a lighting plan containing the name of the electric utility company, location, type, and number of lights. If the State does not have an open ended agreement with the electric utility company to provide electric utility owned lights, the District must write one. Agreements for electric utility owned lights should include maintenance by the electric utility company.

Agreements with the electric utility company may be required for extending power lines to the electrical service point of the lighting system. Costs for extending power lines should not be included in the open ended agreements with the utility for providing power and maintenance for lights.

Lighting plan layout sheets are necessary for additions and changes to existing open ended agreements. A lighting plan layout includes the highway, the city (if applicable), the electric utility company, the feedpoint number, and the total number of lights of each type after the addition or change. Attached to the layout is the Signature Sheet indicating the number and date of the open ended agreement that is being altered by the lighting plan layout sheet and a summary of the changes. The District notifies the electric utility company of the date of effect of the change once the lights have been turned on.

Two copies of all lighting plan layout sheets are sent to the Electrical Services Unit (ESU) and the District Office to update their location files.

10-3.07.03 Agreement with a Local Road Authority - Cost Participation Policy

An agreement with a local road authority details the cost responsibility for the design, installation, maintenance, power cost, and ownership of a roadway lighting system.

- **Cooperative Agreement** - An agreement that includes participation by the local road authority in the installation cost as well as detailing the maintenance and ownership responsibility.
- **Maintenance Agreement** - An agreement that only involves the maintenance responsibility, with no participation by the local road authority for installation.

The roadway lighting system may be installed as a State contract or a local government contract. The local road authority or the State may pay the entire cost or part of the cost of any of these items. The negotiations between the District and the local road authority shall be in accordance with the Cost Participation for Cooperative Construction Projects and Maintenance Responsibilities between MnDOT and Local Units of Government, hereafter referred to as Cost Participation Policy.

Such factors as the location of the lighting units, the agency administering the contract, the types of light poles and luminaires used, the jurisdiction of the intersection roadways, warrants met, and past practice all may influence the negotiated cost splits.

A **Long Form Utility Permit (Form 2525)** is required for all lighting systems that are to be owned and operated by the local road authority regardless of cost splits.

The following are guidelines for lighting installations. See the Cost Participation Policy for more information on cost splits.

1. **Trunk Highways - Freeway (Limited Access Including Interstate)**
   The State determines what portions of freeways and highways will be lighted. Light levels should meet the requirements in this chapter, the AASHTO Roadway Lighting Design Guide, and the MnDOT Lighting Design Manual. Roadways considered for lighting are the main line, ramps, and the intersections of ramps with cross streets (ramp terminals).

   The lighting of frontage roads not concurrent with ramps is the responsibility of the local road authority.
Lighting of every interchange is not deemed necessary, but is recommended in most areas. The State will install lighting units where engineering and economic studies indicate the existence of appropriate justification in accordance with the requirements in this manual. Per the Cost Participation Policy, a local road authority may request the installation of unjustified lighting on an interchange. If approved by the District Traffic Engineer, the system may be installed in accordance with MnDOT’s Standards as indicated in this chapter.

2. **Trunk Highways (Arterial and Expressway)**

   The State will determine what portions of trunk highways will be lighted and the light levels to be provided in accordance with the requirements in this chapter.

   A local authority may request to install a lighting system on a trunk highway per the Cost Participation Policy that meets MnDOT’s standards indicated in this chapter and the MnDOT Lighting Design Manual. Isolated intersection lighting may be installed per the Cost Participation Policy, this chapter, and the MnDOT Lighting Design Manual.

   Preparing an agreement involves several steps. Using the Cost Participation Policy, the District and the municipality must agree on the percentage of the total cost that each agency will pay and the method of payment. The District or Municipal Agreement Unit of Technical Support will prepare the agreement. The agreement should be processed in a similar fashion as the traffic signal agreements, detailed in Chapter 9, “Highway Traffic Signals” of this manual.

3. **Aesthetic Bridge Designs**

   Refer to the Cost Participation Policy.

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**10-3.08 Project Letting**

Upon completion of the plans, special provisions, cost estimate, and agreement, the project will be turned in, advertised, bid, and awarded to the contractor with the lowest qualified bid.

MnDOT may also use a Design-Build process on larger projects that may include lighting as part of the project.

**10-4.00 LIGHTING SYSTEM DESIGN**

Once the decision is made to install lighting, the design stage can begin. This section describes typical MnDOT designs. The design must be appropriate for the site and must provide the level and uniformity of light suggested in the AASHTO Roadway Lighting Design Guide. The lighting described in this section is a product of the illuminance method of lighting design. Lighting may also be designed using the luminance method described in the AASHTO Roadway Lighting Design Guide. Both methods produce satisfactory results. A detailed description of MnDOT’s lighting design standards can be found in the MnDOT Lighting Design Manual.

Minnesota Statute Chapter 16B.328, Subd. 3 provides information regarding the use of state funds for outdoor lighting fixtures. With a few exceptions, state funds may not be used for luminaires that do not meet the cutoff definition or are more restrictive.

Certain luminaire manufacturers and independent companies offer computer programs to analyze light levels for a user-defined roadway with user-defined lighting installed. These programs are excellent tools for determining the correct luminaire, mounting height, and pole spacing necessary to provide the proper light levels and uniformity of light on a roadway. Any consultant doing a lighting design for MnDOT must have lighting design software. The CO Lighting Unit also has lighting design software and can provide assistance to a district. This can be either laying out the pole spacing or verifying the design provided by others.
10-4.01 Typical Lighting Systems

10-4.01.01 Continuous Freeway Lighting

Lighting on MnDOT roadways must meet the recommended 0.6 to 1.1 footcandles light levels, and the 3:1 to 4:1 average to minimum uniformity ratio, and the maximum veiling luminance as indicated for freeways in the AASHTO Roadway Lighting Design Guide and the MnDOT Lighting Design Manual. To meet these requirements, MnDOT lighting systems may be median barrier mounted lighting units, roadside mounted lighting units, or a combination of both.

Lighting units mounted on a median barrier are typically double 6- to 9-foot, davit-type mast arms. Roadside mounted lighting units typically are a single 9-foot, davit-type mast arms placed 19 to 26 feet behind the right edge line of the traveled roadway depending on pole height and luminaire rated light output.

The advantages of median barrier mounted lighting units with double mast arms are:

- They provide the same number of luminaires with fewer poles than roadside mounting requires,
- They are less likely to be knocked down than roadside mounted lighting units, and
- Electrical wiring for the lighting units do not need to be located because it is in the barrier therefore reducing man hours for locating and eliminating the possibility of cable hits due to excavators.

Median barrier mounted lighting units are discouraged in high volume areas where shoulders inside the left yellow edge line are less than 10 feet wide. They are difficult to access and maintain due to traffic, and require lane control. In most cases, roadside lighting units do not require lane control because of wide outside shoulders.

The lights for a roadway with two lanes in each direction are typically 40-foot poles spaced approximately 250 feet apart with a luminaire of adequate luminous intensity to achieve the required light level. On a mainline roadway with three lanes in each direction, 49-foot poles spaced approximately 275 feet with a luminaire of adequate luminous intensity to achieve the required light level are typically used. Pole spacing for both 40- and 49-foot poles may be reduced on ramps and interchanges compared to those on the mainline roadway.

Roadways with more than three lanes in each direction may require reduced spacing or both median barrier mounted lights and roadside mounted lights to achieve the desired light level and uniformity.

10-4.01.02 Partial Interchange Lighting

Figure 10-1: Typical Luminaire Locations Partial Interchange Lighting Davit Arm Poles shows typical luminaire locations for partial interchange lighting. This figure is a modification of similar figure in the AASHTO Roadway Lighting Design Guide. The lights are typically the same as those described above for continuous freeway lighting with two lane roadways.

10-4.01.03 Complete Interchange Lighting

Complete interchange lighting places lights in the merging traffic and gore areas in the same locations as partial interchange lighting. In addition, it places lights along the ramps, the mainline roadway through the interchange, and on the crossroad between the ramp terminals.

10-4.01.04 Tunnel Lighting

The AASHTO Roadway Lighting Design Guide contains information related to tunnel lighting warrants and guidelines. A more detailed guideline along with light level guidelines is located in the Illuminating Engineering Society’s (IES) Tunnel Lighting publication.

A short tunnel may only need lighting at night. A very long tunnel may require separate lighting controls for nighttime, clear days, and cloudy days. These requirements are discussed in the AASHTO Roadway Lighting Design Guide.
10-4.01.05  Underpass Lighting

Where the AASHTO Roadway Lighting Design Guide indicates that underpass lighting is desirable, underpass luminaires for each direction of travel on the roadway are mounted on the bridge abutment or pier. If such mounting would set back the luminaire more than 20 feet from the edge of driving lane or more than 17 feet above the roadway surface, then the luminaire is typically mounted on a bracket or plate that attaches to the bottom of the bridge diaphragm to meet acceptable light levels.

10-4.01.06  Rest Area Lighting

The AASHTO Roadway Lighting Design Guide gives light levels and uniformity values for use in rest areas. The luminaires and poles for the entrance and exit ramps of a rest area are the same as those described above for continuous freeway lighting with two lane roadways.

Poles in the parking area of the rest area are typically 30-foot, non-breakaway, single or double davit or bent straw mast arm poles with LED luminaires. Approved poles can be found on the MnDOT Approved Products List under Roadway Lighting.

The pedestrian lighting around rest area buildings and walkways are typically 15-foot decorative bronze painted poles with LED luminaires. Approved LED luminaires can be found on the MnDOT Approved Products List under Roadway Lighting.

The spacing of poles for these areas varies with the geometrics of the parking areas and walkways. The lighting must be designed to meet AASHTO recommended light levels using MnDOT approved products.

10-4.01.07  Lighting for Other Streets and Highways

Lighting levels and uniformity ratios for streets and highways other than freeways are contained in the AASHTO Roadway Lighting Design Guide. The design for these roadways is often matched to existing lighting in a city rather than to freeway design standards.

10-4.01.08  Bridge Lighting

The roadway on a bridge is normally treated the same as other parts of the roadway. If there is no lighting on the adjacent roadway, there is normally no need for lighting on the bridge. An exception is a very long bridge, which may be lit even though the roadway is not lit at other locations.

The desirable locations for the lighting units on a bridge are at abutments and pier locations, or at a distance from an abutment or pier not to exceed 25 percent of the length of the span. This placement of the lighting units reduces the effects of vibration. The light poles should have a davit arm that is an integral part of the pole shaft so there are no joints to be weakened by vibration. Bolted on mast arm attachments to pole shaft should not be used. The bridge light pole base should have a 4-bolt or 6-bolt high base with dual access doors commonly used on barrier to house the wiring splices.

If a local governmental agency or aesthetic committee requests ornamental lighting on a new MnDOT bridge or bridge replacement project, MnDOT will participate in funding in accordance with MnDOT Policy Guideline: Highways (including Bikeways) 6.1G-1 Policy and Procedures for Cooperative Construction Projects with Local Units of Government.

The installation of marine lanterns (navigation lights) and air obstruction lights are an integral part of the bridge design. Navigation lights are required to meet the light level performance requirements as indicated in the U.S. Coast Guard (USCG) Publication “A Guide to Bridge Lighting” and be compliant with the Code of Federal Regulations (CFR), Title 33, Part 118.

Air obstruction lights will be installed in accordance with the requirements of the Federal Aviation Administration (FAA), Advisory Circular AC 70/7460-1K, A Notice of Proposed Construction or Alteration” (FAA Form 7460-1) must be filed with the Federal Aviation Administration in such instances.
The Office of Bridges and Structures may ask the Lighting Unit to coordinate electrical service points for the roadway lighting and navigational/air obstruction lighting.

10-4.01.09 Airport Impacts on Roadway Lighting

Where an airport or heliport is close enough to a highway lighting project that clearances are at or near minimum requirements, a sketch showing airport runways with all pertinent vertical and horizontal measurements should be done. A Notice of Proposed Construction or Alteration” (FAA Form 7460-1) must be filed with the Federal Aviation Administration in such instances. The location near the airport may (1) limit the height allowable for the poles, (2) may mandate the use of luminaires with no up-light, (3) require L810 air obstruction lights, or may require a combination of all three. If required by the FAA, Form 7460-2, Supplemental Notice, may also need to be filed.

The impact to the airport will vary depending on the type of lighting and the proximity to airports. For example, a high mast tower lighting system would impact an airport at a greater distance than would a lighting system utilizing 40-foot light poles.

10-4.01.10 Weigh Station Lighting

Weigh station lighting level and uniformity values are the same as those for the lighting of rest areas. Because of the variety of weigh station designs, there is no typical weigh station lighting. Weigh station lighting should provide a manual means to turn off all lights except for necessary security lights when the weigh station is not in use.

10-4.01.11 Lighting of Roadways with Median Barriers

Median barrier lighting is described in Section 10-4.01.01 Continuous Freeway Lighting.

10-4.01.12 Intersection Lighting

Roadway lighting for at-grade intersections is shown in Figure 10-2: Standard Illumination Plan for Intersections. The poles and luminaires may be selected according to the guidelines given previously, may be selected to match existing street lighting in the city where the intersection is located, or may be a part of a traffic control signal system. The local agency will be required to maintain anything other than MnDOT standard luminaires.

Lighting should be provided at all signalized and flashing beacon intersections. A signal pole shaft extension with a luminaire davit should be utilized whenever possible to avoid adding more poles at the intersection. Roadway lights on traffic control signal poles should be fed from the traffic signal service point. Additional light poles may be necessary when the intersection has channelization or complex turning lanes. The level of illumination of a signalized intersection is dictated by the area classification of the roadway. Suggested levels of illumination and average horizontal footcandles for roadway lighting are given in the IES RP 8.

The level of illumination at an intersection should be greater than that between intersections where there is continuous lighting.

Where the level of illumination is low between intersections, such as 0.6 footcandles, the light intensity at the intersection should be doubled as a rule.

10-4.01.13 Roundabout Intersection Lighting

Roundabout intersection light levels are similar to that of a standard intersection. Warrants and guidelines are given in the AASHTO Roadway Lighting Design Guide and the MnDOT Lighting Design Manual.
10-4.02 Roadway Lighting System Components

10-4.02.01 Poles

The latest version of the “Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals”, published by AASHTO, specifies structural requirements for light poles. The MnDOT Standard Specification for Construction Book has additional MnDOT requirements for poles. The designer must determine the pole height, type and length of mast arm(s), material and finish, and method of mounting based on MnDOT standard products and luminaires on the MnDOT Approved Products List. Whenever possible, these choices should conform to standard products offered by manufacturers.

Pole height affects the illumination intensity, uniformity, area covered, and relative glare of the unit. Higher mounted units provide greater coverage, more uniformity, and a reduction of glare, but a lower footcandle level. By using higher poles, fewer poles are required and they can be set back farther from the traveled roadway. Typical pole heights are 30 feet, 40 feet, and 49 feet. The applications of the different heights are indicated in Section 10-4.01: Typical Lighting Systems. Power lines, nearby airports, and nearby residential neighborhoods may limit the height of poles used for lighting.

Where pole height is not restricted, high mast tower lighting may replace conventional lighting units at locations with complex roadways, such as at freeway interchanges. High mast tower lighting is a lighting system that includes 3 to 6 foot high wattage luminaires mounted on a stainless steel luminaire ring that is hoisted atop high towers, 100 to 140 feet, to illuminate a large area. A mechanical lowering system is used to lower and raise the luminaire ring to perform maintenance on luminaires.

Advantages of high mast tower lighting systems vs. conventional lighting systems:

- There are fewer towers used than poles on a conventional lighting system.
- Traffic control requirements are reduced because towers can be placed farther from the traveled roadway than poles on a conventional lighting system.
- Provides a more uniform light distribution on roadway surfaces than conventional lighting.
- There are no knockdown lighting units to replace.

Disadvantages of high mast tower lighting systems vs conventional lighting systems:

- The cost to install a high mast lighting system is considerably higher than that of a conventional lighting system.
- High mast lighting systems are not desirable near residential neighborhoods due to discomfort glare and light intrusion.
- If placed in the clear zone they must be protected from impact by guard rail or other barriers.
- The luminaire mounting ring must be lowered and raised on an annual basis if an integral powered lowering unit is installed.

Conventional lighting units should have davit type arms or a tenon-type mounting assembly unless a desire for decorative lighting dictates another type of arm, or the lights must match existing light poles with a different type of arm.

Barrier mounted light poles should be galvanized steel and non-breakaway. Roadside light poles located in the clear zone must be breakaway when on higher speed roads and are unfinished aluminum or stainless steel. Decorative poles should be painted steel or aluminum. A municipality may want painted poles or poles of a specific material to match its existing lighting.

Where traffic speeds exceed 40 mph, any poles located within the “clear zone” (See the MnDOT Road Design Manual for the definition of “clear zone”) must either be breakaway devices, or must be protected by a suitable traffic barrier (guardrail). A breakaway pole has a special base and has been tested as a complete unit to show that it will “break away” when hit and will not impede a vehicle’s movement more than a maximum set amount. In urban areas with speeds less than 30 mph and pedestrians present, a knocked down pole may present a greater hazard to traffic and pedestrians than would a non-breakaway device. In such locations,
non-breakaway poles should be used. In urban areas with speeds between 30 mph and 40 mph, the designer may choose either breakaway poles or non-breakaway poles. These criteria for the use of breakaway poles apply regardless of the State’s participation in the project.

Types of MnDOT pole bases include the tapered high base, the anchor base, the shoe base, and the standard transformer base. Types of MnDOT breakaway poles include the stainless steel progressive sheer base with a stainless steel shaft, the frangible cast aluminum transformer base with an aluminum pole shaft and arm, a slip base pole, and an aluminum shoe base pole.

Roadside light poles up to and including 40 feet in height should mount on the Design E light foundation. Light poles higher than 40 feet and up to 49 feet in height should mount on the Design H light foundation. Light poles on a bridge or median barrier are typically mounted on a six bolt anchor bolt cluster. Six bolt anchor bolt cluster requires a specially widened section of the barrier, called an AL section, to be itemized in the road plans. MnDOT light pole foundations and six bolt anchor bolt cluster are detailed in the MnDOT Standard Plates Manual.

The designations for the various pole types are given in Figure 10-3: Pole Type Designations.

Pole placement is an engineering decision that should be based upon:

- Geometry,
- Character of the roadway,
- Physical features,
- Environment,
- Available maintenance,
- Economics,
- Aesthetics, and
- Overall lighting objectives.

Physical roadside conditions may require adjustment of the spacing determined from the base levels of illumination, indicated in the AASHTO Roadway Lighting Design Guide. Higher levels of illumination are justified when overhead structures, safety, and object clearances restrict the placement of poles. It is advisable to provide the higher illumination levels at diverging and merging areas.

Site considerations affecting pole placement include the presence at the site of noise walls, fences, guard rail, rock, narrow roadside clearances, ditches, steep slopes, standing water, power lines, nearby airports, traffic signals and nearby residential neighborhoods. Poles should be placed behind noise walls if the site permits and coordination is needed to be sure access, such as a doorway, is provided to the poles. Poles should not be placed directly next to a fence and care must be taken that the base of the pole has a minimum of three feet clear area for maintenance personnel. Poles should be placed at least three feet behind any existing guard rail to allow the guard rail to properly deflect upon impact but no more than seven feet to allow for a bucket truck to reach the luminaire for maintenance. Light poles should not be placed in ditch bottoms. When roadway lights are installed in conjunction with traffic signals, the lights should be installed on the same poles as the traffic signals, if possible.

Light pole placement on a long radius curve should be spaced the same distance as poles on a straight roadway. Pole placement on a short radius curve should be placed on the inside of the curve and require closer spacing in order to produce adequate pavement brightness on the curved section. Light poles on the inside of a banked curve should be placed such that they will not be hit by vehicles. Light pole placement should consider maintenance. Bucket trucks must be nearly level to operate and are limited in the height and distance from the roadway that the bucket can reach. Different types of trucks may have different working ranges. Poles should also be placed to minimize knockdowns.
10-4.02.02 Luminaires

A luminaire consists of an LED array with a power supply or a lamp, reflector, lens, and ballast, and a photocell (if required), and housing. There are several factors in choosing the type of luminaires that MnDOT approves. Some of those factors include:

- Efficiency of the luminaire in converting electrical energy to light,
- Ability of the luminaire to maintain light output over the course of the lamp life,
- Length of the LED or lamp life,
- Light color,
- Distribution of the light area.

All factors affect the cost and effectiveness of installing, operating, and maintaining the lights, and, therefore, affect the choice of light source. The luminaires are approved by the CO Lighting Unit and can be found on the MnDOT Approved Products List under Roadway Lighting.

In determining the light output for a luminaire, the lighting system designer must consider the luminaire light loss factor (LLF). This is a factor that is applied to the light output of a new luminaire (initial light output) to determine the light output of the luminaire after a fixed period of time (maintained light output). The AASHTO Roadway Lighting Design Guide discusses the different aspects of the light loss factor. With these considerations, the actual factor to apply to arrive at a maintained light output value for the luminaire is an educated guess. The LLF is different for each type of light source and is also dependent on how dirty the luminaires may become in a given area. LED light loss factors will vary by luminaire manufacturer. A standard LLF for an HPS lamp is .81. The LLF for LED luminaires is determined by luminaire testing. MnDOT's approved method of determining the LLF for an LED luminaire is in the luminaire specification found on the approved products list website. The value for MnDOT approved luminaires is located on the MnDOT Approved Products List.

The most commonly used luminaires for MnDOT roadway lighting typically has been the HPS “cobra head” style. MnDOT is now installing LED luminaires as a standard on our roadways. There are several advantages with using LED luminaires such as:

1. LED luminaires have a longer life expectancy than HPS, which may provide maintenance savings because of a reduction in the frequency of service of the luminaire.
2. LED Luminaires provide a white light that is often more desirable.
3. LED luminaires provide significant energy savings.
4. With some LED luminaires there is a reduction in upward lighting and glare.

Luminaires should only have a photocontrol receptacle and device when the lighting service cabinet does not provide photoelectric control or a lighting control system is used. Lighting control systems at each luminaire may replace the standard photocell on the cabinet if a control system is being utilized.

10-4.02.03 Electrical Service Point

The electrical service point (feedpoint) consists of a lighting service cabinet complete with circuit breakers and photoelectric control where applicable, a concrete foundation or wood pole for mounting, electrical connections to the electric utility service conductors, provisions for grounding, and a meter and meter socket when necessary. The District Traffic Office locates feedpoints from the electric utility company serving the area. The CO Lighting Unit should then be contacted to assign a feedpoint number.

The local electric utility company should be contacted early in the planning stage to determine the various locations where power is available for the project. The electric utility company should be given the voltage, lighting load (sum of the wattages of all the luminaires connected to the system), and any other pertinent information in the form of a letter to a electric utility company representative. The transformers necessary to provide the correct voltage and current are usually furnished and installed by the electric utility company. A sample copy of a letter is available in the MnDOT Roadway Lighting Design Manual.
It is always desirable to have the source of power located at a point nearest the center of the load. Service cabinets should be located:

1. Where they can be easily accessible for maintenance,
2. Will not obstruct the view of motorists,
3. Will not be prone to flooding,
4. Will not be prone to being hit, and
5. Located where highway electrical equipment currently exists or will probably be installed in the future.

Gates should be provided through the right-of-way fence where necessary. If the service cabinet is located at ramp terminals or at intersections on a one-way street, the best locations are in the far left quadrant or far right quadrant of the intersection.

The electric utility company may bring power of the proper voltage to a wood pole, or it may bring its primary voltage underground to a transformer on the concrete foundation with the service cabinet. When the electric utility company brings power to its wood pole, service to the cabinet comes through a weatherhead on the wood pole, through a conduit with drainage provisions, and into the cabinet. When the electric utility company comes to its transformer on the service cabinet foundation, service conductors come through conduit directly from the transformer to the cabinet.

The service cabinet should be a pad mounted type cabinet except for temporary lighting systems or where there is not space for a pad mounted cabinet, in which case a pole mounted cabinet would be installed. MnDOT approved cabinets are on the MnDOT Approved Products List.

A meter should be installed on the wood pole for wood pole service points, or mounted directly on the lighting service cabinet for cabinet foundation mounted transformer service points. The meter should be installed in an accessible location where the safety of personnel is not jeopardized, such as at the side of the road or on a frontage road, rather than in the median of a divided roadway. For some temporary systems, typically in rural areas, the district may request an agreement with the county or utility to pay a fixed monthly rate. This is becoming more uncommon.

Where available, the electrical service should be three-wire, 240/480 volts, 60-cycle alternating current. By using 240/480 volt service rather than 120/240 volt service, smaller wires can be used on the lighting branch circuits for the same lighting load.

For installations consisting of only 3 or 4 lights the smaller RLF cabinet mounted on the pad would be used instead of the larger Type L cabinet.

The branch circuit breakers in the standard Type L1, Type L2, Type A Type B or Type RLF lighting service cabinets are 20 ampere, 2 pole. The National Electrical Code allows circuit breakers to be loaded to only 80 percent of their ampere rating for loads that will be on for more than three hours. This means that the circuits should be designed so that there is no more than 16 ampere current on each phase wire. If it is not possible to limit the current to this value, additional branch circuits must be included to reduce the load current to an acceptable level.

10-4.02.04  Lighting Branch Circuits

The lighting branch circuits normally consist of three-wire single phase circuits, with two phase wires, one shared neutral wire, and a ground conductor. Each luminaire should be wired between a phase conductor and the neutral conductor, not between the two phase conductors. This means that on a 240/480 volt system, the luminaires should operate at 240 volts. On 120/240 volt systems, the luminaires should operate at 120 volts.

Where lighting is installed along the side of a roadway in a grassy area, the lighting branch circuits should utilize direct buried armored cable. Where the direct buried cable passes under roadways, it should pass
through a Schedule 80 rigid PVC or HDPE conduit for protection and to avoid the need to break up the pavement to trench the cable in. See **Figure 10-4**: Typical Conduit Placement (Cloverleaf Interchange) and **Figure 10-5**: Typical Conduit Placement (Diamond Interchange). Conduit size under roadways should be a minimum of three inches to allow space for future conductors to be run under the roadway and should have bell ends on each end to prevent damage to the cable jacket. The conduit should be installed as part of the roadway paving plan.

Where the lighting is installed on a median barrier, a bridge, a tunnel wall, or an underpass, the lighting branch circuits should be individual conductors run through conduit and junction boxes. The conduit and junction boxes will normally be installed as part of the median barrier, bridge, tunnel, or underpass. Conduit installed in a median barrier will usually be Schedule 80 rigid PVC conduit, and conduit installed as part of a bridge or tunnel will usually be rigid steel conduit. Other types of conduit are currently being explored for use in a bridge. All conduit systems require an equipment grounding conductor that must be indicated in the plans along with the phase and neutral wires in the conduit.

Continuous lighting systems should include a standby cable and, if appropriate, conduit between the adjacent end lights on branch circuits from adjacent sources of power for flexibility in the wiring of the lighting units, for temporary wiring during future construction, or for maintenance purposes.

For the main lighting branch circuits, the conductors should be number 4 wires as defined by the American Wire Gage (AWG). The direct buried lighting cable that the State uses is normally manufactured in the number 4 AWG wire size. Because of its availability, the number 4 AWG should be used when direct buried lighting cable is used, even if a smaller wire size would be sufficient. If number 4 AWG wires result in a voltage drop in the wiring system (measured at the farthest light on the lighting branch circuit) of more than 3 percent of the system voltage, a larger wire size is necessary. The procedure for calculating voltage drop in a system is located in the MnDOT Lighting Design Manual.

Lighting circuits that serve an underpass light may be single conductors no smaller than number 10 AWG run in conduit.

Lighting branch circuits are frequently spliced to provide the necessary circuits to operate all of the lights in the system. Splices should be avoided where possible. When splices are necessary because of the layout of the system, they should be made only in light pole bases. A handhole and splices are acceptable in a permanent lighting system for underpass lighting if there is no good way to make the splice in a light pole base. Splices in handholes must be the approved two-way and three-way direct buried handhole splices found on the MnDOT Approved Products List under Roadway Lighting.

Direct buried splices should not be utilized in a permanent lighting system installation. Every splice in a wiring system is a potential point for wiring system failure. Splicing lighting branch circuit wires in the light pole bases are considered above ground and does not add extra splices since a splice is already required at each light pole base to connect the light to the system.

A 15-foot ground rod should be indicated in the plans at every alternate light base, and at the first and last light base on each lighting branch circuit.

### 10-4.03 Temporary Lighting

Providing temporary lighting may be desirable in construction areas or near at-grade intersections on highways where the warrants mentioned previously are met. The District Traffic Engineer may request the installation of temporary lights from an electric utility company, or the temporary lights may be installed by the contractor or State.

Lighting installed by the electric utility company is maintained by the electric utility company, and, while it may be their standard design, it must meet all the State’s safety requirements. Temporary lighting installed by the State or the contractor may be maintained by the electric utility company, the State, or the contractor and is the State’s or the contractor’s design. Temporary lights in a construction zone are subject to being frequently moved, and so maintenance by the contractor is often the simplest to implement in that the State and the electric utility company do not have to keep track of what lights are where at any given time. When the contractor maintains the system, the contract documents should indicate that the contractor also is responsible
for paying for the power. If temporary lighting is to be left in place at the end of a project, to be removed as part of a later project, it may be better for the state to maintain the system and pay for the power. Temporary lighting that is not part of an agreement with the electric utility company should be metered.

Power distribution to temporary lighting units is typically by means of self-supporting ACSR messenger quadplex aluminum cable. Quadplex cable should be used to provide the two phase wires, the neutral wire, and the ACSR messenger equipment ground wire. Aluminum wire should not be used if the lighting will be in place for a long period of time.

10-4.04 Sign Lighting

In general, MnDOT no longer uses sign lighting, however, there may be some instances when it is still desirable. LED luminaires will be used for lighting the signs. The spacing of the lighting units depends upon the width of the sign panel being illuminated.

A roadway lighting unit is the normal power source for a sign light. A means for disconnecting the light for maintenance is provided.

10-5.00 CONSTRUCTION

10-5.01 Field Placement of Light Poles

The exact locations of light poles may be adjusted to avoid obstructions encountered in the field. Such items as solid rock, power lines, slopes, existing guard rail, fences, ditches, standing water, etc., may make it necessary or desirable to locate the pole differently than is indicated in the plans - maintain a 3-foot clear area around the base of the light pole. The project engineer may stake the poles up to 10 feet along the direction of the roadway from the locations indicated in the plans. If a farther change is required, the project engineer should consult with the lighting system designer to determine if such a change requires changing the placement of other light poles in the system. The plans typically place the poles 19 to 26 feet behind the edge of the traveled roadway for davit. If this distance cannot be achieved, contact the District Traffic Office. If a noise wall exists at the location and is not indicated in the plans, light poles should be placed behind it if possible and a door installed in the wall for access to the light pole. If guardrail exists, clearance between the back of the guardrail and the front of the light pole should be at least 2 to 3 feet and no more than 7 feet. Do not place light poles in ditch bottoms. Poles should not be closer than 20 feet in any direction from power lines. If 20 feet cannot be maintained, contact the electric utility company.

10-5.02 Documentation

The project engineer should notify the District Traffic Engineer of the date the lights are energized. The district should then notify the electric utility company of this date, in writing for billing purposes, with a copy to the District Lighting Unit.

The project engineer should document any field changes to the lighting system on final "as-built" plan sheets. These "as-built" plans should be kept by the District Lighting Unit with a copy being sent to the Electrical Services Unit Locate Office.

The Automated Facility Management System (AFMS) must also be updated to show the new lighting and the parties responsible for operation and maintenance.

The MnDOT Standard Specifications for Construction requires the electrical distribution system to be tested for insulation resistance and short circuits to ground. The contractor should document the results of these tests and deliver the documentation to the project engineer.

When a municipality is participating in the cost of installing or maintaining the lighting system, the city utility engineer should attend the final inspection of the lighting system.
10-6.00  OPERATION AND MAINTENANCE

10-6.01  General

Operation of the lights involves supplying power to the light and paying all power costs. Maintenance of the lights includes maintaining everything within the system from the point of attachment to the power source or utility, to the last light from the feed point and is described in the Cost Participation Policy.

Responsibility for operating and maintaining lighting systems is detailed in the agreement and may fall upon the electrical utility company, the local governing body, and/or the State. Responsibility may include performing maintenance, paying for maintenance, and/or paying for power. If a different party performs maintenance work than is responsible for its cost, the cost should be reimbursed.

The following are some definitions for lighting maintenance including power cost. See the Cost Participation for more information:

**Power Cost**
All energy costs associated with the lighting system after the system has been turned on.

**Hook Up Fees**
This includes charges from the electric utility for hooking up the service.

**Luminaire Maintenance**
This includes, but is not limited to, relamping lighting units or replacing of LED luminaires, repair or replacement of all damaged luminaire glassware, loose connections, luminaires when damaged or when the ballast fails, photoelectric controls on luminaires defective starter boards or drivers, and cleaning glassware.

Luminaires must be replaced when they no longer provide required light levels. This will be based on the light loss factor used during design. Current design requires luminaires to be replaced in 18 to 20 years from installation.

**Pole or Knockdown Maintenance**
This includes, but is not limited to, replacing damaged fuse holders and blown fuses, repairing or replacing the pole when knocked down (including the wiring within the pole), replacing damaged poles, and painting poles when applicable.

**Underground Maintenance (including all wiring from the line side of the fuse kit to the source of power)**
This includes, but is not limited to, repairing or replacing handholes or pullboxes when needed, repairing underground wire, locating underground wire, installing approved splices or replacing wires, and repairing or extending conduit.

**Light Foundation Maintenance**
This includes repairing damaged foundations, repairing or replacing bolts, repairing concrete, and repairing conduits.

**Cabinet and Pad Maintenance**
This includes a complete lighting cabinet, maintenance including photoelectric cell, repairing the equipment pad or anything located on the pad, and repairing the electrical distribution system.

10-6.02  Budgeting (MnDOT)

Payment for Energy - The district should budget for the energy bills for roadway lighting for which the State has responsibility.

Payment for Painting of Poles - Where the department has the responsibility of pole maintenance, the painting of light poles and bases should be arranged for, budgeted, and paid for by the district.
10-6.03 Maintenance (MnDOT)

10-6.03.01 Maintenance Procedures

The District Traffic Engineer is responsible for the monitoring and asset management of all lighting owned by MnDOT within their district. The District and the Electrical Services Unit are responsible for entering all lights that are either inoperable or knocked down into AFMS.

When either the Metro or Regional Electrical Services Unit is responsible for the repair they will update AFMS when they complete work. When the work is entirely complete the work order should be closed out.

10-6.04 Obtaining Electrical Power from MnDOT Lighting or Signal Systems

Other MnDOT offices as well as non-MnDOT agencies are discouraged from obtaining electrical power from MnDOT Lighting and Signal equipment. Only in rare circumstances, and after all other options have been exhausted with the local electric utility company, the requester may request to obtain power from a MnDOT Lighting or Signals system. All costs incurred by the new installation should be paid for by the requester.

In order to assure safe and efficient operation of all equipment and to monitor electrical power sharing and billing, approval must be obtained from the District Traffic Office, MESU or ESU before installation and certain procedures must be followed.

The following procedures vary depending on what agency requests the power and the type of equipment involved.

10-6.04.01 Lighting Cabinet or Unit

Process

1. The requester seeking electrical power should submit a scaled CADD plan sheet, signed by a professional engineer or master electrician, of the proposed installation to the District. The drawing shall include the reason for the request as well as the intended electrical loading.

2. The District Traffic Engineer will review the information with ESU, and will work with the requester to develop an acceptable proposal.

3. The requester shall contact the local electric utility company to notify them of the installation and set up a billing procedure. Documentation of this agreement shall be sent to the District prior to the start of construction.

4. If the request is approved, the applicable requirements from the following list and the general requirements must then be fulfilled.

Requirements

- If a MnDOT lighting unit is the power source, a 6 amp in-line fuse on a 240v system or an 8 amp fuse on a 120v system must be provided in the lighting unit. This fuse holder must be a MnDOT approved breakaway type and be labeled as to its use. If the MnDOT lighting unit is operated from a photocontrol device at the lighting cabinet, the circuit is only energized at night. If the lighting unit is part of a metered system you will not be able to separate power use when doing this. The District Traffic Office will be charged for the power of the system being powered using the lighting unit. If this is undesirable then other options must be used.

- If a MnDOT lighting cabinet is the power source, a separate circuit breaker shall be provided and labeled as to its use. Power to the circuit breaker must bypass the photocontrol device unless the new installation is intended to be photocontrolled.

- For metered lighting systems the lighting cabinet may be used as a power source and a separate meter will be required. The conductors that supply the service shall be sized to supply both meters. This will be done by the requester at no cost to MnDOT.
• The installation must be inspected by ESU and the required electrical permits be obtained from the local electrical inspector to insure code compliance and safety to maintenance personnel and the public. ESU shall be notified as soon as a construction date is determined.
• All additional conductors and cables shall be labeled within the Mn/DOT lighting system.

10-6.04.02 Signal System

A signal system is defined as any cabinet containing traffic signal, traffic management, or traffic recording equipment.

The signal system refers to any cables that lead into or out of the signal cabinet. Power shall not be obtained from inside the signal cabinet. Power can be obtained from the service equipment/service cabinet or from the unmetered lighting conductors in the signal bases. If the lighting conductors are to be used as the power source, follow the requirements for obtaining power from a lighting unit as follows:

Requirements
• A separate circuit breaker shall be provided and labeled as to its use. Power to the circuit breaker must be obtained from the unmetered side of the load center or ahead of the meter. A separate meter will be required by the electric utility company.
• All additional conductors and cables shall be labeled within the MnDOT signal system.
• The installation must be inspected by ESU and the required electrical permits be obtained from the local electrical inspector to insure code compliance and safety to maintenance personnel and the public. ESU should be notified as soon as a construction date is determined.

General
• MnDOT may disconnect the system without prior notice if the installation interferes with the operation of the MnDOT system.
• If MnDOT relocates or moves the system providing power, it is the requesting office’s responsibility to reconnect to MnDOT’s system or to find an alternate source of power.
• The requester shall submit as-built plan sheets, signed by a professional engineer or master electrician, to the District within 48 hours of connection into a MnDOT system.
• Only a certified electrician will be allowed access to the systems used as the power source. Prior notification must be given to the District or ESU.
• The requesting office will be responsible for maintaining all equipment after the power source.
• The requesting office shall provide the District and ESU or MESU with contact information for the party who will be performing maintenance on the system.
• The requesting office shall identify a contact person within the office.
• The requesting office must be, or become, a registered owner with Gopher State One Call and be responsible for locating the cable from the MnDOT power source to the location being served.

10-6.04.03 Special Additional Requirements for a Non-MnDOT Agency

A MnDOT permit will be required for any installation request.

10-7.00 REFERENCES

The AASHTO Roadway Lighting Design Guide and the IES American National Standard Practice for Roadway Lighting RP-8 contain many additional references, including references for high mast tower lighting and tunnel lighting.


Figure 10-1
Typical Luminaire Locations
Partial Interchange Lighting
Davit Arm Poles

Text Ref.: 10-4.01.02
NOTE:
Luminaires may be oriented to tie in with existing or proposed city or county lighting systems.
Pole Type Designations generally contain:

1. Mast Arm Length,
2. Type of Pole, and
3. Nominal Pole Height.

The designation appears in the following order:
   Mast Arm Length, Type of Pole - Nominal Pole Height

1. Mast Arm Length
   The first character before the dash is the mast arm length, usually 6 feet, 9 feet, or 12 feet.

2. Type of Pole
   The character(s) just preceding the dash indicate the type of pole used, see the list below. If no characters are in this position, the pole has a transformer base or high base, is intended for mounting on a light base, and has no finish for an aluminum or stainless steel pole or is galvanized for a steel pole.
   The pole type characters are as follows:
   A - Anchor bolt pole (no transformer base)
   B - Barrier or bridge mounting (6 bolt cluster)
   C - Corten steel (no finish applied)
   D - Double mast arms
   M - Ornamental style pole
   P - Painted pole
   S - Combination traffic signal and street light pole
   W - Wood pole lighting unit (for temporary lighting)
   X - Decorative pole (usually square arms)
   VM - Vertical mount

3. Nominal Pole Height
   The characters after the dash give the nominal pole height.

EXAMPLES:
9-40
9 foot mast arm with 40 foot mounting height, transformer base or high based, and aluminum or stainless steel as indicated in the plans.

6BD-40
6 foot double mast arms with 40 foot mounting height, provisions for barrier mounting.

VMD-45
Tenon mount double vertical luminaire with 45 foot mounting height.
78mm (3") Rigid steel conduit placed 610mm (24") below the finished grade.

Text Ref.: 10-4.01.04

January 1, 1996

TYPICAL CONDUIT PLACEMENT (CLOVERLEAF INTERCHANGE)
TYPICAL CONDUIT PLACEMENT (DIAMOND INTERCHANGE)

- 78mm (3") Non-Metallic Conduit placed 610mm (24") below finished grade

Text Ref.: 10-4.01.04
LIGHTING OF TRAFFIC FACILITIES

Appendix A
Voltage Drop Calculations
VOLTAGE DROP CALCULATIONS

A voltage drop calculation shows the amount of voltage that will be present at the farthest luminaire on a lighting branch circuit. The voltage drop is of concern in order to assure that the voltage at all luminaires will be sufficient for the luminaires to operate properly, and also to avoid inefficient operation of the lighting system due to a large amount of power being dissipated in the electrical distribution system (wires).

The wires carrying current to the luminaires in the lighting system have a small amount of resistance. The resistance of the wire depends on the size (gauge) of the wire, the material of the wire, and the length of the wire. When current flows through the wires on its way to the luminaires, a voltage proportional to the resistance and to the current is developed along the length of the wire. This voltage subtracts from the voltage at the source of power and results in a lower voltage at the luminaire. If the resistance of the wire is too high for the amount of current flowing through it, the voltage dropped along the wire will be too high to allow sufficient voltage at the luminaire. The National Electrical Code suggests a value of 3 percent of the system voltage to be a reasonable limit to the amount of voltage drop to allow in the lighting branch circuit. The voltage along the wire multiplied by the current flowing through the wire yields the power dissipated in the wire. The higher the resistance of the wire, the higher the voltage dropped along the wire, and the more power is used up by the wiring system. The voltage drop calculation determines the size (gage) of wire of a specified material that is necessary to carry the required current the required distance without creating too large of a loss in the wire.

The basic equation that is used to determine the voltage drop in a lighting branch circuit is Ohm’s Law

\[ E = I \times R \]

where:
- \( E \) is the voltage drop along a segment of wire,
- \( I \) is the current through the same length of wire, and
- \( R \) is the resistance of the length of wire.

This equation is only completely accurate for direct current systems. With the current in the branch circuits limited to 20 amperes by the circuit breakers, and the frequency of the power at 60 hz, the equation is fairly accurate for the lighting branch circuits also.

\( E \) is the unknown value that is sought. \( I \) (for any segment of wire) is calculated by adding the currents for each luminaire the particular segment of wire feeds (i.e. all the luminaires downstream on that wire). \( R \) (for a particular segment of wire) is calculated by multiplying the length of the wire (in thousands of feet) in that segment by the resistance per 1000 feet of wire for that particular size and material of wire. The total voltage drop to the farthest luminaire is calculated by adding the voltage drops for each segment of wire from the service cabinet to that luminaire. The current for a single luminaire of various types and the resistance values for several types of wire is given in Figure 10.7, “Voltage Drop Calculation Values”

The voltage drop must be calculated for the phase wire (hot wire, ungrounded wire) and for the neutral wire (grounded wire), and these voltages must be added together to arrive at the total voltage drop. In a two-wire circuit, the current that travels out in the phase wire must return in the neutral, and so the current in the neutral wire is the same as the current in the phase wire. The total voltage drop in the two-wire circuit, then, can be calculated by figuring the voltage drop in just the phase wire and multiplying that number by 2.

Most of the lighting branch circuits in lighting systems designed by the state are three-wire single phase circuits. A three-wire circuit consists of two phase wires and a neutral wire instead of one phase wire and one neutral wire as in the two-wire circuit. In a three-wire circuit, the neutral is at approximately zero volts with respect to the ground. The two phase wires share the same neutral and are at opposite voltages with respect to the neutral wire. For example, if at some given time the voltage in one phase wire was 240 volts with respect to the neutral wire, then the voltage in the other phase wire at that same time would be -240 volts with respect to the neutral wire. The significance of this voltage arrangement is that the current returning in the neutral wire from one of the phase wires will cancel out the current returning in the neutral wire from the other phase wire.
Thus, if the loads on the two phase wires are exactly balanced, there will be no current in the neutral wire, and, therefore, no voltage drop in the neutral wire. In this case, the total voltage drop to the farthest luminaire is simply the total voltage drop in the phase wire, and the neutral wire can be disregarded.

Two examples of a voltage drop calculation are shown below. One example is for single luminaires wired to alternate phase wires as is typically done. The second example is for double luminaire poles such as might be found on a median barrier. Two different voltages are used in the examples to illustrate the application of the voltage drop at different voltages.

**EXAMPLE ONE: SINGLE LUMINAIRES**

The system in this example consists of 250 watt high pressure sodium luminaires on poles 130 feet apart. The wires are number 4 gage single conductor wires in a conduit system. This is a 120/240 volt lighting system. There are 9 lights total on the lighting branch circuit, with the lights wired to alternate phase wires. A circuit such as this might be found in a downtown city street light system.

A wiring diagram for the lighting branch circuit is shown in Figure 10.9 “Voltage Drop Calculation Examples.” The wire segment labels and the distances between the lights are also shown on the diagram.

From Figure 10.8, “Voltage Drop Calculation Values,” the current for a 250 watt high pressure sodium luminaire at 120 volts is 2.9 ampere. The resistance for number 4 gage copper wire is 0.259 ohms per 1000 feet. The following table calculates the voltage drop in the phase wire for each wire segment and gives the total voltage drop. The distance is a given from the layout of the system. The resistance is calculated by multiplying the distance in thousands of feet by the resistance per thousand feet. The current is calculated by multiplying the number of luminaires downstream of each wire segment by 2.9 ampere per luminaire. The voltage drop in each segment of wire is calculated by multiplying the current in each wire segment by the resistance of each wire segment. The total voltage drop is calculated by adding the voltage drops of all the wire segments. The current in the neutral wire is disregarded for this calculation. Depending on the system layout, the voltage drop in the neutral may add to the total voltage drop or subtract from the total voltage drop as calculated. The contribution of the voltage drop in the neutral wire is negligible compared to the voltage drop in the phase wire if the system is reasonably balanced.

<table>
<thead>
<tr>
<th>Wire Segment</th>
<th>Distance</th>
<th>Resistance</th>
<th>Current</th>
<th>Voltage Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.06</td>
<td>0.051</td>
<td>14.5</td>
<td>0.7395</td>
</tr>
<tr>
<td>B</td>
<td>0.09</td>
<td>0.0765</td>
<td>11.6</td>
<td>0.8874</td>
</tr>
<tr>
<td>C</td>
<td>0.09</td>
<td>0.0765</td>
<td>8.7</td>
<td>0.6656</td>
</tr>
<tr>
<td>D</td>
<td>0.09</td>
<td>0.0765</td>
<td>5.8</td>
<td>0.4437</td>
</tr>
<tr>
<td>E</td>
<td>0.09</td>
<td>0.0765</td>
<td>2.9</td>
<td>0.2219</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>2.958</strong></td>
</tr>
</tbody>
</table>

Since 3 percent of 120 volts is 3.6 volts, this value is acceptable, and the number 4 wires can be used. The calculation would be identical if three conductor number 4 armored cable were used instead of the single conductor number 4 gauge wires. Had number 6 gage wires been used, the resistance would be 0.410 ohms per 1000 feet and the voltage drop would have been 4.2805 volts. This is more than 3 percent of 120 volts, and so number 6 gauge wires are too small.
EXAMPLE TWO: DOUBLE LUMINAIRES

The system in this example consists of 250 watt high pressure sodium luminaires on poles 75 m apart with two luminaires on each pole. The wires are number 4 gage single conductor wires in a conduit system. This is a 240/480 volt lighting system. There are 16 lights total on the lighting branch circuit, with one light wired to each phase wire at each pole. A circuit such as this might be found in the median of a freeway.

A wiring diagram for the lighting branch circuit is shown in Figure 10.9. “Voltage Drop Calculation Examples.” The wire segment labels and the distances between the lights are also shown on the diagram.

From Figure 10.8, “Voltage Drop Calculation Values,” the current for a 250 watt high pressure sodium luminaire at 240 volts is 1.4 ampere. The resistance for number 4 gage copper wire is 0.259 ohms per 1000 feet. The following table calculates the voltage drop in the phase wire for each wire segment and gives the total voltage drop. The voltage drop in each segment of wire is calculated in the same manner as in example one. The current in the neutral wire is disregarded for this calculation. If only double luminaire poles are on the branch circuit, the load is exactly balanced at all points on the circuit, there is no current anywhere in the neutral, and the voltage drop is correct as calculated.

<table>
<thead>
<tr>
<th>Wire Segment</th>
<th>Distance</th>
<th>Resistance</th>
<th>Current</th>
<th>Voltage Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.06</td>
<td>0.051</td>
<td>11.2</td>
<td>0.5712</td>
</tr>
<tr>
<td>B</td>
<td>0.075</td>
<td>0.06375</td>
<td>9.8</td>
<td>0.62475</td>
</tr>
<tr>
<td>C</td>
<td>0.075</td>
<td>0.06375</td>
<td>8.4</td>
<td>0.5355</td>
</tr>
<tr>
<td>D</td>
<td>0.075</td>
<td>0.06375</td>
<td>7</td>
<td>0.44625</td>
</tr>
<tr>
<td>E</td>
<td>0.075</td>
<td>0.06375</td>
<td>5.6</td>
<td>0.357</td>
</tr>
<tr>
<td>F</td>
<td>0.075</td>
<td>0.06375</td>
<td>4.2</td>
<td>0.26755</td>
</tr>
<tr>
<td>G</td>
<td>0.075</td>
<td>0.06375</td>
<td>2.8</td>
<td>0.1785</td>
</tr>
<tr>
<td>H</td>
<td>0.075</td>
<td>0.06375</td>
<td>1.4</td>
<td>0.08925</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3.0700</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since 3 percent of 240 volts is 7.2 volts, this value is acceptable, and the number 4 wires can be used. Had number 6 gauge wires been used, the resistance would be 0.410 ohms per 1000 feet and the voltage drop would have been 4.7757 volts. This value is still less than 3 percent, and so number 6 gauge wire could have been used. Had number 8 gauge wire been used, the resistance would be 0.6404 ohms per 1000 feet and the voltage drop would have been 7.4594 volts. Therefore, number 8 gauge wire should not be used.
## Current in AMPS for High Pressure Sodium Luminaires

<table>
<thead>
<tr>
<th>Luminaire Voltage</th>
<th>Lamp Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150</td>
</tr>
<tr>
<td>120</td>
<td>1.7</td>
</tr>
<tr>
<td>240</td>
<td>0.9</td>
</tr>
</tbody>
</table>

## Resistance of Conductors in Ohms Per 1000 Feet

<table>
<thead>
<tr>
<th>Conductor Material</th>
<th>Conductor Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Copper</td>
<td>5.31 (1.62)</td>
</tr>
<tr>
<td>Aluminum</td>
<td>8.73 (2.66)</td>
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<table>
<thead>
<tr>
<th>Conductor Material</th>
<th>Conductor Size (AWG)</th>
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<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Copper</td>
<td>0.85 (0.259)</td>
</tr>
<tr>
<td>Aluminum</td>
<td>1.39 (0.424)</td>
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</table>

Text Ref.: Chapter 10 Appendix
EXAMPLE ONE

Service Cabinet

120/240 VOLTS

B & R - Denote carrying conductors.
W - Denotes neutral conductor.

Wire Segment
A  200 ft.  
B  260 ft.  
C  260 ft.  
D  260 ft.  
E  260 ft.  

EXAMPLE TWO

Service Cabinet

240/400 VOLTS

Wire Segment
A  200 ft.  
B  240 ft.  
C  240 ft.  
D  240 ft.  
E  240 ft.  
F  240 ft.  
G  240 ft.  
H  240 ft.  

= Luminaire
NO. 4 AWG Distribution Wires

250 Watt HPS Luminaires

Text Ref.: Chapter 10 Appendix

FIGURE 10.7
# CHAPTER 11 - TRAFFIC SAFETY

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11-1.00 INTRODUCTION

11-1.01 Purpose

Safety is a core value embraced by the Minnesota Department of Transportation and included in the agency’s mission statement. The traffic engineer’s role in safety is to prevent or mitigate crashes involving motor vehicles and other roadway users. Addressing crashes involving the loss of life or serious injury is the top priority in terms of traffic safety - and is supported by the Highway Safety Improvement Program’s (HSIP) objective of reducing fatal and life altering crashes. There is a need to proactively identify fatal and serious injury crash risks systemwide. The general approach and principles are the following:

- Death and serious injuries are unacceptable – efforts to reduce fatal and serious injury crashes are prioritized.
- Understand that people make mistakes – the system can and should be designed and operated to allow for known and common human mistakes.
- People are fragile – people have limits for tolerating crash forces, so system design (vehicles and roadways) should accommodate this human fragility.
- Safe mobility is provided for vulnerable road users (pedestrians, bicyclists, motorcyclists, etc.).
- Redundancy needs to be considered – if one part of the system fails, other elements provide protection.
- Safety is proactive and systematic – proactive risk assessment should be done to identify and mitigate systematic risks instead of waiting for crashes to occur.
- Responsibility is shared between all stakeholders (road owners, road designers, enforcement, education, emergency services, vehicle manufacturers, road users, etc.).
- While maximum safety would be an ideal in an unconstrained world, the balancing of many systemic needs can create difficult choices. Road owners should work to optimize system-wide safety based on the known resource constraints given.

Traffic safety includes many of the products and services MnDOT provides to the traveling public. Items such as winter maintenance operations, well maintained roadways with pavement markings, and roads designed to integrate the needs of all users while economically and efficiently moving people and goods are all part of providing a safe transportation network.

Opportunities to make general improvements that reduce the potential for all crashes should be pursued in conjunction with other programs and funding opportunities.

11-1.02 Chapter Organization

This chapter is organized around improving traffic safety on Minnesota roads. Each section contains a list of resources the traffic engineer may find useful.

- Section 2 is a list of acronyms.
- Section 3 discusses the importance of strategic planning to create a coordinated, systematic approach to safety in a region.
- Section 4 describes the crash reporting process from an incident through officer reporting to a centralized database.
- Section 5 describes crash data regarding data practices, data sources, and data requests.
- Section 6 walks through the resources and techniques in the safety project process, from network screening and analysis to project selection to evaluation.
- Section 7 outlines the Highway Safety Improvement Program (HSIP) and other funding options.
### 11-2.00 LIST OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>4Es</td>
<td>Major focus areas to reduce traffic injuries and fatalities:</td>
</tr>
<tr>
<td></td>
<td>1. Education,</td>
</tr>
<tr>
<td></td>
<td>2. Enforcement,</td>
</tr>
<tr>
<td></td>
<td>3. Engineering,</td>
</tr>
<tr>
<td></td>
<td>4. Emergency Medical &amp; Trauma Services</td>
</tr>
<tr>
<td>A Injury</td>
<td>Suspected serious injury</td>
</tr>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ADT</td>
<td>Average Daily Traffic</td>
</tr>
<tr>
<td>BCA</td>
<td>Bureau of Criminal Apprehension</td>
</tr>
<tr>
<td>CMF</td>
<td>Crash Modification Factor</td>
</tr>
<tr>
<td>CR</td>
<td>Total Crash Rate</td>
</tr>
<tr>
<td>CRF</td>
<td>Crash Reduction Factor</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
</tr>
<tr>
<td>DPS</td>
<td>Minnesota Department of Public Safety</td>
</tr>
<tr>
<td>DVS</td>
<td>Minnesota Department of Public Safety, Driver Vehicle Services Division</td>
</tr>
<tr>
<td>FAR</td>
<td>Fatal (K) and incapacitating injury (A) crash rate</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>HSM</td>
<td>AASHTO Highway Safety Manual</td>
</tr>
<tr>
<td>HSIP</td>
<td>Highway Safety Improvement Program</td>
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<tr>
<td>LRRB</td>
<td>Minnesota Local Road Research Board</td>
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<td>LTAP</td>
<td>Minnesota Local Technical Assistance Program</td>
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<tr>
<td>MnCMAT2</td>
<td>Minnesota Crash Mapping Analysis Tool</td>
</tr>
<tr>
<td>NCHRP</td>
<td>National Cooperative Highway Research Program</td>
</tr>
<tr>
<td>OTE</td>
<td>Office of Traffic Engineering</td>
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<tr>
<td>PAR</td>
<td>Police Accident Report</td>
</tr>
<tr>
<td>PII</td>
<td>Personally Identifiable Information</td>
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<tr>
<td>RSA</td>
<td>Road Safety Audit</td>
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<tr>
<td>SALT</td>
<td>State Aid for Local Transportation</td>
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<td>SHSP</td>
<td>Strategic Highway Safety Plan</td>
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<td>TRB</td>
<td>Transportation Research Board</td>
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<td>TZD</td>
<td>Toward Zero Deaths</td>
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<tr>
<td>VMT</td>
<td>Vehicle Miles Traveled</td>
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11-3.00 TRAFFIC SAFETY PLANNING

11-3.01 Toward Zero Deaths (TZD)

In pursuing the goals of the HSIP, MnDOT employs the Toward Zero Deaths (TZD) approach based on the belief that even one traffic-related death on Minnesota roads is unacceptable. The idea was first adopted in Sweden in 1997 as “Vision Zero.” Since then, several state DOTs, including Minnesota, have identified zero deaths as a core objective in their Strategic Highway Safety Plans. TZD was also adopted as a national strategy in 2009.

Minnesota TZD is the cornerstone of the state’s traffic safety program, employing an interdisciplinary approach to reducing traffic crashes, injuries, and deaths on Minnesota roads. TZD uses a data-driven approach that targets areas for improvement and employs proven countermeasures that integrate education, enforcement, engineering, and emergency medical & trauma services (the “4Es”).

While individual disciplines have a long history of successful traffic safety programs, TZD aims to tie these together with a common vision and mission for even greater success. A combination of strategies from different focus areas is often most effective for solving a particular problem. Often the tendency is to jump to only roadway deficiencies or only driver behavior as potential focus areas to improving roadway safety. Whenever possible, a 4E approach should be the first step in assessing how to improve roadway safety.

The TZD program uses data to target areas for improvement and employ proven countermeasures. Each district has staff assigned to support and promote TZD. These resources should be used to the maximum extent possible when working on safety related items.

The TZD team works in partnership with community and corridor groups to improve the traffic safety of a designated area. Toward Zero Deaths provides technical assistance, materials, and guidance to local groups that are committed to reducing crashes and the fatalities and incapacitating injuries that result from them – both at an infrastructure programming level as well as a community engagement level.

11-3.02 Strategic Highway Safety Plan (SHSP)

The Minnesota Strategic Highway Safety Plan (SHSP) is a policy plan that sets an overall direction for future safety strategies and presents a framework for selecting strategies. The plan provides insight and direction on how to reduce traffic-related crashes on all Minnesota roads. It describes how many, where, what type, and to whom motor vehicle crashes occur. The plan prioritizes key focus areas and strategies and wherever possible, highlights opportunities for collaboration.

The SHSP is a policy plan based on data and trends that affect traffic safety. It was developed in consultation with safety stakeholders from across the 4Es and other disciplines.

The SHSP is tightly integrated with the goals and objectives of the TZD program. Like the TZD program, the SHSP takes a holistic 4Es approach to traffic safety. Performance measures are outlined to chart progress toward a goal of zero deaths on Minnesota roads. By providing benchmarks and measures, decisions can be made to support the various statewide, district, and local projects or programs.

The development of the SHSP is a requirement of the Federal Highway Administration. The plan is intended to be updated every five years. As a living document, it reflects the priorities and practices of the Department, especially for how it intends to operate in coordination with the Highway Safety Improvement Program (HSIP). This resource provides a vast array of data and relationships that can be of assistance when approaching a traffic safety topic.

11-3.03 Regional and Local Planning

Regional and local organizations are encouraged to incorporate safety into their long-term planning. The plans should take into account statewide initiatives through the TZD program or SHSP as well as local crash trends and stakeholder input.
Preparing roadway safety plans should answer three fundamental questions that are essential to developing safety projects for the HSIP:

1. **What are the priority crash types?**
   Analyze data to identify specific safety focus areas, i.e. crash types that represent the greatest opportunity for reduction. To qualify for HSIP funding, the priority crash types must in some way relate to fatal and serious injury crashes.

2. **What are the priority safety strategies?**
   Identify a comprehensive list of effective safety strategies to address the focus areas. Convene a workshop to identify a short list of implementation strategies at specific high-priority locations.

3. **What are the priority locations where projects should be implemented?**
   Conduct a system-wide risk assessment to identify the high-priority candidate locations for safety investment. When selecting locations for an improvement project, multiple criteria will be considered including risk, crash history, mitigation costs, the ability to incorporate an improvement in an upcoming road project, local partner support, and benefit/cost ratios.

The need for safety planning is based on the fact that over 90 percent of severe crashes occur at locations not considered high-crash locations, and typically with no severe crash history. MnDOT OTE staff have extensive experience developing road safety plans and systemic risk assessment, including District and County Road Safety Plans. For more information or assistance in developing a safety plan, contact OTE.

### 11-3.04 Safe System Approach

In alignment with the goals of TZD, the Safe System approach is focused on reducing the severity of crashes. With a variety of causation factors for crashes, it is unrealistic to think we will be able to eliminate all crashes. In a Safe System, it is recognized that crashes will continue to occur, so the focus is on mitigating the impacts on humans in those crashes.

The Safe System approach has been successfully used in several other countries but is relatively new to the United States. MnDOT is currently determining what the Safe System approach looks like in Minnesota.

### 11-4.00 CRASH REPORTING

#### 11-4.01 Statutes

Minnesota Statutes, Section 169.09, Subdivision 7 ([Minn. Stat. Sec 169.09, Subd. 7](#)) states that the driver shall forward a written report of an accident to the commissioner of public safety within 10 days if involved in a crash resulting in bodily injury to or death of any individual, or total property damage to an apparent extent of $1,000 or more.

Minnesota Statutes, Section 169.09, Subdivision 8 ([Minn. Stat. Sec 169.09, Subd. 8](#)) states that a peace officer who investigates an accident shall forward an electronic or written report of the accident as prescribed by the commissioner of public safety within 10 days of an accident.

MnDOT should encourage and promote all law enforcement agencies to complete and submit crash reports that meet the legal definition of a motor vehicle crash to the Department of Public Safety (DPS). State departments and local government units can only do analysis on what is known and reported to DPS.
11-4.02 Crash Report Processing

11-4.02.01 MNCrash

Prior to 2016, a Police Accident Report (PAR) form was used by all law enforcement agencies when reporting a crash to DPS. These reports were submitted either electronically or in a paper copy. Paper copies were scanned and manually entered into the state crash database by DPS staff. Prior to 2003, all PARs were submitted in paper copies which had to be scanned and manually entered into the database. Reports completed by citizens were also entered into the database prior to 2016.

Since January 1, 2016, officer reports are completed and uploaded electronically to the MNCrash system. The MNCrash system was built and is operated by DPS, and the new format allows officers to complete and submit crash reports in a more timely and accurate manner. The MNCrash system also has helped to improve the overall quality and consistency in crash reporting by incorporating an organized sequence of steps for officers to walk through each time they fill out a new report.

11-4.02.02 Encoding Crash Reports

All reports received by DPS are assigned a unique Incident ID number. Individual crashes are coded and geographically located unless the location is unknown. Many elements from the crash report are tied to the individual crash record including details about the location, the time of the crash, weather and road conditions, traffic control, the type of crash, and more. Figure 11.1 shows the core data associated with the Incident ID.

![Figure 11.1 Data Ties to Incident ID](image-url)

11-4.02.03 National Definitions

11-5.00 CRASH DATA

11-5.01 Data Practices

11-5.01.01 Appropriate Use

The Driver and Vehicle Services Division (DVS) at DPS collects and maintains all motor vehicle crash reports for the State of Minnesota in the MNCrash system. Crash reports contain non-public data and are to be used for crash analysis purposes. Caution must be exercised to maintain the confidential status of individual reports as provided in Minn. Stat. 169.09, Subd. 13.

Full crash reports are available directly from DVS for individuals involved in the crash or their authorized representative. No private or confidential data collected, maintained, or used shall be disseminated except as provided in Minn. Stat. 169.09, Subd. 13.

Crash data is provided by DPS for use by MnDOT in two ways. One copy of the data contains necessary Personally Identifiable Information (PII) for damage restitution and the other copy with PII removed for traffic safety engineering. PII includes any information that can specifically identify individuals or vehicles involved in the crash, including names, driver's license numbers, and vehicle plate numbers.

The crash data that has been scrubbed of PII is fed back into the MNCrash system where MnDOT can gain access to it. MnDOT personnel in the OTE Safety section utilize this non-PII data to conduct crash analyses. This data is shared with MnDOT traffic staff, as well as City and County engineering staff. Crash data may not be shared with anyone who is not performing crash analysis for traffic safety engineering purposes. The user must complete an agreement acknowledging the restricted use of this crash data. Figure 11.2 shows the path of crash data in Minnesota.
11-5.01.02 Retention and Security

Electronic and/or paper copies of motor vehicle crash reports may be kept on a temporary basis while needed for crash analysis. Electronic files must be stored on a secure MnDOT networked computer accessible by employee active directory (AD) accounts only, i.e. on the user’s personal network drive.

Paper copies of motor vehicle crash reports must be secured in a locked cabinet or locked room, so they are not accessible to employees or others who are not using them for crash analysis.

It is recommended that private data be redacted from any printed crash report whenever feasible. Crash reports are to be securely disposed of by shredding when they are no longer needed for crash analysis.

11-5.01.03 Citation of Sources

A suite of tools has been developed to work with crash data. Each tool has its own strengths and weaknesses depending on the needs of the analysis. As data become more integrated, a time stamp becomes necessary to record when, during the continuous loading cycle of the data, the export of particular crash data was completed.

To ensure that results can be replicated, always record (1) the data source and (2) date of export. A note of any filters that have been applied may be useful if the analysis needs to be repeated.

11-5.01.04 Editing Crash Data

MnDOT OTE Safety staff use multiple tools to ensure crash data and the ever-changing roadway network are continually aligned with one another. This includes the editing of statewide interchange, intersection, and section files. These files are used to create the Traffic Crash Toolkit and other statewide analyses of trunk highways.

Crash data that have been located by DPS and any changes made over time are imported every hour from DPS. All changes made by DPS or OTE Safety staff will affect downstream systems, e.g. databases, dashboards, etc. MnDOT has the capability to correct location errors as part of the ESRI Event Editor, which allows users to alter the LRS-compatible Route ID and Measure. Access to this tool is available only to users that have the appropriate training.

11-5.02 Data Sources

11-5.02.01 Motor Vehicle Crash Reports

Individual crash reports are no longer used to conduct crash analyses. Crash data that has been scrubbed of PII from DPS is automatically sent to a MnDOT database system every hour. This data includes all the necessary information to conduct crash analyses. Before 2016, authorized MnDOT employees could access motor vehicle crash reports via secure login to a DVS server.

It is noted that crash data that includes all PII is sent from DPS to the MnDOT Damage Restitution group. Those specific crash records are only available to those specialists who are assigned the specific task of reviewing and submitting insurance claims, and the data is not available to anyone outside of that group.

Citizen completed crash reports are no longer used in crash analyses and are not included in the data that MnDOT receives from DPS.

11-5.02.02 CrashMART

CrashMART is a mapping tool that allows users to view, filter, and download crash data for the past 10 calendar years plus the current year. Crash data in this tool is updated daily. CrashMART is only available to approved MnDOT staff.
11-5.02.03 *Minnesota Crash Mapping Analysis Tool (MnCMAT2)*

MnCMAT2 is a mapping tool updated quarterly through the MnDOT State Aid office. Spatial selection and filters provide both high-level trends and detailed drill-down. Exports include crash data, maps, charts, and reports. At this time, the application provides many but not all data fields for filtering; those crashes with a valid location are mapped to the roadway network. For access, request approval from a MnDOT Traffic Engineer, a County Engineer, or City Engineer and complete an online form available on the MnCMAT2 webpage.

11-5.02.04 *Oracle BI*

Oracle BI is a tool that allows all MnDOT users to query, analyze, and trend crash data with interactive dashboards, reports, and analyses. This tool is especially useful in monitoring safety metrics and ad hoc analyses. Currently accessible to all MnDOT staff, contact OTE for access.

11-5.02.05 *MnDOT Traffic Safety Fundamentals Handbook*

The MnDOT Traffic Safety Fundamentals Handbook is a resource that can be used as a reference for many aspects of both understanding factors that go into crashes as well as ways to address traffic safety. This handbook goes into the details of crash characteristics, the safety improvement process, and safety strategies.

11-5.02.06 *Minnesota Motor Vehicle Crash Facts*

Researchers at the Office of Traffic Safety (OTS) at DPS annually produce the Minnesota Motor Vehicle Crash Facts. This detailed report summarizes a variety of information related to crashes: who, what, where, when, and why. In addition, the report breaks out information regarding the following: alcohol, seat belt use, motorcycles, trucks, pedestrians, bicycles, school buses, and trains.

The reports contain a discussion of crash trends as well as graphical and tabular displays of crash data. The purpose is to provide detailed summary information about motor vehicle crashes primarily at a statewide level.

11-5.02.07 *Fatality Analysis Reporting System (FARS)*

FARS is a national dataset maintained by National Highway Traffic Safety Administration (NHTSA) of fatal traffic crashes. The database contains 143 different elements to characterize a crash; certain fields are available in FARS data that are too resource intensive to maintain for all crash severities. No personal identifying information is recorded. All FARS data is publicly available. Due to the time needed to gather this nationwide dataset, the most current FARS data is typically two years old.

11-5.02.08 *Crash Reconstruction Reports*

The Minnesota State Patrol investigates a number of serious and fatal motor vehicle crashes to document how the crashes occurred and determine what factors may have contributed to the crash. These detailed reports can be requested from the Minnesota State Patrol, though a business reason is needed for them and availability is determined on a case by case basis.

11-5.03 *Data Requests*

Requests for crash information are often received by both MnDOT staff and many of our transportation and traffic safety partners. Data requested can vary greatly in size and scope, from statewide reports detailing annual crash trends to site-specific crash data.

Any request for information concerning a specific location on the trunk highway system, regardless of the source, should be directed to the appropriate MnDOT District Traffic Engineer. Project managers and consultants working on MnDOT projects should also obtain crash data through their District Traffic Office contact. General requests for statewide or system wide data should be referred to the OTE Safety section.
Any request concerning information relating to the local system, regardless of the source, should be directed to the local road authority for processing. This guarantees the local government agency will have full knowledge of all information being provided to the requester. District, State Aid, or OTE assistance may be provided if requested.

Regardless of system, a Data Practices Request Form must be completed for all requests originating from legal professionals. This form and other related information can be found on the MnDOT Data Practices Information webpage.

11-6.00 SAFETY ANALYSIS

11-6.01 Network Screening

11-6.01.01 Traffic Crash Toolkit

Identification of hazardous locations is essential to the allocation of resources and to improving safety on our roads. The Office of Traffic Engineering (OTE) provides screening Toolkits for intersections and segments of trunk highways.

The Toolkit spreadsheets detail crash history and roadway characteristics for each site. Sites in the sections Toolkit include over 11,000 miles of trunk highways, and sites in the intersection Toolkit include over 19,000 intersections on trunk highways. These large numbers of sections and intersections are grouped by characteristics of each allowing the user to compare crash results on their section or intersection to a large dataset of comparable locations.

Copious amounts of data are available through the Toolkits including crash frequency, injury severity, crash rates, and traffic volumes. The Toolkits are intended to be objective network screening tools that facilitate the identification of locations for further investigation. There are a variety of methods supported by the Toolkits, each with their relative strengths and weaknesses. The most typical uses of the Toolkits are highlighted below. Additional support in using the Toolkit is available by contacting OTE. Due to changes in crash data reporting beginning in 2016 as well as continuous improvement in crash data locating, the most recent versions of the Toolkits should always be used.

11-6.01.02 Ranking

With limited funds, safety improvements can only be implemented at a certain number of locations per year. To identify where those funds should be directed, locations need to be ranked. The fatal (K) and suspected serious injury (A) crash rate (FAR) index is a key metric in identifying locations where strategies can be implemented to move Toward Zero Deaths.

A number of other criteria can be considered when ranking locations. Those include overall crash rates, crash densities, crash costs, and risk rankings and other surrogate safety characteristics.

For locations that are highly ranked, a site analysis should be done to ensure an understanding of the issue, or even to identify if there is not an issue at this location. Any solutions should be tailored to the site and its specific issues.

Caution should be exercised if only crash costs are used as the basis for ranking locations. Using just one metric like this can lead to skewing. The large number of property damage crashes that occur at high volume signalized intersections can be overrepresented by crash costs even when there are few to no fatal or injury crashes. It is recommended that multiple metrics be considered when identifying locations for improvements.
11-6.01.03 Crash Rate

Published research on transportation and traffic safety has demonstrated there is a positive correlation between crash frequency on a roadway and the traffic volume on that roadway. Calculating crash rates is one method of measuring the number of crashes while controlling for this traffic exposure. For intersections, exposure is defined as entering vehicles; for segments, exposure is defined as vehicle miles traveled (VMT).

\[
\text{Intersection Crash Rate} = \frac{\text{Crashes}}{\text{Days} \times \text{Entering Volume}} \times 1,000,000
\]

\[
\text{Entering Volume} = \frac{1}{2} \times (ADT_{\text{leg}1} + ADT_{\text{leg}2} + \ldots)
\]

\[
\text{Segment Crash Rate} = \frac{\text{Crashes}}{\text{VMT}} \times 1,000,000
\]

\[
\text{VMT} = \text{Days} \times \text{ADT} \times \text{Length}
\]

The total crash rate (CR) is defined as the number of crashes per million vehicle miles traveled for segments or per million entering vehicles for intersections. FAR is defined as the number of fatal and suspected serious injury crashes per 100 million vehicle miles traveled for segments or per million entering vehicles for intersections.

Crash rates are benchmarked against other similar locations. However, a location that has a crash rate exceeding the average crash rate for similar locations should not be interpreted as having a safety issue. Instead, other measures that accommodate the fluctuation in crashes should be used to assess the relative safety of a location.

11-6.01.04 Critical Crash Rate

Critical crash rates provide a statistical threshold for screening sites. The critical rate is calculated by weighting the average crash rate for similar intersections or segments across Minnesota by the existing traffic volume. The critical CR is calculated at a 99.5% confidence interval (K = 2.576); the critical FAR is calculated at a 90.0% confidence interval (K = 1.282).

\[
\text{Critical Crash Rate} = \text{Statewide Crash Rate} + K \times \sqrt{\frac{\text{Statewide Crash Rate}}{\text{Intersection or Segment Exposure}}} + 0.5 \times \frac{\text{Statewide Crash Rate}}{\text{Intersection or Segment Exposure}}
\]

\[
\text{Intersection Exposure} = \frac{\text{Days} \times \text{Entering Volume}}{1,000,000}
\]

\[
\text{Segment Exposure} = \frac{\text{VMT}}{1,000,000}
\]

The example shown below in Figure 11.3 illustrates critical rate screening. In this example, each of the 10 sites are of the same facility type (e.g. roundabouts, all-way stops, rural expressways, etc.) which is why the Minnesota statewide crash rate is consistent between them. The critical crash rate at each location varies based on the volume at each site. In this example, five of the sites have crash rates above the statewide rate, but only Site 8 has a crash rate above the critical crash rate. These results suggest that only Site 8 has a crash rate that is above the expected, normal range for this type of location in Minnesota.
11-6.01.05 Critical Index

A critical index is reported as the ratio of the observed crash rate to the critical crash rate. A critical index exceeding 1.00 indicates there may be a safety concern at the site. When analyzing the critical index, a value at or below 1.00 implies that the site does not deviate significantly from statewide trends, i.e. it is performing within expectations. As shown in Figure 11.3, though several sites have crash rates above the state average, Site 8 is the only location with a critical index of greater than 1.00.

The critical index should be treated as a binary result; either it is above 1.00 indicating a statistically significant safety issue at a site or it is at or below 1.00 indicating there is not a statistically significant safety issue at the site. When comparing multiple similar sites, the critical index could be used to prioritize sites. However, the critical index should not be treated as an order of magnitude ranking of site safety due to the site-specific nature of critical crash rates. For example, a site with a critical crash rate of 2.20 does not necessarily have twice as many safety issues as a site with a critical crash rate of 1.10.

\[
\text{CR Index} = \frac{\text{Total Crash Rate (CR)}}{\text{Critical CR}}
\]

\[
\text{FAR Index} = \frac{\text{Severe Crash Rate (FAR)}}{\text{Critical FAR}}
\]

To facilitate network screening, the Toolkit contains the critical index for filtering of problem locations. The CR Index is the total crash rate (CR) divided by the critical crash rate for total crashes. Similarly, the FAR Index is the fatal and A injury crash rate (FAR) divided by the critical crash rate for fatal and A injury crashes. These two measures are best suited to quantify the safety of an intersection or a segment of road.

Locations that have a high FAR index are good candidate locations for investments from HSIP; locations with a high CR index should be considered for improvements as funding opportunities become available. Below are examples showing how crash rates and critical crash rates are calculated for an intersection and a segment.
Intersection:

The intersection of Trunk Highway (TH) X and Z Street had the following crashes over the last five years:

- 0 Fatal (K) Crashes
- 1 Suspected Serious Injury (A) crash
- 1 Suspected Minor Injury (B) crashes
- 1 Possible Injury (C) crashes
- 4 Property Damage Only (N) crashes

The ADT on TH X is 15,000 vehicles while the ADT on Z Street is 3,000 vehicles. With this being a four-leg intersection, the entering volume is 18,000 vehicles per day. In the last five-year period there were 1,826 days. Using the equation from section 11-6.01.03, the total crash rate (CR) and severe crash rate (FAR) can be calculated.

\[
CR = \frac{7 \text{ crashes}}{1.826 \text{ days} \times 18,000 \text{ vehicles/day}} \times 1,000,000 = 0.213 \text{ crashes per million entering vehicles (MEV)}
\]

\[
FAR = \frac{1 \text{ crash}}{1.826 \text{ days} \times 18,000 \text{ vehicles/day}} \times 100,000,000 = 3.042 \text{ crashes/100 MEV}
\]

The Statewide crash rates can be found in the current version of the Toolkit. With this being a thru-stop intersection in a rural area, the Statewide are 0.065 crashes/MEV for total crashes and 0.349 crashes/100 MEV for severe crashes. Using the equations from section 11-6.01.04, the critical crash rates, both total (Critical CR) and severe (Critical FAR) can be calculated.

\[
\text{Intersection Exposure} = \frac{1.826 \text{ days} \times 18,000 \text{ vehicles/day}}{1,000,000} = 32.868 \text{ MEV} = 0.329 100 \text{ MEV}
\]

\[
\text{Critical CR} = 0.065 \frac{\text{crashes}}{\text{MEV}} + 2.576 \times \sqrt{\frac{0.065 \text{ crashes}}{32.868 \text{ MEV}}} + \frac{0.5}{32.868 \text{ MEV}} = 0.195 \frac{\text{crashes}}{\text{MEV}}
\]

\[
\text{Critical FAR} = 0.349 \frac{\text{crashes}}{100 \text{ MEV}} + 1.282 \times \sqrt{\frac{0.349 \text{ crashes}}{0.329 100 \text{ MEV}}} + \frac{0.5}{0.329 100 \text{ MEV}} = 3.189 \frac{\text{crashes}}{100 \text{ MEV}}
\]

The critical indices can then be found using the equations from section 11-6.01.05.

\[
\text{CR Index} = \frac{0.213 \frac{\text{crashes}}{\text{MEV}}}{0.195 \frac{\text{crashes}}{\text{MEV}}} = 1.092
\]

\[
\text{FAR Index} = \frac{3.042 \frac{\text{crashes}}{100 \text{ MEV}}}{3.189 \frac{\text{crashes}}{100 \text{ MEV}}} = 0.954
\]
Segment:

A 2.3-mile section of TH Y saw the following crashes over the last five years:

- 0 Fatal (K) Crashes
- 1 Suspected Serious Injury (A) crash
- 2 Suspected Minor Injury (B) crashes
- 3 Possible Injury (C) crashes
- 12 Property Damage Only (N) crashes

This section of TH Y has an ADT of 9,000 vehicles. Using the equation from section 11-6.01.03, the total crash rate (CR) and severe crash rate (FAR) can be calculated.

\[ CR = \frac{18 \text{ crashes}}{1.826 \text{ days} \times 9,000 \text{ vehicles/day} \times 2.3 \text{ miles}} \times 1,000,000 = 0.476 \text{ crashes per million vehicle miles (MVM)} \]

\[ FAR = \frac{1 \text{ crash}}{1.826 \text{ days} \times 9,000 \text{ vehicles/day} \times 2.3 \text{ miles}} \times 100,000,000 = 2.646 \text{ crashes/100 MVM} \]

The Statewide crash rates can be found in the current version of the Toolkit. With this being a rural two-lane segment in a rural area, the Statewide are 0.465 crashes/MVM for total crashes and 1.869 crashes/100 MVM for severe crashes. Using the equations from section 11-6.01.04, the critical crash rates, both total (Critical CR) and severe (Critical FAR) can be calculated.

\[ \text{Segment Exposure} = \frac{1.826 \text{ days} \times 9,000 \text{ vehicles/day} \times 2.3 \text{ miles}}{1,000,000} = 37.798 \text{ MVM} = 0.378 \text{ 100 MVM} \]

\[ \text{Critical CR} = 0.465 \frac{\text{crashes}}{\text{MVM}} + 2.576 \sqrt{\frac{0.465 \frac{\text{crashes}}{\text{MVM}}}{37.798 \text{ MVM}} + 0.5} = 0.764 \frac{\text{crashes}}{\text{MVM}} \]

\[ \text{Critical FAR} = 1.869 \frac{\text{crashes}}{100 \text{ MVM}} + 1.282 \sqrt{\frac{1.869 \frac{\text{crashes}}{100 \text{ MVM}}}{0.378 100 \text{ MVM}} + 0.5} = 6.042 \frac{\text{crashes}}{100 \text{ MVM}} \]

The critical indices can then be found using the equations from section 11-6.01.05.

\[ \text{CR Index} = \frac{0.476 \frac{\text{crashes}}{\text{MVM}}}{0.764 \frac{\text{crashes}}{\text{MVM}}} = 0.623 \]

\[ \text{FAR Index} = \frac{2.646 \frac{\text{crashes}}{100 \text{ MVM}}}{6.042 \frac{\text{crashes}}{100 \text{ MVM}}} = 0.438 \]
11-6.01.06 Crash Costs

Crash costs are based on the value of a single life recommended by the US DOT and adjusted to include other related costs, e.g. loss of productivity, vehicle damage, etc. The standard values also account for all the injuries involved in a typical crash. For example, most fatal crashes in Minnesota involve more than one person, thus the crash value of a K crash is the average cost of all injuries per crash. The injury statistics are based on Minnesota recent (three year) crash data and are adjusted annually for inflation.

As mentioned previously, using only crash costs as the basis to conduct network screening is not recommended. However, crash costs are a vital component to assessing the magnitude of the safety improvement so that it is justified based on the crashes that are occurring. Ideally, the benefit (value of crashes reduced) is much more than the costs of the improvement over its expected life span. In some instances, other factors are incorporated into the benefit-cost calculations that go beyond safety such as travel-time savings, emissions, etc. Each program throughout the department considers what factors go into the benefit-cost calculations.

For purposes of the Highway Safety Improvement Program, the benefit-cost calculations should only quantify the savings from crash reductions. Due to the great discrepancy between the cost of a fatal crash versus a serious injury crash, a value of two times the A injury cost is substituted for a fatal crash for conducting benefit-cost calculations for HSIP. At the time of writing, the cost associated with a fatal crash is $12,800,000 while the cost associated with a serious injury crash is $720,000. Updated values can be obtained from the MnDOT Planning and Programming Group.

11-6.01.07 Other Screening Measures

Other data are available in the toolkit to do exploratory investigations including the ability to sort the data by the total number of crashes and crashes per mile. These measures can provide the basis to determine frequency of crashes, however no inference on the magnitude of the problem can be made due to the lack of a normalizing factor such as traffic volume.

11-6.02 Other Analytical Considerations

11-6.02.01 Selecting an Appropriate Time Period

In general, a five-year time period should be used when conducting network screening. Typically, traffic patterns and geometric conditions are stable within this window of time. Five years provides an adequate time period for patterns to emerge from the data while minimizing the potential for one year’s worth of crash history to skew the results.

The Minnesota Strategic Highway Safety Plan (SHSP) utilizes a five-year data period. If a five-year period is used in another large scale or statewide analysis, the SHSP analysis can be used as a benchmark.

Shorter or longer time periods can be considered on a case-by-case basis. For example, if significant development has occurred, or a drastic jump in traffic volume has occurred near the intersection in question, a three-year time period might be appropriate. Conversely, if the roadway environment has not changed for quite some time and the traffic volume has been relatively stable, a 10-year time period may be appropriate.
11-6.02.02  *Intersection Collision Diagram*

An intersection collision diagram is a tool used to graphically represent crashes at a specific intersection. Collision diagrams help identify crash patterns and may help identify potential problem areas. See Figure 11.4 for how a typical collision diagram may look. Collision diagrams are typically one page per intersection but can be more if there are many crashes that need to be included.

![Image of collision diagram]

**Figure 11.4  Typical Collision Intersection Diagram**

Each recorded crash should be located near where the crash occurred in relation to the intersection. Include a summary of the number of crashes by severity for the entire intersection. Only data from crash reports should be diagrammed, do not include other sources.
Each located crash should summarize at least the following information:

1. Date of crash
2. Time of crash
3. Lighting conditions
4. Weather
5. Surface conditions
6. Crash severity
7. Manner of collision
8. Crash type
9. Relevant notes

11-6.02.03 Road Safety Audits

A Road Safety Audit (RSA) is the formal or informal traffic safety examination of an existing or future roadway by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements. The emphasis usually focuses on reducing fatal and serious injury crashes. The State of Minnesota works with the FHWA, local jurisdictions, and Tribal governments to perform RSAs on existing roads and intersections and may also perform these functions during the project development process for new roads and intersections. RSAs are also encouraged during reconstruction, rehabilitation, and resurfacing projects.

Road Safety Audits should be performed while keeping crash trends (statewide (e.g. SHSP) and local) as well as traffic operations in mind. Often, individual segments and intersections may lack certain types of crashes or severities. However, in a broader context, the facility may be at just as high of a risk as those similar facilities with fatal and A injury and/or frequent crashes.

Road Safety Audits consist of three main components: Pre-Audit, Audit, and Post-Audit.

1. **Pre-Audit**
   This phase typically consists of gathering all the appropriate data. This may include crash history, traffic volumes, turning movement counts, vehicle classifications, peak hours and traffic flow characteristics, land use planning (past, present, and future), and bike/pedestrian usages. The pre-audit may include meeting with transportation officials, local citizens, politicians, and stakeholders to understand previous efforts and perceived issues.

2. **Audit**
   During the audit, an independent multidisciplinary team performs a field review of the particular location or stretch of roadway. All members of the team should have the pre-audit information on hand. Those leading the audit should be careful not to imply or direct certain strategies, but rather, let ideas occur “naturally” for discussion among the team. Segments and intersections should be discussed both as individual facilities and in the context of the entire corridor. Locations with frequent crashes should not be the only areas of focus. All discussions should be recorded by a designated person for later use in the development of the final report.

3. **Post-Audit**
   In this phase, everything is brought together and written into a final document. A presentation is provided to the stakeholders and owners of the road. The report includes recommendations ranging in costs, implementation time, and public acceptance.

For more information on road safety audits, see the RSA section on the OTE website, or the RSA section on the FHWA website.
11-6.03 Project Selection

11-6.03.01 Estimating the Safety Benefit of a Countermeasure

Once a location has been identified through a critical rate calculation or a systemic risk assessment, an appropriate countermeasure must be identified to help mitigate the root cause or characteristics of the crashes.

While no countermeasure can provide a 100 percent reduction in crashes, implemented countermeasures will change the frequency of a specific crash type. By matching specific countermeasures to the relevant crashes, an estimate for the safety benefit can be calculated. In general, estimated benefits can be obtained through CMFs or models. Crash prediction models and functions are powerful tools that incorporate a variety of countermeasures in their calculations.

11-6.03.02 Crash Modification Factor

One of the best tools for evaluating options for projects in regard to traffic safety is the use of Crash Modification Factors (CMF). The use of CMFs can be an easy tool to evaluate the overall effectiveness of a given strategy. However, other factors must still be considered, e.g. feasibility, cost, right-of-way impacts, local traffic conditions, public input, etc.

CMF

<table>
<thead>
<tr>
<th>CMF</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.00</td>
<td>Expect number of crashes to be lower than current conditions.</td>
</tr>
<tr>
<td>1.00</td>
<td>Expect number of crashes to remain the same as current conditions.</td>
</tr>
<tr>
<td>&gt; 1.00</td>
<td>Expect number of crashes to be greater than the current conditions.</td>
</tr>
</tbody>
</table>

The lower the number is below 1.00, the greater the anticipated reduction in crashes. Conversely, the greater the number above 1.00, the greater increase in the number of anticipated crashes. A CMF of 2.00 would represent a doubling of the number of crashes.

Below is an example of how a CMF can aid in selecting an appropriate safety strategy:

An intersection has 12 crashes over three years. Two options are being considered: Option A with a CMF of 0.50, and Option B with a CMF of 1.50. Over the next three years, one would expect 2 crashes per year with Option A and 6 crashes per year with Option B. Based on crash performance, Option A would be the better option.

\[
\text{Option A: } \frac{12 \text{ crashes}}{3 \text{ years}} \times 0.50 = \frac{2.0 \text{ crashes}}{\text{year}}
\]

\[
\text{Option B: } \frac{12 \text{ crashes}}{3 \text{ years}} \times 1.50 = \frac{6.0 \text{ crashes}}{\text{year}}
\]
11-6.03.03 Crash Reduction Factor

The crash reduction factor (CRF) is the expected reduction in crashes after implementation of a given countermeasure. It should be viewed as intrinsically related to the CMF.

\[ \text{CRF} = 1.00 - \text{CMF} \]

11-6.03.04 Crash Modification Factors Clearinghouse

The **CMF Clearinghouse** is one of the largest and most comprehensive sets of crash modification factors currently in use. The website is managed by the Federal Highway Administration (FHWA) and includes high-level summaries of CMFs and links to the actual research papers detailing how the CMF was developed. Currently, nearly anyone can submit a potential CMF to the website. Once received, the submissions are reviewed, and appropriate values are assigned to the reductions. The CMF is also given a star quality ranking that indicates the quality or confidence in the results of the study submitted. More stars indicate a higher quality CMF (five is the most, zero the least). OTE recommends using a CMF of at least three stars.

There are situations when multiple CMFs are available for the same treatment. A careful review should be conducted to ensure the CMF being used matches the project site as closely as possible. The CMF Clearinghouse provides guidance on selecting and using CMFs.

11-6.03.05 Highway Safety Manual

The **Highway Safety Manual (HSM)** was developed by AASHTO and the first edition was released in 2010. The HSM has several models for calculating the expected number of crashes for various types of segments and intersections. Some of these models have been calibrated for Minnesota conditions. In addition to the models, the HSM has a large number of CMFs that can be used. These CMFs are typically only applicable to the specific model that they are assigned to, making these very reliable when used correctly.

In addition to CMFs related to individual models, the HSM contains a number of additional generic CMFs that may be used (see Appendix D of the manual). Some of the CMFs listed can also be found on the CMF Clearinghouse website.

FHWA provides two free tools that automate the application of HSM methodologies:

- Enhanced Interchange Safety Analysis Tool (ISATe)
- Interactive Highway Safety Design Model (IHSDM)

ISATe is a workbook used for safety performance analysis on small freeway segments. IHSDM is a software suite used to evaluate the safety and operational effects of geometric design decisions on highways.

11-6.03.06 NCHRP 500 Series

The National Cooperative Highway Research Program (NCHRP) is a part of the Transportation Research Board (TRB) of the National Academies. The program conducts research in problem areas that affect highway planning, design, construction, maintenance, operations, and safety. The **NCHRP 500** series is a set of publications that primarily focuses on traffic safety and countermeasures that can be used to address specific issues. Though CMFs are not provided specifically, the proposed countermeasures are given a designation of “Proven”, “Tried”, and “Experimental”.

**Proven**

Strategies that have been used in one or more locations and for which rigorous evaluation has shown them to be effective.
Tried
Strategies that have been implemented at a number of locations and may even be accepted as standards, but for which no rigorous evaluations have been found.

Experimental
Strategies representing suggested ideas that at least one agency has considered sufficiently promising to try as an experiment in at least one location. These strategies should be considered only after others have been determined not to be appropriate or feasible.

11-6.03.07 Additional Sources
There are a wide variety of sources for Crash Modification Factors. Universities and other academic institutions, local technical assistance programs (LTAP), the Minnesota Local Road Research Board (LRRB), MnDOT, and many local transportation/highway agencies often conduct, evaluate, and study many different types of countermeasures. Depending on the sample size, time in place, and type of statistical analysis, these CMFs can provide a realistic understanding of the expected crash modification.

11-6.04 Project Evaluation
11-6.04.01 Evaluation Design
Countermeasure evaluations are utilized to determine the impact of an implemented safety improvement. Evaluations are not normally made until at least one year of crash data after installation has accrued; three years of after data is preferred. In a typical before-after study, the year of installation is excluded from the analysis.

Similar to safety projects, there are many factors for consideration in designing a robust evaluation. Additional factors, including analysis complexity and intended outcome should be weighed. The following table summarizes some common evaluation designs. The number of stars, summed for each of the analysis considerations shown, provides a relative scale for how robust the results are.

<table>
<thead>
<tr>
<th>Evaluation Design</th>
<th>Comparative Rigor</th>
<th>Target Crashes</th>
<th>Control Group</th>
<th>Retrospective</th>
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</thead>
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<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before-After with Target Crashes</td>
<td>★</td>
<td>★</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before-After with Experimental &amp; Control Groups</td>
<td>★</td>
<td></td>
<td>★</td>
<td></td>
</tr>
<tr>
<td>Retrospective Experimental &amp; Control Groups</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Retrospective Experimental &amp; Control Groups, Targeted</td>
<td>★★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
</tbody>
</table>

Before-after studies evaluate the change in a selected metric, e.g. fatal and serious injury crashes, before and after the implementation of a specific countermeasure. While this straightforward method provides a CRF, until a large body of studies have been completed, findings may be difficult to reproduce.

Analyzing only crashes that would be impacted by a safety improvement, i.e. Target Crashes, provides added focus to the evaluation. Comparing the treatment site(s) to a similar selection of sites, i.e. Control Group, accounts for variation across designs. A retrospective tracks changes in crashes through time rather than categorizing before and after periods; this helps address variation over time.
11-6.04.02 Evaluation Services Provided

Research and evaluation allow us to explore new ways to address existing problems and evaluate the effectiveness of our countermeasures, projects, and programs. Evaluation helps ensure that MnDOT invests in effective and efficient safety countermeasures, projects, and programs.

The Office of Traffic Engineering (OTE) supports this process in three ways: in house professional evaluations, MnDOT supported professional evaluations, and support and review for developing evaluation projects. The OTE Traffic Safety section website provides more information about research and regularly posts existing studies.

OTE monitors and evaluates projects that were programmed with HSIP funds; however, several safety enhancements are programmed outside of the HSIP. A partnership with the districts and OTE safety staff is needed so that safety evaluations are inclusive of all safety deployments and not just HSIP projects. Whenever possible, location details, installation dates, and countermeasures implemented should be recorded and shared with OTE safety staff.

11-7.00 FUNDING AND PROJECT ELIGIBILITY

11-7.01 Highway Safety Improvement Program (HSIP)

11-7.01.01 HSIP Project Priority

HSIP is a federal-aid funding program designed to reduce traffic fatalities and serious injuries on all public roads. Locations must have a significant crash history that includes a fatal or serious injury crash or be identified as a location with multiple risk factors associated with fatal or serious injury crashes at similar locations. The critical crash rate will be used to determine if a significant crash history either fatal, serious, or a combination of both, exists at a particular location. Five years of crash data should be used for this calculation; however, three or 10 years may be considered on a case-by-case basis in consultation with OTE. Additionally, low cost, high impact improvements identified through a risk analysis (e.g. systemic safety plans) will also be considered for HSIP funding. It is anticipated that a balance of risk mitigation and historical crash consideration will be part of HSIP in the foreseeable future.

Two types of projects are candidates for HSIP funding: 1) reactive or sustained crash locations, and 2) systemic, risk-based projects. Sustained crash locations are areas where, statistically, there are a higher number of crashes associated with a particular location when compared to other similar locations throughout the state. Sustained crash locations greatly exceed statewide rates and can be determined by using a critical crash rate to establish if a location has a sustained crash problem. Systemic projects tend to apply known risk factors to address a high frequency but a very low density of crashes. These projects typically deploy cost-effective strategies across many intersections or miles of roadway to be effective.

Two critical crash rates (total crash rate and fatal plus suspected serious injury crash rate) are available to measure if a roadway segment or intersection meets the requirements of a sustained crash location. If a location has a crash rate that exceeds the associated critical crash rate, a benefit cost ratio should be completed to determine the amount of safety impact that can be considered at that particular location compared to the safety investment under consideration.

HSIP projects should be programmed four years in advance. If Year One and Year Two funds are left unallocated after solicitation, then those funds will go to a project or District that can deliver in the necessary time frame.

In addition to HSIP, Minnesota receives funding from the Federal Section 164 program. This is a program that sanctions a state for not meeting certain criteria with its repeat intoxicated driver laws. These funds are transferred away from the Federal-aid funds of two large highway programs and directed to be used for safety programs administered by MnDOT and DPS. These funds are typically evenly split between the two agencies. While HSIP requires a ten percent local match on projects, Section 164 funds can be used without a local match. However, at this time, MnDOT is treating Section 164 funds identically to HSIP.
11-7.01.02 Incidental Safety Improvements

HSIP is not the only source of funding for safety projects and improvements. Districts should be spending an amount equal to or greater than their HSIP goal each year on safety improvements included in larger projects. These types of minor safety improvements shall be installed on each project undertaken on the trunk highway network. The intention of these projects is that they are incidental to the overall scope of the project. In some instances, they are required by a standard or policy in place for the Department. No HSIP funding will be used to offset the costs of these incidental improvements.

11-7.02 Safety Set-Aside Funds

Safety is an integral part of any transportation program. Having specific resources for safety allows programs to be financially effective by taking advantage of cost-effective scheduling. For example, turn lanes may be an appropriate addition to a mill-and-overlay project rather than as a separate project. Whenever possible, larger program funds should be used to fund safety improvements, particularly when they are a relatively small portion of the overall project budget.

Practices vary among the districts regarding set-aside funds to implement improvements. Districts can allocate specific money from their construction funds for safety improvements as identified by the District Traffic Engineer. OTE supports a district set-Aside fund to ensure that the priority safety items outside the HSIP program have an opportunity to be funded.

Some districts have opted into this safety investment and have been pleased with the results. This structure provides consistent leadership in a core agency without pitting traffic safety against other projects and while better utilizing the district’s HSIP allocation. By creating set-aside funds specifically for safety, districts can more efficiently invest in agency and regional priorities.
# CHAPTER 12 - TORT CLAIMS

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12-1.00 INTRODUCTION
This Chapter is a basic discussion of a complex subject. It is intended to inform MnDOT personnel of the need to recognize the importance of maintaining and safeguarding the highway system. It also provides guidance on responding to outside requests for information and for responding to a lawsuit.

12-1.01 Background
At one time, government entities were generally immune from lawsuits on the theory of “sovereign immunity” derived from English common law. Under the sovereign immunity doctrine, a government entity could be sued only if it consented to the suit in advance.

The State of Minnesota lost its Sovereign Immunity in 1976. At that time the State Legislature passed the Tort Claims Act (Minnesota Statutes Section 3.736) which defines the conditions under which the State, its agencies, and its employees may be held accountable for damages resulting from the State’s negligence.

12-2.00 GLOSSARY
Claim
A request for compensation for damages caused by the alleged negligence of MnDOT or a MnDOT employee, authorized by Minnesota Statutes Section 3.736.

Claimant
The person filing a claim.

Defendant
The person or persons in a lawsuit against whom the plaintiff has initiated a claim seeking some kind of relief.

Lawsuit
A legal action filed in a court-of-law alleging negligence by MnDOT or a MnDOT employee and requesting compensation for damages.

Legal Hold
A formal directive issued by the Office of Chief Counsel or Responsible Authority directing MnDOT employees, contractors, and consultants to identify, preserve, and not alter, delete, or destroy any evidence that may be relevant to any reasonably anticipated litigation or other legal proceedings in which MnDOT is or is reasonably likely to be a participant. A Legal Hold may convert to a Litigation Hold with the commencement of legal proceedings.

Litigation Hold
A formal directive issued by the Office of Chief Counsel or Responsible Authority directing employees, contractors, and consultants to identify, preserve, and not alter, delete, or destroy any evidence that may be relevant to any actual litigation in which MnDOT is a named party or witness.

Plaintiff
The person, persons, or entity that initiates a lawsuit for some kind of relief, typically monetary damages.

Responsible Authority
The state official designated by law or by the commissioner as the individual responsible for the collection, use and dissemination of any set of data on individuals, government data, or summary data.

Tort
A tort, in legal terminology, is a civil wrong other than breach of contract, for which a court of law will provide a remedy in the form of an action for monetary damages. Torts can be either intentional (e.g., assault and battery, false imprisonment, trespass, and theft) or unintentional (e.g., negligence).

Tort Liability
Tort liability is the legal obligation to pay money for damages to the person injured or damaged. More than one person or organization may be liable for damages arising out of the same incident.
12-3.00 TORT LIABILITY

12-3.01 Basic Characteristics of a Tort

In order for MnDOT to be liable for a tort claim, three elements must be present:

1. MnDOT must have a legal duty to the plaintiff to perform a particular task;
2. MnDOT must have been negligent in its duty to perform that task; and
3. The damages incurred by the plaintiff must have been caused by the negligent performance of that duty.

12-3.02 Legal Duty

In tort law, duty is an obligation requiring persons to conform to a certain standard of conduct for the protection of others against unreasonable risks. MnDOT owes certain duties, specifically or generally imposed by law, to all travelers on the Trunk Highway system to avoid creating unreasonable risks for those travelers, and to meet the standard of care imposed upon the Department.

12-3.03 Negligence

Negligence is defined as the failure to do something which a reasonable person would ordinarily do, or doing something which a reasonable person would not do. The reasonable person is a criterion used to set the standard of care in judging conduct. Determining whether a particular act or omission is reasonable is dependent upon the facts of the specific situation.

In the context of this Manual, the State may be found to be negligent if the conduct of its employees does not measure up to that of a hypothetical reasonable, prudent, and careful employee under similar circumstances.

12-3.03.01 Notice of Defect

MnDOT has a duty to correct a dangerous condition when it has received actual or constructive notice of the hazard. The courts have held that MnDOT must have had notice of the defect or hazard for a sufficient or reasonable time to afford them an opportunity to repair the condition or take precautions against the danger.

Actual notice occurs when an employee, law enforcement official, or any other party reports the existence of a hazard to MnDOT. Receipt of actual notice should be recorded in a dispatcher’s log, diary, or other type of recording system.

Constructive notice occurs when the hazardous condition has existed for such a time and is of such a nature that the State should have discovered the condition by reasonable diligence. In this instance, the State’s knowledge of the condition is said to be implied (i.e., the State should have known).

In deciding whether the State had notice, the courts may consider whether the defect was latent and difficult to discover. That is, the court will consider the nature of the defect, its location and duration, the extent and use of the highway, and whether the defect could be readily and instantly perceived.

This notice requirement does not apply when the dangerous condition is the result of MnDOT’s own negligence. For example, it is not required for the State to have notice of faulty construction or poorly performed maintenance of its highways, because the State is expected to know of its own actions.

12-3.03.02 Standard of Care

The standard of care may be established by a multitude of factors. As a minimum, all persons are required to avoid the creation of unreasonable risks, where feasible. In addition, statutes and regulations governing conduct are also components of the standard of care by which conduct is judged. (For example, Rules of the Road for Operating Vehicles.) In general, a violation of a uniform law or regulation may be evidence of negligence or may constitute negligence per se.
The accepted standards and practices of a profession, trade, or industry may also define the standard of care by which conduct is judged. Included in the definition of “accepted standards and practices” is the MN MUTCD, this manual, and other similar manuals.

The Federal Manual on Uniform Traffic Control Devices (MUTCD) states that “The U.S. Secretary of Transportation under the authority granted by the Highway Safety Act of 1966, decreed that traffic control devices on all streets and highways open to public travel in accordance with 23 U.S.C. 109(d) and 402(a) in each State shall be in substantial conformance with the Standards issued or endorsed by the FHWA.” The MN MUTCD is the Minnesota document in substantial conformance with the Federal MUTCD.

The MN MUTCD has been adopted by the State of Minnesota through a Commissioner’s Order, and applies to all public roads and private roads open to public travel in Minnesota. As regulated, this requirement has the full force and effect of the law.

A failure by government personnel in Minnesota to conform to the requirements of the MN MUTCD may be sufficient to establish negligence (and therefore liability) should a crash result from failure to conform. On the other hand, as the MN MUTCD only sets forth minimum requirements, compliance may not in itself be sufficient to establish reasonable care. If more than a “minimum” is required by a specific situation, it should be done.

12.3.04 Causation

The third element in tort liability is causation. Causation is defined as an action or inaction which leads to or contributes to a particular event. To collect on a claim against MnDOT, a claimant must demonstrate that a negligent action or failure to act by MnDOT was a greater cause of the damages than any negligence on the part of the claimant, or in other words, MnDOT must be comparatively more negligent.

Comparative negligence is a rule of law adopted by this State whereby the negligence of both parties is compared, and recovery is permitted despite the negligence of the plaintiff. However, plaintiff’s damages are decreased proportionately to his/her own negligence. If the plaintiff is found to have a higher percentage of negligence than a defendant, then the plaintiff is not entitled to collect from that defendant.

12-3.05 Liability

In order for MnDOT to have liability for tort damages, a claimant must prove that:

1. MnDOT had a legal duty to use reasonable care towards the plaintiff,
2. MnDOT breached that duty by falling below the standard of care thus committing an act of negligence,
3. The damages (injuries, property damage, pain and suffering, loss of income, etc.) incurred by the plaintiff were caused by MnDOT’s negligence, and,
4. In order for the claimant to recover the damages suffered, the claimant must have had a percentage of fault that was less than or equal to the fault of the defendant.

12-4.00 IMMUNITIES

12-4.01 Statutory Discretionary Immunity

When the Torts Claim Act was passed in 1976, and the State lost its sovereign immunity, the legislature created other limited immunities for state agencies from liability for negligence. The first of the immunities which is commonly applied to MnDOT is called statutory discretionary immunity (Minnesota Statutes Section 3.736, Subdivision 3(b)).

Discretionary actions are planning level decisions involving questions of public policy, and are usually made at a high level in the organization. Discretionary actions require the evaluation and weighing of factors such as the financial, political, economic, and social effects of a given plan or policy.
Statutory discretionary immunity is based upon the principle of separation of powers. This immunity prevents the judiciary branch of government from using tort suits as a medium to second guess, or otherwise to engage in, policy-making activities reserved to the legislative and administrative branches. Because statutory discretionary immunity is based on this constitutional principle, claims of negligence are barred since the immunity applies “whether or not the discretion is abused”.

Examples of MnDOT activities which would likely be protected by discretionary immunity include; project selection, design standards, and snow removal priorities.

12-4.02 Official Immunity

Official immunity, in contrast to statutory discretionary immunity, is a common law doctrine which survives the abolition of sovereign immunity. Official immunity serves a different purpose than statutory discretionary immunity. While statutory discretionary immunity exists to preserve the separation of powers by preventing juries and courts (the judicial branch) from second-guessing the policy decisions of MnDOT (i.e., the executive branch), the official immunity doctrine exists to encourage the exercise of discretionary judgment by governmental employees. While the immunities analysis is dependent upon the facts of a given situation, generally, official immunity extends to non-policy type discretionary judgments such as professional engineering decisions. Official immunity prohibits plaintiffs from suing the government for discretionary judgments when the threat of litigation will chill the exercise of this independent judgment.

Official immunity distinguishes between discretionary and ministerial actions. Discretionary acts are immune; ministerial acts which do not require the use of discretionary judgment, are not immune. Ministerial acts are defined as those which are “absolute, certain and imperative, involving merely the execution of a specific duty arising from fixed and designated facts.” An example of a ministerial act may be the installation of a sign where the engineering decision has already been made that a sign is necessary.

In contrast, discretionary decisions are those that are not dictated by policy and which involve the exercise of judgment, including scientific or engineering judgment. For example, an engineering decision that a sign should not be used in a particular location may be an immune decision under official immunity.

Official immunity applies to individual public employees, and ensures that the threat of personal liability does not unduly inhibit the exercise of judgment required of public employees in discharging their duties. In order to avoid defeating this purpose in cases where a claimant brings suit against the governmental employer claiming negligence by a public employee, the Minnesota Supreme Court has recognized the concept of vicarious official immunity. Vicarious official immunity may be granted to an agency if it can be shown that the exercise of independent judgment by a public employee would be chilled if immunity were not granted to the agency.

Together official immunity and vicarious official immunity may apply to many situations in MnDOT.

12-4.03 Other Immunities

Minnesota Statutes Section 3.736, Subdivision 3 contains several other immunities relevant to various departments of state government. Following are three that are applicable to MnDOT:

1. Snow and Ice Immunity. The State and its employees are not liable for a loss caused by snow or ice conditions on a highway or public sidewalk that does not abut a publicly owned building or a publicly owned parking lot, except when the condition is affirmatively caused by negligent acts of a state employee.

2. Outdoor Recreation Immunity. The State and its employees are not liable for a loss incurred by a user arising from the construction, operation, or maintenance of the outdoor recreation system, as defined in Section 86A.04. This immunity is most commonly applicable to MnDOT at rest areas, which by definition are part of the outdoor recreation system.

3. A loss involving or arising out of the use or operation of a recreational motor vehicle, within the right-of-way of a trunk highway, as defined in Section 160.02, except that the state is liable for conduct that would entitle a trespasser to damages against a private person.
12-5.00 RECORD KEEPING

Good records are crucial in reducing MnDOT’s exposure to liability. Complete written or photographic records often provide the grounds for denying a claim, being granted immunity from a lawsuit, or in proving that MnDOT was not negligent.

Some suggestions for helpful records to keep are:

1. Logs of complaints or reports of defects. This is used for establishing when MnDOT had notice of a defect. The log should include when the reported defect was repaired.
2. Diaries or other daily work record sheets that indicate when and where routine work is performed. This has proven particularly useful in defending against pothole and traffic control claims by documenting MnDOT’s use of due care.
3. Written records of decisions involving the use of engineering judgment or which involve policy considerations, such as those made in design of traffic signals, are valuable in establishing discretionary or official immunity.
4. Contact or incident reports are frequently helpful for preserving facts surrounding a particular incident. Many claims and lawsuits are filed months or years after the incident and these reports are a way to reconstruct past events.
5. Photographs or videos may be useful in certain situations. The Department of Administration (DOA) encourages taking photos when a fleet vehicle is involved in a crash. Photos are also helpful if safety personnel want to document a chemical spill or a situation related to employee personal safety. However, if an incident occurs in a MnDOT work zone, and does not involve a fleet vehicle, caution in taking photos should be used by employees on the scene:
   - Camera settings should be checked to ensure accurate date and time stamps.
   - Shutter speeds should be adjusted if taking photos of changeable message signs or other electronic devices.

It is usually best from a legal perspective to rely on the State Patrol’s photos to document the crash scene.

In general with respect to tort liability, the more documentation that is kept, the better it is for MnDOT to demonstrate that it was not negligent. While it is not practical to record and maintain documents on every activity, MnDOT employees should be alert to situations that are particularly prone to claims and document those situations accordingly.

12-6.00 REQUESTS FOR INFORMATION

12-6.01 Purpose

As previously stated, tort claims against the State continue to be filed. As these claims become more sophisticated, it is important that we have uniform procedures within the Department for handling the release of information.

The reason for these procedures is that the investigation to prepare a case is a privileged activity, protected by law. Opposing litigants must abide by the rules for discovery which ensure that all parties to a lawsuit are treated equally and receive only the information that they are legally entitled to receive.

Documents assembled in response to a claim or lawsuit and kept in a claims file are considered confidential discussions between the client (MnDOT) and the Department of Administration (DOA) Risk Management Officer (claims), and/or the Attorney General’s Office (lawsuits). This protection is only provided to the claims file. It is important to keep an exclusive claim file since discovery of related documents could jeopardize the State’s efforts to present the best defense possible.

All other documents are considered public record and are subject to review at any time, with the exception of any crash data retrieved from the DPS MnCRASH database or any information generated from crash data from
the MnCRASH database. MnCRASH data may be privileged and not producible under both the Minnesota Government Data Practices Act (Minnesota Statutes, Chapter 13) and under 23 U.S.C. 409. In each case a decision regarding the release of MnCRASH data must be made in light of those statutory provisions.

12-6.02 Procedure to Follow When Requests are Made

Frequently, requests for Department documentation are made directly to MnDOT employees by people outside the Department. These requests may or may not involve current claims against the Department.

When a request is received, determine the reason for the request. If the requester is not seeking information to investigate a crash, personal injury, or property damage incident, and it appears unlikely that the information will lead to a claim, the information may be provided without involving the Office of Chief Counsel or the Data Practices Office.

If the information is being requested as the result of a crash, personal injury, or property damage, or if the requestor is an attorney, investigator, member of the media, or insurance representative, refer the requestor to the Data Practices Office: http://www.dot.state.mn.us/information/datapractices/index.html

In some cases, responses to requests will result in a claim or lawsuit being filed. When this occurs it will be helpful to be able to retrieve all information that has been provided. Copies of all correspondence should be retained so that it can be easily retrieved for review by the Attorney General’s Office, the Chief Counsel’s Office, or the DOA Risk Management Officer.

12-7.00 FILING A CLAIM

When a person reports damages that the person believes were caused by MnDOT’s negligence, the following steps should be taken:

1. Determine if the incident occurred at a location that is under MnDOT jurisdiction. If not, refer the person to the appropriate agency.
2. Determine if the incident directly involved a MnDOT vehicle (such as a collision). If so, refer the person to the District Safety Officer who will handle the claim with MnDOT’s insurance carrier.
3. Determine if the incident occurred within the project limits of a MnDOT construction project. If so, refer the person to the prime contractor of the project.
4. If the incident is at a location under MnDOT jurisdiction and did not directly involve a MnDOT vehicle or a MnDOT construction project, send a Claim Report and Demand form to the person. The claim forms are produced by the DOA Risk Management Officer and are available from the Office of Chief Counsel. Inform the person that their claim will be investigated and they will be notified of the results by the Department of Administration (DOA) Risk Management Officer.

If a claimant has any questions after filing a claim, they may be referred to the DOA Risk Management officer.

12-8.00 INVESTIGATIONS

12-8.01 Claim File

When a District or Office has been notified that a claim or lawsuit has been initiated against the State, only one file should be kept in the District or Office regarding the case. This file should include any and all correspondence that has occurred as a result of the claim.

The claim file should be kept by the District Tort Claims Coordinator or District Traffic Engineer. This file is not public information. It is considered attorney work product and, by law, is confidential. Work with the Office of Chief Counsel to provide information for lawsuits and claims.

Any questions regarding this procedure may be directed to the Office of Chief Counsel.
12-8.02 Investigating Claims

After a claim has been filed, the Department of Administration (DOA) Risk Management Officer will send a copy of the claim and a request for information to the Office of Chief Counsel, which will in turn forward the claim and more detailed instructions on information that should be gathered during the investigation to the appropriate District Traffic Engineer or District Tort Claims Coordinator to conduct an investigation.

The investigation will usually entail gathering documents from various District files, copying entries in logs or diaries, interviewing involved employees, and possibly a site visit. The State endeavors to respond to claims within a 3-4 week period, so the investigation needs to be completed and returned promptly within 2-3 weeks of receipt of the notice.

Upon completion of the investigation, the Office of Chief Counsel will respond to the DOA Risk Management Officer with the requested information and a recommendation on payment or denial of the claim. The DOA Risk Management Officer will then respond to the claimant.

12-8.03 The Discovery Process

When a notice of claim or a lawsuit is filed, a more formal investigation process called discovery will begin. A litigation hold will likely be instituted through the MnDOT Office of Chief Counsel, and an attorney from the Minnesota Attorney General’s Office will be assigned to the case. If the lawsuit was not preceded by a claims investigation, then the Office of Chief Counsel will likely request that all information relevant to the lawsuit be gathered by the district.

If the lawsuit proceeds, then at some point, plaintiffs’ attorneys are likely to make a formal request for information through the court.

The request for information will include one or more of the following:

- **Interrogatories**, which are simply a series of questions requesting information about a particular incident, location, or activity.
- **Demand for Production of Documents**, which may include any documents in MnDOT’s possession which are not privileged or otherwise protected by law. Generally this includes the contents of the construction, maintenance, and/or design files and any supporting manuals or documents.

Discovery documents are prepared jointly by the District Tort Claims Coordinator and key personnel, MnDOT’s Office of Chief Counsel, and the Attorney General’s Office. It is extremely important to provide the requested information by the deadline in the request to avoid legal sanctions against the Department. If the deadline cannot be met an extension must be requested.

If a lawsuit continues to proceed, the next phase of discovery is depositions. The purpose of a deposition is for the plaintiff’s attorney to gather additional information by directly questioning specified MnDOT employees. Employees subpoenaed or designated to appear at a deposition will be briefed prior to their appearance by the Assistant Attorney General assigned to the case on procedures and the nature of the questioning. The assigned Assistant Attorney General will also represent the MnDOT employee at the deposition.

12-9.00 EFFECT OF LITIGATION ON MnDOT

The incidents of civil litigation, primarily in the area of torts, have increased greatly in the last 30 years. This strong tendency toward legal action is closely followed by the trend towards large awards to plaintiffs.

It is more economically effective to expend public funds on sound management practices and on proper highway operations than on the settlement of claims or payment of adverse judgments. Consequently, it would seem appropriate to review operations activities and reporting procedures to reduce our risk of and limit exposure to tort liability. All agency employees involved in such activities should be properly trained and informed of the legal implications of their function.
CHAPTER 13 - NON-MOTORIZED FACILITIES

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13-1.00 INTRODUCTION

13-1.01 Purpose

The purpose of this chapter is to provide users with guidance regarding pedestrian crosswalk markings, where to install curb ramps, and pedestrian crossing enhancements.

Placing crosswalk markings and facilitating pedestrian crosswalk markings will often be dependent on the context or circumstances specific to a particular area and/or situation. When considering a non-motorized facility, short term solutions should be considered before implementing long term fixes. Many factors are involved in determining the need for and solution to pedestrian crossing enhancements.

13-1.02 Scope

This chapter describes locations where pedestrian crossing enhancements should be provided and whether or not they should be marked or enhanced in other ways. Pedestrian crossing facilitation should be considered as early in a project as scoping, and issues should be tracked to be able to correct issues in the future.

13-2.00 PEDESTRIAN CROSSING FACILITATION

This section describes locations where facilitated crossing opportunities should be provided for pedestrians at signalized and unsignalized intersections. Regardless of pavement markings, pedestrians are afforded the legal right to cross the street at all intersections unless specifically prohibited (Minn. Stat. Sec. 169.21, Subd. 1 and Subd. 2).

Minn. Stat. Sec. 169.011, Subd. 20 defines a Crosswalk as:

“Crosswalk” means (1) that portion of a roadway ordinarily included with the prolongation or connection of the lateral lines of sidewalks at intersections; (2) any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface.

Although every intersection affords pedestrians the legal right to cross regardless of the existence of sidewalks (unless specifically prohibited), pedestrian signal heads, or curb ramps; providing convenient access for all users is an important consideration.

13-2.01 Curb Ramp Installation

The installation of curb ramps at unsignalized crossings does not necessitate the installation of crosswalk markings. See Section 13-3.00 for further guidance.

At a crossing, sidewalks and trails should always have curb ramps. Exceptions to this are:

1. If an alternate route is provided due to measurable safety concerns (such as unresolvable sight distance issues or crash history) with the crossing, or
2. If the phasing at a signalized intersection is not possible, or prohibited. See Section 13-2.03 for more information.

13-2.01.01 Goat Paths

Curb ramps should be installed where there is indication of regular pedestrian activities. The term “goat path” is often used with regard to a path that is made by people consistently walking along the same area (See Figure 13-1). Pedestrians should be accommodated at the location of the goat path. If the location of the goat path cannot physically be made accessible, an attempt should be made to provide an equally convenient alternate crossing. If a goat path is present, installing a sidewalk or shared use path should be investigated as
an option. Installations of curb ramps or sidewalks/shared use paths should be coordinated with any bicycle or pedestrian plans as well as with the MnDOT Americans with Disabilities Act (ADA) Transition Plan.

Figure 13-1 Goat Path

13-2.01.02 Sidewalks or Trails

Sidewalks or trails that end at a shoulder or an intersection shall have a curb ramp to allow users to enter and exit the sidewalk or trail system. Where a sidewalk or trail system runs parallel to a roadway but there are no perpendicular sidewalks or trails to destinations, curb ramps should be provided perpendicular to the sidewalk system. When placing curb ramps perpendicular to a sidewalk system, only one side of an intersection needs to have a crossing. These crossings should be chosen based on the side of the street with the least conflicts (i.e., trees, drainage grates, etc.). These ramps should be spaced so that a pedestrian would not have to travel further than 660 feet (1/8 mile) out of their way to access to the sidewalk or trail system (See Figure 13-5 and Figure 13-6).

T-intersections should always include a perpendicular curb ramp to a sidewalk because pedestrians have no other options to access the sidewalk from that point. T-intersections create an ADA barrier and should have a perpendicular curb ramp for access to the sidewalk system. Where a sidewalk system ends a ramp shall be added at the end of the system terminating either into the shoulder or the street (see Figure 13-5 and Figure 13-6).

On the side of the street without sidewalk, curb ramps would only be needed when

1. A striped crosswalk or signed crossing exists, or
2. There is no shoulder to receive the crosswalk (see Figure 13-3 and Figure 13-7).

As a last resort, a grade-compliant driveway may be used to receive a crossing. If it is decided to not place a curb ramp at any of the locations illustrated in Figure 13-7, an engineering study shall be completed documenting a lack of need and shall be kept in the project file. The engineering study shall follow the guidelines set forth in the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD).

Curb ramp placement will often depend on context. More curb ramps may be needed depending on the context of the location. Crossings should connect destinations/pedestrian generators. Pedestrian generators are locations that influence pedestrian volume by acting as a source or destination of pedestrians, including, but not limited to:

- housing (paying special attention to vulnerable users such as senior or assisted living facilities)
- restaurants
• shopping
• hotels
• schools
• places of worship
• transit station
• parks
• museums
• gas stations
• civic buildings (libraries, post offices, etc.)
• health care facilities

Pedestrian generators will create pedestrian traffic regardless of the size of the road, the speed of traffic, the ADT, crossing facilitation, or presence/absence of sidewalks. That being said, if the road is difficult to cross or there are not adequate facilities but there are generators, there is likely pent up demand for pedestrian facilities. As long as there is a lack of measurable safety issues (sight distance, crash history) providing pedestrian crossing facilitation where pedestrians are already crossing can make the crossing safer. Regardless of the distance between crossings at unsignalized corners with sidewalks or trails, curb ramps should be provided from the sidewalk or trail system to access a pedestrian generator/destination, whether it is parallel or perpendicular to the sidewalk or trail (See Figure 13-5 and Figure 13-6).

Small segments of sidewalk should be installed to connect parking lots to sidewalk or trail systems (See Figure 13-8). Often these connections provide the shortest path for pedestrians and in the absence of installing these sidewalks goat paths will likely be created. These improvements should be coordinated with property owners as redevelopment occurs. The Cost Participation Policy should be consulted for funding these segments of sidewalk. Maintenance agreements will also need to be in place.

Midblock curb ramps should be evaluated on a case-by-case basis; much of the same guidance laid out in this section can be used. Midblock crossings may be necessary at some locations. An analysis of context, location, volume, need, traffic operations will assist in determining whether a midblock crossing is appropriate.

13-2.02 Signalized Pedestrian Crossings

Signalized intersections will sometimes merit the installation of curb ramps and Accessible Pedestrian Signals (APS) push buttons even without sidewalk connections. Curb ramps are necessary for ADA purposes in order to use APS push buttons. Crossings should be provided for all of the reasons listed in the “Curb Ramp Installation” section and destinations should be connected regardless of the existence of sidewalk or trail. Shoulders can be classified as a pedestrian facility leading up to a signal. Shoulders are a legal walking area for pedestrians when there is no sidewalk.

If crossings are provided on three legs of a signalized intersection, a crossing should be provided on the fourth leg of the intersection unless a severe operational problem (i.e., operations at LOS F for a movement) or a measurable safety issue (i.e., sight distance, crash history) is present on the fourth leg. This is to decrease pedestrian exposure and increase safety so that pedestrians can choose to cross one leg instead of crossing three. It also increases pedestrian level of service (LOS) if pedestrians can choose to cross one leg instead of three to get to one destination. It is important to remember that pedestrians are the most vulnerable user, and sometimes exposed to harsh weather conditions without protection. Minimizing pedestrian wait time is an important safety and LOS concern.

Some quadrants of signalized intersections may not contain a destination or require a pedestrian crossing. Some signalized intersections are in locations without sidewalks or trails and where little to no pedestrian or bicycle activity is expected. At these locations selected pedestrian crossings may be excluded from design. An engineering study should be completed recording existing conditions and lack of pedestrian generators in the area and expected pedestrian paths. The study should be kept with the project file.
13-2.03 Prohibiting Pedestrian Crossing

Pedestrian crossings may be prohibited if allowing the pedestrian crossing would severely impact vehicular traffic operations and an equally convenient alternate path for pedestrians is available. Judgment of when operations are severely affected should be decided by the District Traffic Engineer after consultation with local agency(s), MnDOT ADA Policy, and MnDOT’s Office of Traffic Engineering (OTE) Bicycling and Pedestrian Section as necessary. One example of an acceptable location to prohibit pedestrian crossings is at the inner legs of ramp interchange intersections due to the fact that the crossing would be a redundant route and affect LOS. If safety issues are present, such as a sight distance problem (for either sidewalk/shared use path users or roadway users) and it is deemed not feasible/possible to correct or eliminate the problem, the pedestrian crossing should be prohibited. Install "No Pedestrian Crossing Signs" (Figure 13-2) in locations where it is deemed necessary to prohibit pedestrian crossings.

The R9-3 R9-3a sign use should be judicious and limited in order to retain effectiveness. At locations where only very occasional pedestrian activity is expected, a good rule of thumb is to never strand a pedestrian in a quadrant by prohibiting crossings. If no convenient alternate route is available (a reasonable distance to walk in a suburban or rural setting is approximately 660 feet) then pedestrians should not be legally prohibited (i.e., by installing an R9-3 R9-3a sign) from using the signal indications to cross even if a pedestrian signal head is not provided. The following items should be considered when deciding whether to prohibit pedestrian crossings at a signal:

- The presence of medians.
- If crossings are prohibited where would a wheelchair cross?
- Will snow prohibit pedestrian crossings in the winter?
- Crossing distance and number of lanes.
- Speed
- AADT
- Phasing complexity
- Minimum green time (short minimum green times across 4-lane roadways mean that pedestrians will not be able to cross far enough to be seen and a crossing should be provided of at least one leg).
- Whether the side street is on recall.
- Railroad preemption (consideration should be given to eliminating a pedestrian crossing to avoid excessively long preemption lead times).
- T-intersections (pedestrians approaching from the unsignalized leg do not have a green ball to cross with and will not know when to cross).
- The presence of adjacent signals (Minn. Stat. Sec.169.21, Subd. 3(c) prohibits a pedestrian crossing the road between two signalized intersections).
- Context
- Pedestrian generators/destinations

If a grade separated crossing is nearby (within 660 feet), it is unnecessary to prohibit crossings at nearby signalized or unsignalized intersections unless operations are severely impacted or a measurable (sight distance, crash history) safety issue is present. Grade separated crossings should be as convenient (placement should be optimized and grade change minimized for pedestrians) as possible to reap the safety benefits of grade separation. Allowing the at-grade crossing gives opportunities for those who find the grade separated crossing more difficult, whether because of the crossings location, distance to the crossing, or the user’s mobility issues, to use the at-grade option.
At semi-rural, 4-lane, high speed (45 mph or greater), roads that intersect with a two-lane lower volume road a crossing on one leg of the main road should be provided while prohibiting pedestrians on the other leg of the main road (if desired). Pedestrians would then be allowed to use the vehicle signal face to cross parallel to the main road (See Figure 13-4).

13-3.00 CROSSWALK MARKINGS AND ENHANCEMENTS

This section describes locations where crosswalk markings or additional crossing enhancement should be considered. Marking crosswalks alone does not improve safety, but does delineate an approved path to alert pedestrians, bicyclists, and motorists of potential pedestrian movements across a roadway. At intersection locations, pedestrians have the legal right to cross. At non-intersection locations crosswalk markings legally establish the crosswalk. Before placing crosswalk markings or other crossing treatments at unsignalized locations, an engineering study should be completed to determine the necessity and feasibility of pedestrian crossing treatments. One option is to use the methodology set forth in the guide: Pedestrian Crossings: Uncontrolled Locations. An engineering study can be as simple as a site review and notes. The study should include input from stakeholders such as ADA, the (OTE) Bicycling and Pedestrian Section, local units of government, and any bicycle and pedestrian plans. The study should consider the following information:

- Geometrics
- Sight distance
- Traffic volumes, truck traffic, turning movements, queues from adjacent intersections.
- Pedestrian/bicycle volumes (methodology included in the FHWA Traffic Monitoring Guide).
- Site observations and driver distractions.
- Posted speed limit.
- Crash history
- Requests for a crosswalk/crossing facilitation.
- Existing pedestrian/bicycle crossing facilities (at intersection and along corridor).
- Nearby transit stops.
- Surrounding land use and pedestrian/bicycle generators.

Some of this information, particularly volumes, may not be available or easily maintained. Context and season should also be kept in mind. If a location near a beach is being reviewed in the winter, critical volumes may not be reached. Volumes taken near a school in the summer may not represent the volumes that occur during a school year. Origins and destinations could be considered as a stand-in for volumes. See bulleted list under 13-2.01.

13-3.01 Crosswalk Markings Installation Criteria

Crosswalk markings should be installed at all legs of signalized intersections that have pedestrian facilities. Channelized right turn movements should follow the criteria of an unsignalized crosswalk, discussed below. Crosswalk markings should be installed at all pedestrian crossings at roundabouts.

The following criteria should be considered for marking unsignalized crosswalks:

- Locations for a marked crosswalk should be connected by sidewalks or trails and have ADA compliant curb ramps and landings.
- Parking will be prohibited at least 20 feet prior to and after a marked crosswalk (Minn. Stat. Sec. 169.34, Subd. 1(6)).
- Crosswalk markings and advanced warning signs should not be installed at stop-controlled locations, although additional pedestrian treatments such as curb extensions and medians can be installed if an engineering study indicates a need.
• Crosswalk markings and signs (Figure 13-3) should be installed at all uncontrolled crossings along approved school crossings or crossings included in a Safe Routes to School plan. An intersection near a school will not necessarily be marked with a crosswalk; it needs to be included as an approved crossing or in a Safe Routes to School plan in order to be marked. Additional crossing enhancements should be considered at school crossing locations by analyzing the crossing with Figure 13-9 and Table 13-1 (see Section 13-2.00 for more information on school crossings).

• Crosswalk markings should generally not be installed at channelized right turn movements. Some channelized right turn movements may benefit from treatments such as signing and other enhancements and should always include appropriate geometrics to control speed, such as tight radii and appropriate crosswalk placement, while serving the typical vehicle within the corridor.

Midblock crossings should be carefully evaluated for markings and additional treatments. Midblock crossings may be unexpected by motorists. Unmarked midblock crossings afford pedestrians no legal right of way (Minn. Stat. Sec. 169.21, Subd. 3(a)), and pedestrians must yield to cars. Therefore, unmarked midblock crosswalks should be limited to low ADT and low speed locations. Additional crossing facilitation should be considered at these locations. If a midblock crossing is between two signalized intersections, it shall be marked (Minnesota Statute 169.21 Subd. 3(c)).

Some unsignalized locations may not qualify for marked crosswalks. Locations where the speed limit is 45 mph or greater, locations where pedestrian traffic occurs below the threshold volumes, or locations where there are no sidewalks, trails, or ramps but regular pedestrian traffic still occurs do not qualify for striping. See MN MUTCD, Part 3 for more information.

13-3.02 Additional Treatment Considerations

A marked crosswalk alone may not be enough to facilitate safe and efficient pedestrian movements. Pedestrian crossing enhancements have been shown to significantly improve motorist yielding behavior.

Marked Crosswalk Crossing Enhancements

• Advance and crosswalk-located warning signs,
• Prohibiting parking prior to the crossing,
• Medians,
• Curb extensions,
• Reduced corner radii,
• Advance stop lines,
• Raised crosswalks,
• Crosswalk lighting,
• Rectangular rapid flashing beacons (RRFBs),
• In-roadway lights,
• Pedestrian Hybrid Beacon Systems (see MN MUTCD, Part 4),
• Pedestrian signals (see MN MUTCD, Part 4), and
• Grade separation.

Other enhanced crossing treatments should be considered at locations where an engineering study indicates a need. Short term solutions can be implemented while waiting for the long term ultimate solution. Engineering
judgment, research, and national best practices need to be used to find the best treatment for each unique location. Coordination with maintenance staff should occur to ensure efficient snow removal in areas such as median cut-throughs.

See Figure 13-9 and Table 13-1 for determining the need for a crosswalk and other crossing enhancements.

Locations that do not qualify for marked crosswalks should still be given consideration for other crossing enhancements. Treatments such as lighting, eliminating sight distance issues, curb ramps, curb extensions, and median cut-throughs can benefit all types of pedestrian crossings whether they are marked or not. Coordination with maintenance staff should occur to ensure efficient snow removal in areas such as median cut-throughs. The following mitigation measures should be considered for all corridors where pedestrian activity occurs, and all legal crossings regardless of whether they are marked or not.

**Non-Marked Crosswalks Crossing Enhancements**

- Calm traffic by narrowing or removing lanes, adding bike lanes, widening sidewalks, providing curb extensions and planting trees. All of these can be used to slow traffic flow and increase the expectation of pedestrian activity by the driver.
- Remove and relocate obstructions, add curb extensions, and add illumination to address visibility. Curb extensions place pedestrians within the drivers’ field of vision, and allow for a shorter pedestrian crossing distance at the same time.
- Tighten turn radii.
- Install median islands to simplify crossings into two steps. Porkchop right turn islands can simplify the crossing even further. Access management can be used to eliminate turn lanes and turning conflicts.
- Move bus stops to the downstream side of the crosswalk.
- Prohibit on street parking 20-50 feet upstream and downstream of a crosswalk. Providing greater visibility should be balanced against traffic calming, as some measures to improve visibility may increase speeds.

13-4.00 INSTALLATION AND REMOVAL GUIDELINES

It is important for pedestrian, bicyclist, and driver expectation and compliance that crossing treatments are applied appropriately and consistently. Overuse of crosswalk markings and electronic enhancements such as flashers, beacons, and pedestrian signals should be avoided to maximize their effectiveness. Crosswalks and signs should be used at locations that meet the minimum pedestrian volume thresholds to avoid deteriorating effectiveness by overuse. Electronic enhancements may lose their effectiveness over time and usually have much higher ongoing maintenance costs. Electronic enhancements should be limited to locations with higher needs and where more standard engineering options (medians, curb extensions, etc.) are not effective or are infeasible.

Electronic crossing enhancements, such as in-roadway lighting, pedestrian flashers, and RRFBs should always be pedestrian-activated (either passively or actively) and meet ADA requirements for activation.

Conditions that contribute to the need for a crossing treatment may change over time. When a roadway is to be resurfaced, a review of existing crosswalks should be performed to determine whether the need for a crosswalk continues to exist. If the crossing no longer meets the guidelines, it should be removed. A review of the surrounding area should be conducted at this time to determine if pedestrian traffic has shifted to another nearby location that may need consideration or if conditions are affecting/compromising the pedestrian crossing volumes.

13-5.00 APPROVAL OF LOCAL REQUESTS

The District Traffic Engineer shall approve the proposed location for the crosswalk and/or pedestrian crossing enhancement. Prior to installation, the proposed location must have met the requirements of an engineering study as described above and have a request from the local agency requesting a marked crosswalk or other crossing enhancement.
If approved, the applicant will need to (unless otherwise agreed upon):

1. Work with MnDOT to determine cost share according to the Cost Participation Policy of the crosswalk or crossing enhancement.

2. Apply for a MnDOT permit to install the system in the right-of-way. As part of the permit the applicant will agree to:
   - Install crosswalk pavement markings (if not currently present) or refresh existing crosswalk pavement markings at the crossing.
   - Install or refresh existing “no parking” yellow curb, 20 feet in advance of, and 20 feet beyond the crossing.
   - Be responsible for installing, operating, and maintaining the crossing system and associated curb and pavement markings to MnDOT standards; along with all costs associated with said responsibilities.
   - Allow MnDOT to remove the system at their discretion. If removed by MnDOT, static pedestrian or school crossing signs may be installed by MnDOT in place of the system.
   - Provide an operations plan to MnDOT upon installation and provide an updated plan to the District Traffic Engineer if ever revised.

13-6.00 REFERENCES


2. Traffic Engineering Division, Virginia Department of Transportation. Guidelines for the Installation of Marked Crosswalks.

3. Fitzpatrick, Kay; Turner, Shawn; Brewer, Marcus; Carlson, Paul; Ullman, Brooke; Trout, Nada; Park Eun Sug; Whitacre, Jeff; Lalani, Nazir; and Lord, Dominique. Improving Pedestrian Safety at Unsignalized Crossings. NCHRP Report 562, TCRP Report 112, 2006.


A curb ramp without a sidewalk should be installed:
1) At an unsignalized location with a marked or signed crosswalk,
2) Where there is no shoulder to receive a pedestrian (see Figure 7).

See Section 13-2.01.02 Sidewalks or Trails for further discussion.
PEDESTRIAN CROSSING SCHEME AT SIGNALIZED INTERSECTION

FIGURE 5

November 2014
Ramps shall be placed for entrance/exit at the end of a sidewalk.

Pick a side of the street to cross. Cross at a minimum every 660’ or at every pedestrian generator.

Line ramp up with shoulder. Pick a side of the street.

Connect all through sidewalks.
RAMP INSTALLATION WITH SIDEWALK ON BOTH SIDES OF THE STREET

No Perpendicular Sidewalks

Pick a side of the street to cross. Cross at a minimum every 660’ or at every pedestrian generator.

One Perpendicular Sidewalk

Must cross on corner with perpendicular sidewalk.

T-intersection with No Perpendicular Sidewalks

Pick a side of the street to cross.

One-Way Perpendicular Sidewalk Extensions

Cross wherever a sidewalk is approaching perpendicular to a parallel system.

End of Sidewalk System

Ramps shall be placed for entrance/exit to the sidewalk system at the end of a sidewalk.

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FIGURE 7
REFUGE AREA WITHOUT SIDEWALK

FIGURE 8
Notes
1. Urban, suburban, and rural locations may vary in this classification. Urban may want to use locations that have higher volumes than the surrounding crossings. Rural locations may want to mark locations that have regular pedestrian crossings but may never meet the 20 pedestrians/hour minimum.
2. A reasonable walking distance is 660’ in some suburban/rural applications, urban marked crossings should never be closer than 150’.
3. See the "Additional Treatment Considerations" section for more information.
### Table 13-1 Pedestrian Facility Treatments

<table>
<thead>
<tr>
<th>Roadway Configuration</th>
<th>Vehicle ADT ≤ 9000</th>
<th>Vehicle ADT &gt; 9000 - 12,000</th>
<th>Vehicle ADT &gt; 12,000 - 15,000</th>
<th>Vehicle ADT &gt; 15,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 30 mph</td>
<td>35 mph</td>
<td>40 mph</td>
<td>≥ 45 mph</td>
</tr>
<tr>
<td>2 lanes (with or without a raised median)</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>3 lanes with raised median</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>3 lanes without raised median</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Multilane (4 or more lanes) with raised median</td>
<td>A</td>
<td>A</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Multilane (4 or more lanes) without raised median</td>
<td>A</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

**Treatment Descriptions:**

A. **Consider marked crosswalk and signs**
   - Guidance: Consider installing marked crosswalk with advance warning signs (W11-2); use S1-1 signs for school crossings. Consider in-roadway (R1-6) or overhead signs (R1-9a) or (R1-9b) signs.

B. **Consider marked crosswalk with enhanced signs (R1-6a or R1-9a R1-9b) and/or geometric improvements**
   - Guidance: Consider installing treatment options from Type A treatments. Add curb extensions or median refuge islands.

C. **Consider marked crosswalk with signs, geometric improvements, and pedestrian activated warning devices**
   - Guidance: Consider installing a raised median refuge island if one is not present. Consider installing marked crosswalk and appropriate crossing signs along with a pedestrian activated

D. **Do not install marked crosswalk.**
   - Guidance: Consider pedestrian hybrid beacon, pedestrian traffic signal, or grade separated crossing.

**Specific Notes:**
1. Advanced stop lines and signing (R1-5b or c) should be used whenever possible if a multiple threat crash issue is present. Overhead signing, RRFBs or other overhead treatments should be used to mitigate multiple threat crash risks.
2. Do not install a marked crosswalk where there are 3 or more through lanes per direction. Consider a pedestrian hybrid beacon, pedestrian traffic signal, or grade separated crossing.
3. Traffic calming measures should be considered to reduce speed.
4. If a median cannot be or is not currently installed go to Treatment Type D.
5. Minimum acceptable median width to provide a refuge is 6 feet.

**General Notes:**
1. Adding crosswalks alone will not make crossings safer, result in more vehicles stopping for pedestrians, nor will they necessarily create a false sense of security.
2. Crosswalks have not been proven to create a false sense of security - research shows that pedestrians scan the road more at marked crosswalks.
3. Whether a crosswalk is marked or not, additional crossing enhancements should be considered. See the "Additional Treatment Considerations" section.
4. See MUTCD Section 3B.18 for additional guidance on using this table.
5. Lanes are total cross section.
# CHAPTER 14 - MISCELLANEOUS TRAFFIC ITEMS

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CHAPTER 14 - MISCELLANEOUS TRAFFIC ITEMS

14-1.00 INTRODUCTION

14-1.01 Purpose
The purpose of this chapter is to present traffic engineering functions which do not fall within material covered in other chapters.

14-1.02 Scope
This chapter includes review procedures and permits and guidelines for conducting specific studies and investigations. Other specialized subjects are also discussed.

14-1.03 Chapter Organization
This chapter has five major sections:

1. School Crossing Protection,
2. Review and Permits,
3. Route Numbering and Reference Point System,
4. Special Investigations and Studies, and
5. Engineering and Traffic Investigation Requirements to Establish or Change Regulatory Speed Limits.

14-2.00 GLOSSARY

Ball Bank Indicator
An instrument used to determine the safe speed that a passenger vehicle can comfortably travel around a curved section of roadway. This instrument typically consists of a steel ball in a sealed curved glass tube filled with an alcohol solution. New style ball bank indicators utilize technology and accelerometers to replicate the inclinometer of a traditional ball bank indicator.

Commissioner
Unless stated otherwise, “commissioner” means the commissioner of transportation of this state. Regardless of the commissioner referred to, however, the commissioner is to be considered as acting directly or through the commissioner’s duly authorized officers and agents. Minn. Stat. Sec. 169.011, Subd. 17.

County Highway Engineer
A registered professional engineer employed as the County Highway Engineer or the Director of Public Works/County Highway Engineer of each county.

County State-Aid Highway
A highway which:

1. Is projected to carry a relatively heavy traffic volume or is functionally classified as collector or arterial as identified on the county’s functional plans as approved by the county board;
2. Connects towns, communities, shipping points, and markets within a county or in adjacent counties; or provides access to rural churches, schools, community meeting halls, industrial areas, state institutions, and recreational areas; or serves as a principal rural mail route and school bus route;
3. Occurs at reasonable intervals consistent with the density of population, provides an integrated and coordinated highway system affording, within practical limits, a state-aid highway network consistent with projected traffic demands.

**Department**

Unless stated otherwise, “department” means the Department of Transportation of this state. Regardless of the department referred to, however, it is to be considered as acting directly or through its duly authorized officers and agents. [Minn. Stat. Sec. 169.011, Subd. 23](#).

**District Engineer**

A District Engineer of any of the eight districts of the Minnesota Department of Transportation.

**District State-Aid Engineer**

A registered professional engineer employed as the District State-Aid Engineer.

**Eighty-Fifth Percentile Speed**

The speed at or below which 85 percent of vehicles travel. This metric aids in the establishment of speed limits.

**Experimental Traffic Control Device**

Any device which varies from the specifications set forth in the Minnesota Manual on Uniform Traffic Control Devices ([MN MUTCD](#)).

**Municipal State-Aid Streets**

“Municipal state-aid streets” includes all streets within the cities having a population of 5,000 or more, established in accordance with law as municipal state-aid streets. [Minn. Stat. Sec. 160.02, Subd. 21](#).

**Pace**

The 10 mph speed range representing the speeds of the largest percentage of vehicles in the traffic stream. The pace can usually be determined by visual inspection of the vehicle speed data sheet. In general, a normal speed distribution will contain approximately 70 percent of the sample within the pace with 15 percent above and 15 percent below the pace.

**Railroad**

“Railroad” means a carrier of persons or property upon cars, other than streetcars, operated upon stationary rails. [Minn. Stat. Sec. 169.011, Subd. 58](#).

**Roadway**

“Roadway” means that portion of a highway improved, designed, or ordinarily used for vehicular travel, exclusive of the sidewalk or shoulder. During periods when the commissioner allows the use of dynamic shoulder lanes as defined in Minn. Stat. Sec. 169.011, Subd. 25, roadway includes that shoulder. In the event a highway includes two or more separate roadways, the term “roadway” as used herein shall refer to any such roadway separately but not to all such roadways collectively. [Minn. Stat. Sec. 169.011, Subd. 68](#).

**Rumble Stripes**

“Rumble Stripes” are defined as a rumble strip that contains a pavement marking stripe. These are referred to as either edgeline rumble stripes or centerline rumble stripes. [MnDOT Technical Memorandum No. 14-07-T-01](#).

**Rumble Strips**

A series of intermittent, narrow, transverse areas of rough-textured, slightly raised, or depressed road surface. Transverse rumble strips extend across the travel lane to alert road users to unusual traffic conditions. Edgeline or centerline rumble strips are located along the shoulder, along the roadway center line, or within islands formed by pavement markings to alert road users that they are leaving the travel lanes.
Rural Residential District
(a) "Rural residential district" means the territory contiguous to and including any city street or town road that is built up with visible dwelling houses situated at intervals averaging 300 feet or less for a distance of a quarter of a mile or more.
(b) For purposes of this subdivision, “interval” means the distance, measured along the centerline of the roadway, between the primary access points for adjacent dwelling houses, regardless of whether the dwelling houses are located on the same side of the road. Minn. Stat. Sec. 169.011, Subd. 69a.

Rural Section
A section of highway that has wide rights-of-way, open ditches for drainage, and a clear zone of usually 30 feet from the edge of the outside lane.

Shoulder
The part of the roadway which is contiguous to the regularly traveled portion of the roadway and is on the same level as the roadway. The shoulder may be pavement, gravel, or earth. Minn. Stat. Sec. 169.011, Subd. 74.

Sidewalk
That portion of a street between the curb lines or the lateral lines of a roadway, and the adjacent property lines intended for the use of pedestrians. Minn. Stat. Sec. 169.011, Subd. 75.

State-Aid Engineer
A registered engineer employed as the State-Aid Engineer of the Minnesota Department of Transportation.

State Traffic Engineer
A registered professional engineer employed as the Director of the Office of Traffic Engineering (OTE) in the Operations Division of the Minnesota Department of Transportation.

Street or Highway
The entire width between the boundary lines of any way or place when any part thereof is open to the use of the public, as a matter of right, for the purposes of vehicular traffic. Minn. Stat. Sec. 169.011, Subd. 81.

Through Highway
Every highway or portion thereof at the entrances to which vehicular traffic from intersecting highways is required by law to stop before entering or crossing the same and when stop signs are erected. Minn. Stat. Sec. 169.011, Subd. 82.

Trunk Highway
As defined in Minn. Stat. Sec. 160.02, Subd. 29, “Trunk highways” includes all roads established or to be established under the provisions of Article 14, Section 2 of the Constitution of the State of Minnesota.

Trunk Highway Turnback
A former trunk highway or portion of it that has reverted to a county or municipality in accordance with law.

Urban District
The territory contiguous to and including any street which is built up with structures devoted to business, industry, or dwelling houses situated at intervals of less than 100 feet for a distance of one quarter mile or more. Minn. Stat. Sec. 169.011, Subd. 90.

Urban Section
A roadway design used in urban districts where the right-of-way width is restricted. Because of the restricted right-of-way, there is not enough room for ditches, thus necessitating curbs and gutters.
14-3.00  SCHOOL CROSSING PROTECTION

14-3.01  Responsibility

The safety of school crossings is the joint responsibility of parents, school administrators, other public officials, and the general public. On trunk highways, the Department will install appropriate signs and markings at designated school crossings and may authorize local authorities to install additional devices conforming to approved standards in situations that meet reasonable warrants.

14-3.02  Laws and Guidelines

Minn. Stat. Sec. 169.14, Subd. 5a sets forth the legal requirements of speed zoning in a school zone. Information on traffic controls and speeds for school areas can be found in the MN MUTCD, Part 7. More information can be found regarding speed limits at MnDOT’s Speed Limits in Minnesota website.

14-3.03  School Safety Patrols and Crossing Guards

School Safety Patrols and/or Crossing Guards are strongly recommended at all crossings used by grade school students. No other means of protection has been as effective at facilitating crossings used by the younger students at grade schools. However, these patrols have not proven effective for high school or junior high school students. Where a School Safety Patrol or Crossing Guard is functioning as recommended, normally the only necessary controls are the standard school crossing warning signs and markings.

14-3.04  School Speed Limits

Each road authority may establish school zone speed limits on roads under their jurisdiction. In order to provide an objective, uniform, and safe environment for walking and biking students, Minnesota law (Minn. Stat. Sec. 169.14, Subd. 5a) requires an engineering and traffic investigation as prescribed by the Commissioner of Transportation prior to establishing a school speed limit. A Guide to Establishing Speed Limits in School Zones can be found in the MN MUTCD, Part 7.

14-3.05  School Site Plan Review

It is the responsibility of the School District, when planning to build a new school facility or make major changes to an in-place facility, to obtain all the necessary permits and approvals. The Minnesota Department of Education Planning Guide requires that the School District contact the District Traffic Engineer for guidance in planning for pedestrian and vehicle movements when trunk highways are involved. Other road authorities are to be contacted when their roadway is involved. MnDOT will also assist school districts in planning student, vehicle, and community user access to a school site based on available resources. In some cases an engineering consultant may need to be retained by the school district to work in conjunction with MnDOT staff.

14-4.00  REVIEW AND PERMITS

14-4.01  Geometric Reviews

Geometric design is concerned with the visible features of a highway such as pavement width, horizontal and vertical alignment, slopes, channelization, interchanges, etc. The design of these features can significantly affect traffic operation, safety, and capacity. In fact, some of the traffic problems existing today are the result of geometric design features that could have been corrected during the design stages if the design had been reviewed from a traffic engineering perspective. It is essential to maintain regular and cooperative communication between traffic and design personnel. Each group needs and benefits from the knowledge, expertise, and experience of the other.
14-4.02 Preliminary Layouts

The District Traffic Engineers should review all preliminary layouts to provide early input into the design process.

14-4.03 Evaluation of New Facilities

All newly constructed facilities should be evaluated on a systematic operating basis by District Traffic Engineers to assess their effectiveness in moving traffic safely and efficiently. If the improvement is not working as expected, it is imperative that an evaluation of the reasons be made. Positive and negative feedback based on traffic engineering evaluations can be an important contribution toward upgrading design standards and criteria to meet changing conditions. A copy of comments should be sent to the State Traffic Engineer.

14-4.04 Entrance Permits

No entrance or driveway from a trunk highway to private property may be constructed without permission of the Department. Under normal conditions any necessary entrance facilities are provided by the Department when the highway is constructed or reconstructed. In the event of a change in land use or major change in the traffic pattern of an existing facility, existing access often must be revised. After a highway has been constructed, no additional entrances shall be constructed, nor shall an existing entrance be changed without the approval of the District Engineer. It is the responsibility of the Area Maintenance Engineer to investigate all requests for such permits and to recommend proper action to the District Engineer. Traffic engineering principles should be applied in the investigation, and the District Traffic Engineer should have direct input. Entrance permit application forms and instructions can be found on the MnDOT Land Management website.

A variance from the standards set forth in Minnesota Rules, Chapter 8810 parts 4100-5600 may be allowed by the Department when the variance will facilitate the safe, efficient use of the property for a lawful purpose and will not interfere with the construction, maintenance, or safe and efficient use of the highway and its appurtenances by the public.

14-4.05 Transportation Permits

Permits for the movement of over-size or over-weight loads are issued by MnDOT’s Office of Freight and Commercial Vehicle Operations. Permit guidelines and forms can be found at www.dot.state.mn.us/cvo/oversize/oversize.html.

14-4.06 Use of Trunk Highway Right-of-Way for Special Events

Use of trunk highway right-of-way for special events and activities will not be allowed unless a legitimate public interest is to be served. Use of trunk highway right-of-way not related to construction or maintenance requires that the requester contact the MnDOT District Office. MnDOT authorization will be granted, through the district permitting process, if all pertinent criteria covered in the following guidelines are satisfied.

1. The permit shall identify that the sponsor agrees to assume the entire responsibility and liability for all damages or injury to all persons, whether employees or otherwise, and to all property, arising out of, resulting from, or in any manner connected with the operation of the special event.

2. The sponsor shall agree to defend and indemnify MnDOT, its agents and employees from all such claims including, without limiting the generality of the foregoing, claims for which MnDOT may be claimed to be liable and legal fees and disbursements paid or incurred to enforce the provisions of this paragraph, and the sponsor shall further agree and pay for such general liability coverage which protects the state as an additional named insured.

3. The permit shall also identify that the sponsor shall be responsible for any damage done to trunk highway property as a result of the special event. Damages are payable upon receipt of invoice.

If MnDOT provides assistance in the form of traffic control devices, signs and/or labor, the requester should be billed for the actual costs incurred by MnDOT.
For purposes of these guidelines, the use of trunk highway right-of-way is split into four categories:

1. Use of Right-of-Way Involving Road Closure,
2. Use of Right-of-Way Involving Traffic Restrictions,
3. Use of Right-of-Way Not Involving Traffic Restrictions, and
4. Signs, Banners, and Decorations.

Within each of these, the categories are subdivided as follows:

**Freeways** - includes interchange areas on expressways.

**Expressways** - does not include interchange areas.

**High Speed, Two-Lane, Two-Way Highways** - speed limit of 45 miles per hour or greater (includes segments that may have additional lanes for passing, turning or bypassing and/or short segments of four or more lanes).

**Low Speed Roads** - speed limit of 40 miles per hour or less (generally includes those segments of trunk highways that pass through a city and/or serve a city street-type function and all frontage roads).

**14-4.06.01 Use of Right-of-Way Involving Road Closure**

Examples of road closures include parades, races, filming, etc.

1. Closures should not be allowed for Freeways, Expressways and High Speed, Two-Lane Two-Way Highways.

2. Low Speed Roads

   Closures may be allowed at the discretion of the District Office subject to the following criteria:

   a. Closures shall not be allowed during peak traffic periods unless authorized by the District Traffic Engineer.

   b. If the right-of-way is located within a city, requests shall be made through the offices of or by the city.

   c. A plan for traffic control and documentation of the means to implement it should be submitted. An adequate detour route shall be provided. Motorists shall be guided through the detour by signs, traffic control personnel, law enforcement personnel or a combination of the three.

   d. Signs, if used, shall be in accordance with the [MN MUTCD](https://www.dot.state.mn.us/mutcd/).

   e. Detour signing, advance notices, and publications are the responsibility of the requester. MnDOT should review, comment on, and approve the plan. Upon request, MnDOT may provide assistance in the form of traffic control devices, signs, and/or labor. The requester should be billed for the actual costs incurred by MnDOT.

   f. All road closures should be coordinated with the State Patrol and the local law enforcement agency.

   g. Adequate traffic control and law enforcement personnel shall be arranged by the requester.

   h. Festivals with a long history of occurrence and no traffic mobility or safety problems in the past should be allowed to continue. If a new traffic mobility or safety problem arises, it should immediately be brought to the attention of the event sponsor, local municipality, and enforcement agencies to be addressed. If no solution can be found, the organizations shall jointly agree to revise the location of the festival.

   i. Denials of permits for road closures may be appealed to the Commissioner of Transportation by the requester.
14-4.06.02 Use of Right-of-Way Involving Traffic Restrictions

Examples of this category include races, filming, etc.

1. Freeways
   Use of the freeway mainline and the adjacent right-of-way should not be allowed. However, use of a local road overpass or underpass area may be allowed in those cases where there is no significant impact on freeway traffic, subject to the criteria covered under “High Speed Two-Lane Two-Way Highways and Low Speed Roads,” below.

2. Expressways
   Use of right-of-way should not be allowed. However, use may be allowed in those cases where there is a limited impact on traffic, subject to the criteria covered under “High Speed Two-Lane Two-Way Highways and Low Speed Roads,” below.

3. High Speed Two-Lane Two-Way Highways and Low Speed Roads
   Use of right-of-way should not be allowed during peak traffic periods. Limited use is allowed subject to the following criteria:
   a. The period of time for which a road is restricted for partial use should not exceed four hours.
   b. If the right-of-way is located within a city, requests shall be made through the offices of or by the city.
   c. The use of the right-of-way shall not interfere with motorists’ safe operation of their vehicles.
   d. The use of the right-of-way shall not obstruct sight distance and shall not detract from motorists’ view of traffic control devices.
   e. A plan for traffic control and documentation of the means to implement it should be submitted.
   f. Adequate traffic control and law enforcement personnel shall be arranged by the requester.
   g. All traffic restrictions should be coordinated with the State Patrol and the local law enforcement agency.

14-4.06.03 Use of Right-of-way Not Involving Traffic Restrictions

Examples in this category are parking, booths, sales, etc.

1. Freeways
   Use of the freeway mainline and the adjacent right-of-way should not be allowed. However, use of a local road overpass or underpass area may be allowed in those cases where there is no significant impact on freeway traffic, subject to the criteria covered under “Low Speed Roads” below.

2. Expressways and High Speed Two-Lane Two-Way Highways
   Use of right-of-way should not be allowed. However, use may be allowed in those cases where there is a limited impact on traffic, subject to the criteria covered under “Low Speed Roads” below.

3. Low Speed Roads
   Use of right-of-way may be allowed subject to the following criteria:
   a. If the right-of-way is located within a city, requests should be made through the offices of or by the city.
   b. No advertisements should be permitted on the right-of-way.
c. The use of the right-of-way shall not interfere with motorists’ safe operation of their vehicles.

d. The use of the right-of-way shall not obstruct sight distance and shall not detract from motorists’ view of traffic control devices.

e. Adequate law enforcement personnel protection shall be arranged by the requester, as necessary.

f. Use of the right-of-way shall not exceed 30 days and similar use should not recur within ten months.

14-4.06.04 Signs, Banners, and Decorations

1. Freeways
   Signs, banners, and decorations should not be allowed on the right-of-way.

2. Expressways, High Speed Two-Lane Two-Way Highways, and Low Speed Roads
   Directional signs may be allowed at the intersection of the local road leading to the event. Non-directional signs, banners, and overhead decorations will be allowed only on low speed roads subject to the following criteria:

   a. If the signs, banners, or decorations are to be located within a city, the requests should be made through the offices of or by the city.

   b. Signs, banners, or decorations shall not be attached to any MnDOT structure (sign, signal, bridge, etc.).

   c. Directional and non-directional signing are the responsibility of the requester. If, upon request, MnDOT provides assistance in the form of signs and labor, the requester should be billed for the actual costs to the Department.

   d. The requester for directional signing will be advised that signing must conform to the MN MUTCD or as directed by the District Office.

   e. Directional signing shall contain only directional information for the event.

   f. Non-directional signs or banners shall not appear to represent or conflict with an official traffic control device in shape, form, color, or legend. They should be of a neutral color.

   g. Non-directional signs or banners should display only the name of the event and the scheduled time.

   h. Signs, banners, and decorations shall not obstruct sight distance or detract from motorists’ view of traffic control devices.

   i. No changeable message signs of the type used for temporary or permanent traffic control shall be permitted for event advertising purposes.

   j. The minimum clearance for all signs, banners, and decorations spanning a highway should be 22 feet above the roadway and shoulder.

   k. Letter height displayed on city banners is not to exceed two inches.

   l. Stroke width displayed on city banners is not to exceed width of B Series Highway Gothic lettering.

   m. No logos or product advertising is allowed.

   n. Adequate traffic control shall be provided when overhead signs, banners, and decorations are being installed and removed.
14-5.00 ROUTE NUMBERING AND REFERENCE POINT SYSTEM

14-5.01 General

Each highway in Minnesota is part of a dual system of numbering. The first part of the system is a Constitutional or Legislative route number and the second part is a route signing number (i.e., U.S. route number, Interstate route number, or a Minnesota Trunk Highway number). The total numbering system must be kept in logical order and great care must be exercised in changing or revising any portion of the system. There are certain rules which must be followed and certain committees, both locally and nationally, that must be involved to make the system workable.

14-5.02 Constitutional Routes

The Constitutional amendment adopted in 1920 establishing the Minnesota highway system listed 70 routes that by their very description connected various cities and areas in the state into a highway system. These first 70 routes are known as Constitutional Routes and are numbered 1-70. These routes are described in Minn. Stat. Sec. 161.114 and, because of the constitutional nature of their establishment, should be considered unchangeable.

14-5.03 Legislative Routes

Since the original 70 routes were established, many additional routes have been added to the trunk highway system by the State Legislature. These routes, currently numbering over three hundred, are known as Legislative Routes. These routes are modified, revised, changed, and added to from time to time by the Legislature, usually on the recommendation of the Department. These routes are described in Minn. Stat. Sec. 161.115. Any changes proposed by the district to these routes should be coordinated through the Department’s Control Section and Route Numbering Committee.

14-5.04 Names and Designation of Certain Highways

At various times the Legislature has named and designated portions of certain constitutional and legislative routes. Examples include “Capitol Highway,” “Floyd B. Olson Memorial Highway,” “Yellowstone Trail,” etc. Named routes are listed in Minn. Stat. Sec. 161.14 where the route itself is described and the special conditions for signing each route are set forth. Refer to MnDOT Policy, Names and Designation of Highway and Bridge Memorials located on the MnDOT Policies - Operations and Engineering website for more information.

14-5.05 Interstate Routes

The National System of Interstate Highways was established in 1957 with a numbering system and distinctive markers designed by the American Association of State Highway and Transportation Officials (AASHTO). East-west routes have even numbers and north-south routes have odd numbers with the lowest number routes in the west and south. Major routes have one or two digit numbers, and the most important routes have numbers ending with 0 or 5. Special, related three-digit numbers are used to designate spurs and circumferential routes in urban areas. Any proposed revisions to this numbering system must be coordinated through the Route Numbering and Control Section Committee (RNCS) since approval by a national committee is required prior to any change in the system.

14-5.06 U.S. Highways

The system of United States Numbered Highways was adopted in 1926 in order to provide a uniform system of numbered highways extending across the nation for the benefit of the interstate traveler. The numbering system
and the distinctive markers were developed by AASHTO at the request of the Federal Highway Administration with advice from several states. This system is kept current through the coordination of AASHTO and the cooperation of the states. Even numbered routes generally follow an east-west alignment, while odd numbered routes are generally north-south. Any proposed changes to this system must be coordinated through the Route Numbering Committee since the approval of the Executive Board of AASHTO is necessary. The U.S. route system is only a route numbering signing system and is not related to federal funding.

14-5.07 Trunk Highway Routes

All routes not designated as part of the Interstate or U.S. Route numbering systems are given a “Minnesota” route number. These numbers are assigned by the Route Numbering and Control Section Committee (RNCS) and all requests for new numbers or changes must be coordinated through that committee.

14-5.08 Turnbacks

As roads are rebuilt or new roads are constructed, certain old routes are turned back to the counties and municipalities. The route is deleted from the trunk highway system and is normally assigned a route number by the involved jurisdiction. Funds are available for restoration of the roads that have reverted to county and municipal jurisdiction. See Minn. Stat. Sec. 161.082 and 161.083.

Rules and regulations for implementing a “turnback” are set forth in the current MnDOT Right of Way Manual. Upon completion of a “turnback” all responsibility for providing traffic control devices rests totally with the local jurisdiction. The Project Manager should review any existing signal agreements to assure that any responsibilities of MnDOT identified within any existing signal agreement are met.

14-5.09 Reference Point System

Reference posting is a continuous distance reference system which indicates the distance from a known starting point. The purpose of a reference point system on freeways and highways is to provide uniform and accurate reference points for all highway-oriented activities. Actual physical reference points consist of reference location signs, installed at approximately one mile intervals along the roadside, showing the continuous distance along the route.

Distance numbering is continuous for each route within the state, except where overlaps occur. Distances are computed from the west state line or the westerly terminus for highways running in a general west-east direction (increasing going east) and from the south state line or the southerly terminus for highways running in a general south-north direction (increasing going north).

The Trunk Highway Log Point Listing specifies the locations of side roads, bridges, crossroads, culverts and other identifiable physical features to the nearest thousandth of a mile. The Log Point Listing was developed for the purpose of providing more precise and specific reference to locations between the reference location signs. Log Point systems are available for both county and municipal road systems. More information can be found on the Roadway Data website.

The Reference Point System and Trunk Highway Log Point Listing are used to aid offices and organizations directly associated with highway-oriented activities. Included in the practical uses of the system are the following:

1. Precise identification of crash locations.
2. Reference points for the location of emergency incidents.
3. Reference points for roadway maintenance servicing.
4. Reference points for use in road inventory records.
5. Aid to motorists in estimating their progress.
6. Transportation planning purposes.
14-5.09.01 Overlapping Routes

Mileage numbering should be continuous for each route within the state. On overlapping routes, continuity should be established for only one of the routes in accordance with the Control Section Record. On the route without reference location sign continuity, the first reference location sign beyond the overlap should indicate the approximate distance traveled from the beginning of the route.

14-5.09.02 Divided Highways

For divided highways, mileage measurements shall be made on northbound and eastbound roadways. The reference location signs for southbound and westbound roadways shall be set at directly opposite locations.

14-5.09.03 Transportation Information System (TIS)

TIS is an integrated database system that stores roadway related traffic information such as Average Annual Daily Traffic (AADT), Heavy Commercial Average Annual Daily Traffic (HCAADT), and select roadway physical characteristics such as bridge, crash, traffic, and pavement data.

Reference location signs play a critical role in TIS as all road features, inventory items, or crash locations are directly or indirectly referenced to the field reference location sign. It is imperative that the sign be in place. If replacement is required, it must be done in accordance with location instructions found in Chapter 6 of this Manual.

When construction projects or turnbacks affect reference posting on any trunk highway, the Transportation Data and Analysis office should be contacted as to placement of the required posts. Do not invent a new method, as the True Mileage System of TIS has established adjustment rules and procedures to follow.

14-5.10 Exit Numbering

Exits from freeway and expressway interchanges in Minnesota are numbered in accordance with Federal Highway Administration requirements which specify a reference post format. Exit numbers are displayed at the top of major guide signs located in advance of an interchange at the exit. The exit number normally utilizes the last reference post number in a decreasing reference post direction from the interchange. When there are multiple exits at an interchange (cloverleaf, for example), or more than one interchange for a given reference post, the first exit number in the increasing reference post direction is given the letter “A” and the second the letter “B”. Occasionally, a third exit may occur within the same reference post number assigned to an interchange. In that case, the exit would carry the reference post number followed by the letter “C”.

14-6.00 SPECIAL INVESTIGATIONS AND STUDIES

14-6.01 Rumble Strips and Rumble Stripes

Rumble Strips

Rumble strips are grooves or rows of indents in the pavement designed to alert inattentive drivers through noise and vibration to reduce crashes. There are two general types of rumbles, longitudinal and transverse. Technical Memo 14-07-T-01 Rumble Strips and Stripes on Rural Trunk Highways contains details of MnDOT requirements, exceptions, and typical dimensions of longitudinal rumbles.

Shoulder rumble strips are longitudinal rumble strips installed outside of the edgeline. The intent of shoulder rumbles is to notify inattentive drivers that they are leaving the roadway with the goal of reducing run-off-the-road crashes. They are also useful during snowy conditions to help the driver keep the vehicle on the road. The edgeline may also be installed on top of the rumble. These are typically called edgeline rumbles or edgeline rumble stripes.
Centerline rumble stripes (or simply centerline rumbles) are longitudinal rumbles installed along the centerline of undivided roads with the goal of reducing head-on, opposite direction side-swipe, and run-off-the-road-left crashes. The centerline is installed on top of the rumble.

Transverse rumble strips may be used when unusual alertness is required of drivers of an upcoming hazard and standard traffic control devices such as signs and/or flashers have not proven to give adequate warning. Several strips are placed laterally across the pavement to cause a rumble or bumpy motion that, when traversed by a vehicle, will alert the driver. Typical locations for use of transverse rumble strips are approaches to toll gates and to stop signs hidden by horizontal or vertical curves. Proximity of the rumble strip to the hazard is important. If the rumble strip is located too close to the hazard, sufficient driver reaction time is not given. If they are located too far away, the driver may not relate the rumble strip to the hazard. MnDOT has developed a formal rumble strip layout, see the MnDOT Road Design Manual.

14-6.02 Experimental Traffic Control Devices

14-6.02.01 Legal Authority

Minnesota Statutes 169.06, Subdivision 2, states, “The Commissioner may authorize variations from the manual and specifications for the purpose of investigation and research into the use and development of traffic-control devices. When such authorized variation pertains to the regulation of traffic, notice of the intended regulatory purpose shall be published in a qualified newspaper of general circulation in the area where the research is being conducted.”

14-6.02.02 Procedures

The following procedures shall be followed to obtain approval to use experimental traffic control devices:

1. The District Traffic Engineer or other MnDOT representative shall originate the procedure by making a thorough investigation relative to the needs for the experimental device, reasons for choosing it, description of device, and expected results. See MN MUTCD Chapter 1A.10.2 “Request to Experiment”.

2. The originator shall submit the Request to Experiment to the Traffic Standards Engineer, Office of Traffic Engineering (OTE) for review with a request for approval.

3. The OTE Traffic Standards Engineer, shall draft a letter to the FHWA requesting approval of the experimental device(s). The District Traffic Engineer or other MnDOT representative shall review the site upon installation of the device and shall monitor it periodically to assure safe and efficient operation of the device and to recommend any necessary alterations to the OTE Traffic Standards Engineer.

4. Upon termination of the operation or experiment, the originator shall submit a report to the OTE Traffic Standards Engineer and the FHWA, outlining all aspects of the experiment and evaluating the device, recounting both positive and negative aspects, and including comments and suggestions.

14-6.03 Speed Trend Studies

Minnesota Department of Transportation Districts typically conduct speed trend studies. The data collection procedure may require staff hours in the field to set up portable data collection machines. These machines may require in-road placement of road tubes, in-pavement loop detectors, or portable magnetic sensing devices.

Speed trend studies measure motorist’s travel speed at a particular site or on a roadway type. The study is a compilation of speed monitoring sessions (sometimes called speed surveys). Analyses of these data determine one or more roadway speed metrics. The results from a speed trend study may identify changes in speeds due to changes in the roadway environment, i.e. road construction, changes to the roadway geometric, etc.
14-6.03.01 Minnesota Speed Monitoring Program

Detailed information regarding the Minnesota Speed Monitoring Program can be found at www.dot.state.mn.us/trafficeng/speed_monitoring/index.html.

Previously, the Federal Highway Administration required states to submit speed trend studies of highways with posted speed limits of 55 to 65 miles per hour. This program established a consistent statistical method to measuring vehicle roadway speeds. Annual reports of vehicle roadway speeds determined Minnesota’s public compliance with the National Maximum Speed Limit Law (NMSL), a provision of the 1974 Emergency Highway Energy Conservation Act. In 1995, Congress passed the National Highway System Designation Act which repealed the NMSL and all federal speed limit controls.

The Minnesota Department of Transportation, Office of Traffic Engineering continues to provide annual speed reports. The reports are found at http://www.dot.state.mn.us/trafficeng/speed_monitoring/speed_reports.html. The annual speed report shows the 85th percentile speed for urban freeways, rural freeways, rural two-lane two-way highways, rural divided highways, and urban divided highways.

The Office of Traffic Forecasting and Analysis coordinates, collects, and manages the roadway speed data. Automatic Traffic Recorders (ATR), Weigh-in-motion (WIM), and Wavetronix (SmartSensor HD) devices, located throughout the state, provide continuous data collection.

- The Automatic Traffic Recorder is a permanent data collection device in the pavement surface. ATRs offer continuous automatic data collection throughout the year. These devices collect roadway volume, vehicle classification, and travel speed.
- Weigh-in-motion is similar to the ATR, but also provides axle loadings, vehicle and axle configuration, and truck volume characteristics.
- The Wavetronix SmartSensor HD operates off radar technology to measure volume, individual vehicle speed, average speed, 85th percentile speed, average headway, average gap, lane occupancy, and length based vehicle classification.

More information regarding traffic data collection methods can be found at http://www.dot.state.mn.us/traffic/data/coll-methods.html.

Speed Monitoring Session Location Requirements

When conducting short-term speed surveys or installing long-term data collection devices, the following roadway conditions should be avoided.

1. Locations near or at a sharp horizontal curve with a speed advisory plate less than the posted speed limit.
2. Locations with steep grades (i.e. greater than 4 percent).
3. Locations within 100 feet of a significant at-grade intersection.
4. Locations within 1000 feet of an interchange exit or entrance ramp.
5. Locations within the interchange (defined as the distance from the beginning of a deceleration lane through the end of an acceleration lane).
6. Locations with other features that may influence vehicle speeds (e.g. a narrow bridge or railroad crossing).

14-6.04 Sight Distances at Crossroads

A major safety aspect is the sight obstruction caused by noise barriers, plantings, poles, signs, fences, bridge rails, etc., at or near the intersections of ramps, frontage roads, and crossroads. When evaluating sight distance at intersections, two different procedures must be followed in order to determine if it is adequate, 1) perceptual and 2) driver acceptance of a minimum 10 second vehicle interval. It is very desirable that both of these be met at all intersections.
14-6.04.01 Perceptual

When approaching an at-grade intersection, the operator of a vehicle should have an unobstructed view of the whole intersection and enough of the intersecting highway such that the driver can perceive a hazard in sufficient time to alter the speed of his vehicle as necessary before reaching the intersection. Minimum distances along the intersection road (setback distance) which should be unobstructed are determined by the approach speed and the distance traveled by the vehicle in three seconds. This does not provide enough distance to stop the vehicle; however, the three seconds gives the driver two seconds for perception and reaction plus one additional second to actuate braking or accelerating his vehicle to avoid a collision. For additional information see Chapter 5 of the MnDOT Road Design Manual.

14-6.04.02 Driver Acceptance of a 10-Second Vehicle Interval

Once a vehicle has stopped at the intersection, the driver must be provided adequate sight distance to safely enter the intersection. This distance is based on the acceptance of a 10-second vehicle interval. This may or may not be provided using the perceptual sight triangle method. Telephone and power poles, fences, and bridge rails do not obstruct vision when approaching an intersection (i.e., perceptual sight) but can block the entire view when stopped at the intersection. Figure 5-2.01A of the Road Design Manual provides the necessary information to determine the lengths needed for this sight distance.

14-6.05 Railroad Crossing Review

Information regarding Railroad Crossings can be found on MnDOT's Rail Safety website and also in the MN MUTCD, Part 8.

14-6.06 Advisory Curve Study

The need for installation of Horizontal Alignment signs can be found in the MN MUTCD, Part 2C. Advisory speeds will be determined by the established engineering practice using a ball bank indicator as stated in Chapter 6 of this manual (6-6.05 Advisory Speed Plaques and 6-6.21 Truck Rollover Warning Signs). Field ball bank readings may be measured by making several trial runs through the curves in a test vehicle equipped with a slope meter or an electronic meter. The ball bank reading is a measure of the overturning force (side friction) measured in degrees, on a vehicle negotiating a horizontal curve.

Slope Meter

The slope meter is an instrument used to help determine the speed that a passenger vehicle can comfortably travel around a curved roadway section. This instrument consists of a steel ball within a sealed, curved glass tube filled with an alcohol solution. The tube, bent on the arc of a circle, is graduated from 0 to 20 degrees, both to the left and right of the zero point. The tube is enclosed in a metal case. When mounting the ball-bank indicator, the vehicle should be in a stationary level position. The speedometer of the test vehicle must be accurately calibrated and the tires uniformly inflated. The indicator should be mounted vertically, with the steel ball at the zero point. All occupants who are to be in the vehicle when the observations are made should be in the same position when mounting or checking the instrument as when making the test drive. This is necessary because changing the position of a passenger or the load in the test vehicle may cause the vehicle body to tilt to the right or left. This tilting action or body roll will cause a change in the slope meter readings.

Procedures for Testing a Curve

The use of the slope meter or electronic meter to measure the comfortable speed on curves involves the efforts of two people - one to drive and the other to observe the meter. The following procedures should be followed for each test:

1. The curve under observation should first be appraised by the driver to determine the approximate safe speed that can be maintained.

2. The driver should then conduct the first test at a speed 10 mph below the appraised speed.
3. Each succeeding test should be made at a speed 5 mph greater than the preceding test, until the
meter has reached the degree of ball bank as shown in “Chart 6.5: Ball Bank Angles for Safe Turn
or Curve Speeds” found in Chapter 6 of this manual.

4. On each test, the driver should attain the trial run speed at a distance of at least 1/4 mile from the
beginning of the curve.

5. The course throughout the curve should be maintained precisely in the center of the lane and at
uniform speed. Using a vehicle with cruise control aids in this process.

6. The observer shall note carefully the position of the ball on the slope meter or the display on an
electronic meter at the approximate center of the curve and shall record the reading.

Curve Study Sheet
It is important that all information be recorded as indicated on a curve study sheet. As provided on the curve
study sheet, trial runs should be made in each direction. The ball bank angles in Chart 6.5 shall be used to
establish the safe speed on curves. As an example, for the speed range 35 mph and above, the comfortable
speed for the curve is the exact speed which swings the ball 12 degrees off center on a slope meter or displays
12 degrees on an electronic meter. Any speed which causes the ball to move more than 12 degrees away from
the zero position is considered uncomfortable to the driver and possibly unsafe at higher speeds.

14-7.00 ENGINEERING AND TRAFFIC INVESTIGATION REQUIREMENTS TO ESTABLISH OR
CHANGE REGULATORY SPEED LIMITS

14-7.01 Authority

Minnesota Statute Section 169.14 sets forth speed limits to govern all highways and alleys in the state. Any
posted speed limit greater or less than the statutory limits (Minn. Stat. Sec. 169.14, Subd. 2) must be authorized
by the Commissioner of Transportation. Any alteration of statutory speed limits on any public road or street
shall be based upon the results of an engineering and traffic investigation. It is MnDOT’s standard practice that
the entire trunk highway system shall have regulatory speed limits and the speed limits shall be determined
by an engineering and traffic investigation. The regulatory speed limit shall be effective when such signs are
erected.

The Commissioner delegates authority to the Assistant State Traffic Engineer, OTE, to authorize the
establishment of speed limits. The District Traffic Engineer is responsible for performing the engineering and
traffic investigation necessary for speed limit determination.

There are exceptions to the Commissioner’s authority to establish regulatory speed limits:

1. School zone speed limits on local roadways (see Minn. Stat. Sec. 169.14, Subd. 5a and MN
MUTCD, Part 7).

2. Work zone speed limits when workers are present (see Minn. Stat. Sec. 169.14, Subd. 5d and MN
MUTCD, Part 6).

3. Manufactured home parks and recreational areas (see Minn. Stat. Sec. 327.27, Subd. 2).

4. Roadways that have a designated bike lane (Minn. Stat. Sec. 160.263 and the MnDOT Bikeways
Facility Design Manual).

5. Speed limits within a park (Minn. Stat. Sec. 169.14, Subd. 5e).

14-7.02 Principles of Speed Zoning

The statutory speed limits described in Minn. Stat. Sec. 169.14, Subd. 2 are intended to provide uniformity for
typical highways, under ideal conditions, and no apparent hazards. Alteration of the statutory speed limits to
fit existing traffic and physical conditions of the highway constitutes the basic principle of speed zoning. The
Objective of correct speed zoning is to influence as many drivers as possible to operate at or near the same speed, thus reducing conflicts created by wide speed differentials. Wide differences in speed are statistically proven to contribute to crashes. A speed zone study is conducted to determine the maximum safe speed that should be posted for a particular location in order to provide continuity of traffic flow.

Correct and realistic speed zoning will serve to protect the public and regulate the unreasonable behavior of an individual. Recognizing that careful and competent actions of a reasonable driver should be considered legal, MnDOT has a responsibility to assure this protection. If a speed zone is determined by the actions of the majority of drivers on a highway, it will facilitate the most efficient and orderly movement of traffic by increasing driver compliance of a reasonable and prudent speed. The speed limit should aid the motorist in adjusting speed to the conditions and furnish police officers with an indication of what is excessive and unreasonable speed.

14-7.03 General Administrative Requirements and Procedures

Trunk Highways (Minn. Stat. Sec. 169.14, Subd. 4)

All speed limits on trunk highways are under the authority of the Commissioner of Transportation and not local authorities. Alteration of these speed limits is at the discretion of MnDOT. All trunk highways should be investigated at least once every ten years to ensure that every speed zone is appropriate. Any trunk highway that is reconstructed must also be investigated.

The District Traffic Engineer shall compile all supporting documentation along with a completed Trunk Highway Speed Limit Authorization Form (THSLA). The THSLA shall be written for the entire control section, even if only one portion is under explicit investigation. These documents shall be submitted to the Assistant State Traffic Engineer, OTE, for review and approval. After this review and approval, the authorization will be signed and returned to the district for implementation. When signs are erected, the new authorized speed limit will be enforceable.

Local Streets and Highways (Minn. Stat. Sec. 169.14, Subd. 5)

When a local authority deems an existing speed limit is not reasonable or safe on a road under its jurisdiction, and the roadway is not eligible for any other statutory speed described in Minn. Stat. Sec. 169.14, Subd. 2, the local road authority may request MnDOT to conduct an engineering and traffic investigation to determine the speed limit.

The procedure is for the local road authority to draw up a formal request for an investigation. The request should describe the road or street fully and indicate the exact termini of each section where an investigation is desired. This request should be submitted to the District Traffic Engineer to initiate the investigation by MnDOT. Before the investigation begins, it is important to discuss the possible impact of this request with the roadway authority. The roadway authority should be informed of any statutory speed limit options it may have overlooked.

The termini should describe a sufficiently long section (at least one quarter mile or more) to provide for a meaningful study. If MnDOT has issued previous authorizations for the requested section of road, the road authority should be notified to expand its request to ensure that there are no gaps or inappropriate overlapping authorizations. If the road authority (or the adjacent road authority) refuses expansion of the study, this should be documented and included with the study report when it is submitted to Central Office.

The District Traffic Engineer shall conduct the field investigation and prepare speed limit recommendations. The local authority should be furnished with a copy of the investigation results. These recommendations should be discussed with the local authority after completion of the investigation.

The District Traffic Engineer shall compile all supporting documentation along with a completed Local Speed Limit Authorization Form (LSLA). The LSLA shall be written for the roadway and extent agreed upon by the local authority and MnDOT. These documents shall be submitted to the Assistant State Traffic Engineer, OTE, for review and approval. After this review and approval, the authorization will be signed and returned to the local authority for implementation. When signs are erected, the new authorized speed limit will be enforceable.
14-7.04 Investigation Procedures

The posted regulatory speed limits should reflect off-peak hour traffic on an average weekday under ideal conditions, so that the road may be driven at the highest safe speed. Hazards such as weather, road surface conditions, or traffic congestion will negatively impact a proper investigation.

Factors to Determine Appropriate Speed Limits

Prevailing speeds, physical features, crash experience and traffic characteristics are the primary factors in determining the appropriate speed limit. The most revealing factor is the 85th percentile speed from a spot speed study. This is the speed that 85 percent of observed traffic is traveling at or below. The 85th percentile speed reflects a safe and reasonable speed for existing conditions. Using the 85th percentile speed recognizes the need for compliance which is necessary to establish an enforceable limit.

Collecting Speed Samples

Using calibrated radar or lidar tools to collect samples, the 85th percentile speed is usually at or near the upper limits of the 10 mile per hour pace speed – the 10 mph window that contains the majority of samples. Posting a speed limit near the 85th percentile speed will result in the highest percentage of drivers being grouped in the pace speed. Speed limits less than the midpoint of the 10 mph pace should be avoided as they tend to increase the relative speed differentials among vehicles.

Speed samples should be collected during low-congestion periods in order to minimize the impact of these hazards. Intersections alone do not necessitate a reduction in speed, but the traffic congestion that occurs near intersections does affect speed. The 85th percentile speed will reflect the maximum safe speed for the roadway without measuring the impact of each factor.

Number of Vehicles Sampled

A minimum of 100 free-flowing vehicles should be sampled on roadways with more than 1000 Average Annual Daily Traffic (AADT). On roadways with less than 1000 AADT, a minimum of 30 free-flowing vehicles should be sampled. In both scenarios, the study should be discontinued after two hours. Free-flow vehicles are those drivers choosing their own speed with at least 6 second headway. Only the speed of the first vehicle in a platoon should be sampled. Cars involved in passing maneuvers or slowing to make turns should not be sampled. Speeds of trucks and buses should be sampled separately, to determine if they are over-represented on the roadway.

Sample Locations

Care should be taken to select locations sufficiently removed from any stop signs, traffic signals, or other traffic flow interruptions that significantly affect operating speeds. Mid-block locations generally represent typical flow conditions for accurate sampling in urban areas. In rural areas, the spacing of speed check locations may be at much greater intervals so long as they reflect the general speed pattern and roadway design and roadside features.

In all situations, the roadway section under investigation should be test-driven by experienced MnDOT staff to ensure the uniformity of the recommended speed limit as well as how well it transitions into the speed zones at both termini by driving a minimum of 10 seconds beyond the termini of the investigation area. The test drive is particularly important in locations where traffic flow is too low to provide meaningful samples.

Crash Experience

Crash experience shall be reviewed for the preceding 3-year period. Many requests for speed studies are initiated by the public after a specific crash. It is important to review the crash history of the study area to determine if there is a problem that should be resolved independent of the speed limit. Crashes involving tailgating, illegal passing maneuvers, or other aggressive factors can be associated with a large speed differential.

14-7.05 Conditions Justifying Variations from the 85th Percentile Speed

The approved posted speed should normally be the nearest value below the 85th percentile speed which ends in 5 or 0. Conditions which justify varying the zone speed from the 85th percentile speed are:
1. Different speed limits may be established for opposing directions if sampled directional speed differences are greater than 10 mph. Enforcement officials should be notified of this decision.

2. Speed limits may be authorized 5 mph under the 85th percentile speed when there is an exceptionally high crash history involving crashes of a type that would be reduced by enforcement of a lower speed limit. A lower speed limit shall only be established only after the commitment of reasonable enforcement is assured and documented.

3. If the study area is of a continuous curvilinear design, the area should be test driven and a ball bank survey done. Radar checks should be made at midpoints of tangents (if available) and used as a guideline for determining reasonable values. The controlling factor of the speed limit will be the average of the safe speeds as determined by the ball bank survey. Individual curves will still have to be checked and advisory speeds posted where necessary.

4. When physical features at spot locations such as limited sight distance, narrow bridges, blind intersections, or potential hazards such as pedestrians or children in unfenced playgrounds occur, the use of warning signs and advisory speeds should be considered.

5. Transition zones may be used to accomplish a gradual reduction from higher speeds to a lower speed. Transition zones on an approach to a city are where speeds fluctuate. The sections of such a zone may be as short as one quarter mile. The change in speed for a transition zone should be 10 or 15 mph, not lower or higher. Speed samples collected at these points will show large differences for opposing directions, but a single speed limit value is appropriate.

14-7.06 Speed Zones on Gravel Roads

Gravel roads have considerable differences from paved roads. Typically, gravel roads are designed with minimal design criteria, are subject to fluctuating surface conditions, have low enforcement priority, and serve low ADT's usually comprised of local repeat traffic. The principles of speed zoning are described in the ITE Traffic Engineering Handbook (6th Edition). In summary they address reduced stopping distance, traffic flow, capacity, safety, and crash severity reduction. It is very difficult to equate these principles with the conditions that usually exist on a gravel road. Due to these principles and the operational characteristics of gravel roads, MnDOT has generally not set speed limits on gravel roads and has relied on the “Basic Rule” described in Minn. Stat. Sec. 169.14, Subd.1.

It is the policy of MnDOT to evaluate gravel roads based on the merits of the principles described above and if these principles are not met or there will be no improvement in the operation or safety of the road, then a reduced speed limit will not be authorized. MnDOT will, however, honor all requests to investigate any type of road and perform the traffic investigation.

To aid the investigation teams, the following list of typical qualifications should be used in the first phase of an investigation in order to facilitate the team's prompt judgment of whether or not a speed limit should be established on a gravel road.

1. Speed limits are not necessary on gravel roads that are:
   a. Having dust problems.
   b. DEAD END roads.
   c. Not a connecting road between arterial roads or major traffic generators.
   d. Non-collector roads that serve scattered local residents only.
   e. Prone to other enforcement-related problems.

2. Speed limits may be beneficial on gravel roads that are:
   a. Serving as a connector between two paved roads as one continuous roadway.
   b. Densely populated with seasonal homes and cabins.
All gravel road speed limit authorizations will include a contingency that will void the speed limit authorization in the event that the gravel road is paved or reconstructed with new alignment or grade.

14-7.07 Checklist of Items Submitted with a Speed Report

1. Copy of request for initiating a study from the road authority.
2. Cover Letter from the District Traffic Engineer summarizing the investigation, feedback from the road authority (for local roadways), and any other essential findings.
3. Related correspondence from officers, citizens, or political factions (if available).
4. Map(s) of the area investigated at a scale capable of depicting crossing roadway names and jurisdictional boundaries as well as locations of speed samples taken.
5. Roadway Summary Form describing the roadway width, shoulder width, surface type and condition, AADT, test run speeds, and crash summary.
6. Log of buildings, entrances, and general development along the road (map or video footage may be substituted).
7. Log of traffic signals, signs, and markings (map or video footage may be substituted).
8. Log of vertical curves (map or video footage may be substituted).
9. Log of school zones, playgrounds, or other special zones (map or video footage may be substituted).
10. Speed sample form for each location sampled.

14-8.00 REFERENCES

1. 2014 Minnesota Statutes
2. Minnesota Administrative Rules
5. MnDOT Technical Memoranda
# CHAPTER 15 - TRAFFIC ENGINEERING ORGANIZATION (TEO)

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15-1.00 INTRODUCTION

15-1.01 Introduction

To provide a forum for sharing new ideas, experiences, and the opportunity to discuss general traffic engineering topics of mutual interest, the Traffic Engineering Organization (TEO) was established to better address the traffic engineering challenges of the present and the future. These challenges include the need to:

1. Remain innovative and flexible in order to maximize the traffic safety and operations benefits derived from the utilization of limited available funding for improvements.
2. Maximize the utilization of existing corridors for increasing traffic volumes.
3. Accommodate other modes of travel, including non-motorized users and non-traditional vehicles.
4. Take the initiative on matters affecting traffic safety and engineering within MnDOT.

15-1.02 Purpose

Deliberate and active pursuit of the following purposes of the TEO will produce effective cooperation within MnDOT and other agencies, and will provide better service to the traveling public.

1. Provide leadership and promote uniformity in traffic engineering practices and policies within MnDOT.
2. Play a cooperative role in addressing traffic engineering topics that affect the Districts.
3. Communicate, obtain information, and exchange ideas with other traffic engineers, MnDOT groups, other agencies, and outside groups and organizations; and become aware of and act on issues affecting MnDOT.
4. Make recommendations for the implementation of solutions to traffic problems of a department wide nature.
5. Stay abreast of new technology and methods and promote the implementation of new technology in daily practice.
6. Continue relationships with District staff and assist them in solving problems affecting District operations.
7. Provide leadership to identify, design, and deliver continuing education courses for traffic engineering professionals.

15-1.03 Committees

MnDOT has adopted a general organizational philosophy of decentralization. With regard to the Districts, the role of the Office of Traffic Engineering (OTE) is to provide leadership, education, standards and policies, technical expertise, and support.

The District Traffic Engineering Offices are largely responsible for direct public and agency contact on specific issues, as well as program delivery and traffic operations in the field.

In order to maintain efficiency in the working relationships between the Central and District Traffic Offices, MnDOT has adopted a formal TEO structure, which consists of the following committees:

- Full Committee
- Executive Committee
- Standing Committees
• Ad-Hoc Committees
• Sub Committees

**Full Committee**

1. Membership

Membership consists of the following:

- State Traffic Engineer
- Assistant State Traffic Engineers
- Functional Area Supervisors from OTE
- District Traffic Engineers (DTEs)
- Director of the Regional Transportation Management Center (RTMC)
- Director of the CAV-X office
- State TSMO Director
- Director of Electrical Services
- Geometrics Engineer in the Office of Project Management & Technical Support
- MnDOT State Aid representative
- Representative from the Traffic Data Analysis unit in the Office of Transportation System Management
- FHWA Safety and Traffic Operations Engineers.
- Others may be invited by TEO members to attend and participate in the meetings as non-voting members.

2. Responsibilities

Responsibilities of the Full Committee are to:

a. Provide overall direction and guidance to MnDOT on traffic policy, operation, and uniformity.

b. Recommend formal positions of the Organization.

c. Initiate action on items needing work.

d. React to items in which input from the Full Committee is desired.

e. Exchange information related to traffic engineering issues.

3. Meetings

The responsibilities identified in number 2 above are accomplished during Full Committee meetings. There are two types of meetings: Semi-Annual meetings and Information Exchange meetings.

a. Full Committee Semi-Annual meetings are face-to-face in order to exchange information, provide an opportunity to build relationships and work on traffic engineering issues. Meeting locations are rotated between the greater Minnesota Districts and the Twin Cities Metropolitan area, with responsibility for the Twin Cities Metropolitan area meeting rotating between Metro Traffic, RTMC, CAV-X, Electrical Services and OTE.

At Full Committee Semi-Annual meetings there are two officers, the Chair and the Recorder. Chair duties are assumed by the host district or office. Recorder duties will be assigned by the host district or office.
b. Information Exchange meetings are held monthly via video conferencing or other remote participation method. These meetings are chaired by the State Traffic Engineer. OTE will provide a recorder for Information Exchange meetings.

4. Chair duties

a. The Chair of the semi-annual meeting has the duty to arrange meeting times and facilities with the Executive Committee and to govern activities at the semi-annual meeting.

b. The Chair of the Information Exchange has the duty to arrange meeting times and remote participation method.

5. Recorder duties

a. The Recorder requests agenda items, prepares the agenda in consultation with the State Traffic Engineer and distributes the agenda for the meeting.

b. The Recorder also takes appropriate notes and distributes them in final form to the mailing list as soon as possible after the meeting. Action items indicating who is responsible for follow-up are to be highlighted in the notes.

Executive Committee

1. Membership

Membership consists of the following:

- State Traffic Engineer
- Three non-Metro DTEs
- Metro DTE

Non-voting members include the following:

- Assistant State Traffic Engineers
- Director of Electrical Services

If a member is unavailable, an alternate should attend in their place. It is the responsibility of the member to arrange for their alternate.

After the last meeting of each year one non-Metro DTE will rotate off the committee and another will rotate on to serve on the Executive Committee for a three year term. District membership will progress in order by district number. Any vacancies that occur during the year will be filled on an interim basis by majority vote of the remaining Executive Committee members.

2. Responsibilities

Responsibilities of the Executive Committee are to:

a. Vote on traffic engineering items brought to it by the Standing Committees or the Full Committee. Items may include the following:

- Changes to the Traffic Engineering Manual
- Significant changes to other traffic engineering documents
- Significant changes to traffic engineering policies and processes
- Controversial issues needing an official TEO position
- Other significant issues referred to the Executive Committee

b. Be the contact body for the Organization.

c. Coordinate and direct the working activities of the Organization.

d. Assist the State Traffic Engineer in recommending policy to MnDOT staff.

e. Assist the chair of the Full Committee in arranging the meetings.
f. Identify and present to the Full Committee those items in which input is requested.

g. Make decisions on behalf of and speak for the Full Committee.

h. Periodically review the operating procedures of each Standing Committee, Ad Hoc committee, and Sub-committee to “fine tune” them as needed.

i. Evaluate and approve scientific equipment requests for traffic engineering uses.

j. As appropriate, seek the desires of the other TEO members regarding standing Committee assignments and then make appointments. The Executive Committee will resolve all assignment conflicts by majority vote.

3. Meetings

Executive Committee meetings are held monthly via video conference or other remote participation method. The meetings will typically follow the Information Exchange meeting.

4. Chair duties

The State Traffic Engineer will serve as the Chair of the Executive Committee. In the absence of the Chair, another voting or non-voting member of Executive Committee may temporarily serve as Chair. The responsibilities of the Chair are to:

a. Call meetings of the Executive Committee as needed.

b. Serve as the initial principal contact of the Full Committee for other people or groups.

5. Recorder duties

OTE will provide the Recorder for the Executive Committee. The recorder will call for agenda items, prepare the agenda and take minutes for the Executive and Information Sharing meetings. Minutes and appropriate attachments will be distributed to all TEO members.

In order to maintain transparency and provide for appropriate consideration of TEO decisions, Executive Committee agendas and materials should be made available at least 2 weeks prior to the Executive Committee meeting date for agenda items that will result in a decision. Minutes should be provided within one week of the meeting date.

6. Liaison with other groups

A member of the Executive Committee, or one of the OTE Assistant State Traffic Engineers serves as the TEO contact with the Operation Managers Group (OMG), the Construction Managers Group (CMG), the Pre-Construction Managers Group (PCMG), the Office of Technical Support, and the District Operation Division's staff.

**TEO Standing Committees**

The TEO has nine Standing Committees.

1. Active Transportation
2. ITS
3. Lighting
4. Operations
5. Pavement Marking
6. Safety
7. Signals
8. Signing
9. Temporary Traffic Control

1. Membership

Each Standing Committee should consist of at least one member from OTE, two DTE’s or their representatives, and additional members as deemed appropriate. Other non-members may be invited to attend, but are not allowed to vote.

Appointments to the Standing Committees will be recommended by the Standing Committee Chair and approved by the Executive Committee. Individual desires will be accommodated as much as possible.

2. Responsibilities

The responsibilities of the Standing Committees are to:

a. Review, evaluate, and report to the Executive Committee on matters that have been referred to it.

b. Identify issues related to their focus area and provide recommendations to the Executive Committee for consideration including corresponding updates to the appropriate TEM chapter and other related technical documents.

c. Act as a resource group by serving on other MnDOT committees or task forces at the request of the Executive Committee.

d. Assist other Standing Committees when issues overlap.

e. Report on activities to the Full Committee and/or the Executive Committee as requested or as appropriate.

3. Meetings

a. Standing Committee meeting schedules and mode are determined by the individual Standing Committees. Most committees will want to meet at least twice during a year, between the face to face Full Committee meetings. Many committees will meet more often.

4. Chair duties

A member of the Full Committee appointed by the Executive Committee will serve as Chair of the Standing Committee. Normally, this person will be the OTE functional area engineer or their appointee.

The Standing Committee Chair will be responsible for:

a. Organizing the work of the Committee.

b. Keeping the Executive Committee informed on activities.

c. Ensuring that Committee work is well documented.

5. Recorder duties

The chair will appoint a Recorder for the Standing Committee. The Standing Committee Recorder will be responsible for:

a. Creating and distributing an agenda for Standing Committee meetings. The Recorder will distribute the agenda to the Full Committee in addition to the members of the Standing Committee. If the agenda includes voting on an issue, the agenda must be distributed at least one week prior to the Standing Committee meeting date.
b. Recording and distributing minutes. The minutes should be distributed as soon as possible after the Standing Committee meeting date and should include any decisions, votes and action items with responsible person.

Ad Hoc Committees

Ad Hoc committees will be established by the Executive Committee or Standing Committees as necessary.

1. Membership
   Membership will consist of a Chair and at least two other people with appropriate backgrounds (within or outside of MnDOT).

2. Responsibilities
   Responsibilities for each Ad Hoc Committee will be determined by the requesting authority.

3. The requesting authority will disband the Ad Hoc Committee when its charge is completed.

Sub-Committees

1. The Full Committee, any Standing Committee or an Ad Hoc Committee may establish one or more Sub-committees to assist in carrying out its responsibilities.

2. Sub-Committees will serve at the discretion of the Committee Chair.

3. DTE/OTE Sub-Committee
   The Full Committee has established a DTE/OTE Sub-Committee that consists of all the DTEs and the State Traffic Engineer and Assistant State Traffic Engineers from OTE. The DTE/OTE Sub-Committee may meet in conjunction with the Full Committee semi-annual face to face meetings and/or may meet separately. Recommended to meet quarterly. OTE Sub-Committee members will serve as chair and recorder.

15-1.04 Documentation

It is imperative that work done and decisions made within the TEO are well documented. The Executive, Standing, Ad Hoc, and Sub-Committee Chairs are responsible for keeping accurate written documentation of their activities.

The State Traffic Engineer will maintain a web-based record of meeting minutes of all TEO group activities. This will serve as the official record of the TEO's activities. Minutes will be stored for a time period consistent with MnDOT record retention policy.

The State Traffic Engineer will ensure that the appropriate parties incorporate all issues resolved by the TEO into the appropriate manuals and other technical documents.

15-1.05 TEO Scientific Equipment Process and Guidelines

The TEO Scientific Equipment Budget exists to provide a funding source for scientific equipment for traffic related functions. The Traffic Engineering Organization Executive Committee approves TEO scientific equipment requests and has established the following guidelines for distribution of the budget:

1. The Office of Traffic Engineering (OTE) will send out a notice to the DTEs near the mid-point of the fiscal year asking for TEO scientific equipment purchase requests.

2. Confer with your coworkers within your district or division to establish a combined, prioritized, and itemized list of fiscal year needs. This should be your “best guess” of your fiscal year needs.

3. Submit a prioritized and itemized request to the TEO Executive Committee. The request should include information regarding vendor, manufacturer, model information, estimated cost
and a MnDOT contact person to respond to any questions about individual requests. The cost estimate included with the request should identify if delivery is or is not included and should not include tax. Use the form for submitting each request.

4. The TEO Executive Committee will review all requests submitted at their regularly scheduled meetings and will approve expenditures. The TEO Executive Committee will maintain a spreadsheet, by fiscal year, of all requests, approvals, and acquisitions. After each review of requests, the TEO Executive Committee will update the spreadsheet.

5. OTE will act as custodian of the funds, completing the purchasing activities and updating the spreadsheet with actual cost information.

6. As the fiscal year progresses, additions may be made to previous requests if available funds still remain within the budget. Revised request lists submitted to the TEO Executive Committee should clearly indicate what items are NEW requests.

Guidelines for Requests:

- The budget is for equipment necessary to integrate systems, deliver the program (inspection and operation), maintain, retrofit, construct, operate and manage systems.

- Acquisitions must be related to traffic functions.

- Preference will be given to requests that will demonstrate innovation that can be considered for more widespread future adoption.

- Acquisitions should be over $1,500 (equipment for lesser amounts should be handled within office budget).

- The budget is not for vehicle acquisition.

- The budget is not for office PC acquisition or office software acquisition. (Software integral to the operation of the equipment being procured is eligible.)

- Ongoing operational, maintenance or license fees are not eligible.
# Scientific Equipment Request Form

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<tbody>
<tr>
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<td>Activity Code:</td>
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**Purpose of the equipment:**

**Benefits to the Division/District:**

**Date Approved by TEO Executive Committee:**

*Attach specifications if available.*