



Minnesota Department of Transportation

Office of Traffic, Safety, and Technology

Mail Stop 725,
1500 West County Road B2
Roseville, MN 55113

Date: October 20, 2015

Re: 2015 Traffic Engineering Manual Update

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,

A handwritten signature in black ink that reads "Susan M. Groth".

Susan M. Groth, PE, PTOE
State Traffic Engineer

An Equal Opportunity Employer



CHAPTER 1 - GENERAL INFORMATION

Table of Contents

1-1.00 INTRODUCTION	1-2
1-1.01 Purpose of the Traffic Engineering Manual	1-2
1-1.02 Scope of the Manual.....	1-2
1-1.03 Organization of the Manual	1-3
1-1.04 Revisions	1-4
1-2.00 OFFICE OF TRAFFIC, SAFETY, AND TECHNOLOGY FUNCTIONS	1-4
1-2.01 MnDOT Organization.....	1-4
1-2.02 OTST Organization.....	1-4
1-2.03 OTST Functions and Responsibilities	1-5
1-2.04 Delegation of Authority	1-8
1-3.00 DISTRICT TRAFFIC ENGINEERING FUNCTIONS.....	1-8
1-3.01 General Functions of the District Traffic Engineering Staff.....	1-8
1-3.02 Specific Functions	1-8
1-4.00 TRAFFIC ENGINEERING ORGANIZATION.....	1-12
1-4.01 Introduction.....	1-12
1-4.02 Purpose	1-12
1-4.03 Structure and Procedures.....	1-12
1-4.04 Documentation	1-16

CHAPTER 2 - TRAFFIC LAWS

Table of Contents

2-1.00 INTRODUCTION	2-3
2-1.01 Purpose	2-3
2-1.02 Scope	2-3
2-1.03 Chapter Organization	2-4
2-2.00 GLOSSARY	2-4
2-3.00 LEGAL RESPONSIBILITIES	2-5
2-3.01 General Powers of the Commissioner	2-5
2-3.02 Legal Responsibilities of a Local Authority	2-6
2-3.03 MnDOT Approvals	2-6
2-4.00 SIGNS, SIGNALS, AND MARKINGS	2-6
2-4.01 Minnesota Manual on Uniform Traffic Control Devices	2-7
2-4.02 Placement and Maintenance Signs, Signals, Markings	2-7
2-4.03 Unauthorized Sign, Signal, or Marking	2-7
2-4.04 Prohibited Light or Signal	2-8
2-4.05 Railroad Stop Crossings	2-8
2-4.06 Vandalism	2-8
2-5.00 SPEED RESTRICTIONS	2-8
2-5.01 Duty to Drive with Due Care	2-8
2-5.02 Authority to Establish Speed Limits	2-8
2-5.03 Speed Limits	2-8
2-6.00 NO PASSING ZONES AND LANE DESIGNATIONS.....	2-11
2-6.01 No Passing Zones	2-11
2-6.02 Lane Designations	2-11
2-7.00 THROUGH HIGHWAYS AND CONTROLLED ACCESS HIGHWAYS.....	2-11
2-7.01 Through Highways	2-11
2-7.02 Controlled Access Highways	2-11
2-8.00 PARKING REGULATIONS.....	2-11
2-8.01 General Regulations	2-11
2-8.02 Limited Time Parking	2-12
2-8.03 Parking Meter Zones	2-12
2-8.04 Disabled Parking	2-12
2-8.05 Angle or Parallel Parking	2-12
2-8.06 Parking on One-Way Streets	2-13
2-9.00 LOAD RESTRICTIONS	2-13
2-9.01 General Load Restrictions	2-13
2-9.02 Seasonal Restrictions	2-13
2-9.03 Truck Routes	2-13
2-9.04 Load Permits	2-13
2-10.00 ADVERTISING DEVICES	2-14
2-10.01 Minnesota Outdoor Advertising Control Act	2-14
2-10.02 Resort and Camping Information Signs (County Slat Sign Program).....	2-15
2-10.03 Specific Service Signs	2-15
2-10.04 LOGO Sign Franchise Program	2-15
2-10.05 Directional Signs (Advertising Devices) - Minn. Stat. Sec. 173.081	2-15

2-11.00 PERMITS.....2-16
2-11.01 General.....2-16
2-11.02 Studded Tire Permits.....2-16
2-11.03 Parade Permits.....2-16
2-11.04 Entrance Permits.....2-16
2-11.05 Special Event Permits and Agreements2-16

2-12.00 OTHER LEGAL CONSIDERATIONS2-17
2-12.01 Particular Use of Right-of-Way - Minn. Stat. Sec. 160.27.....2-17
2-12.02 Plat Review - Minn. Stat. Sec. 505.03.....2-17
2-12.03 Technical Assistance - Minn. Stat. Sec. 161.39.....2-17
2-12.04 Bridge Width and Clearance Requirements2-18

2-13.00 REFERENCES.....2-18

CHAPTER 3 - FREEWAY CORRIDOR TRAFFIC MANAGEMENT

Table of Contents

3-1.00 INTRODUCTION	3-2
3-1.01 Purpose	3-2
3-1.02 Chapter Organization	3-2
3-2.00 GLOSSARY	3-2
3-3.00 REGIONAL TRANSPORTATION MANAGEMENT CENTER (RTMC)	3-3
3-4.00 SURVEILLANCE SYSTEMS	3-4
3-4.01 Purpose	3-4
3-4.02 Electronic Vehicle Detectors	3-4
3-4.03 Closed-Circuit Television (CCTV)	3-4
3-4.04 Radio Relay of Visual Observations	3-5
3-5.00 CONTROL SYSTEMS	3-5
3-5.01 Purpose	3-5
3-5.02 Ramp Control Signal Systems	3-5
3-5.03 Ramp Meter Algorithm	3-6
3-5.04 Ramp Design	3-6
3-5.05 Lane Control Signals	3-6
3-6.00 PREFERENTIAL TREATMENT SYSTEMS FOR HIGH OCCUPANCY VEHICLES AND	
MNPASS	3-7
3-6.01 Purpose	3-7
3-6.02 Preferential Treatment Ramps	3-7
3-6.03 MnPass Express Lanes	3-7
3-6.04 Reversible Lanes	3-7
3-6.05 Team Transit	3-8
3-7.00 INCIDENT MANAGEMENT	3-8
3-7.01 Purpose	3-8
3-7.02 Incident Detection and Response	3-8
3-7.03 Motorist Information and Route Guidance	3-8
3-7.04 Emergency Response Vehicles	3-9
3-8.00 COMPUTER SYSTEMS	3-9
3-8.01 Purpose	3-9
3-8.02 Field Microprocessor Activities	3-10
3-8.03 Intelligent Roadway Information System (IRIS)	3-10
3-8.04 Communication with Field Microprocessors	3-10
3-8.05 Communication with Control Center Devices	3-10
3-8.06 Operational Reports	3-10
3-8.07 Data Retention	3-10
3-8.08 Research and Statistical Reporting	3-11

TRAFFIC RESEARCH

Table of Contents

4-1.00 INTRODUCTION	4-2
4-1.01 Purpose	4-2
4-1.02 Scope	4-2
4-2.00 ROLE OF TRAFFIC RESEARCH	4-2
4-3.00 TRAFFIC RESEARCH PROGRAM	4-2
4-4.00 INDIVIDUAL ROLES IN TRAFFIC RESEARCH	4-3

CHAPTER 5 - INTELLIGENT TRANSPORTATION SYSTEMS

Table of Contents

5-1.00 INTRODUCTION	5-3
5-1.01 Purpose	5-3
5-1.02 Scope	5-3
5-1.03 Chapter Organization	5-3
5-2.00 GLOSSARY	5-4
5-2.01 Definitions	5-4
5-2.02 Acronyms	5-7
5-3.00 SYSTEMS ENGINEERING PROCESS	5-9
5-3.01 Regional ITS Architecture	5-9
5-3.02 Concept of Operations	5-11
5-3.03 System Requirements	5-11
5-3.04 Detailed Design Documents	5-11
5-3.05 Test and Acceptance Plans	5-11
5-3.06 Operations and Maintenance Plan	5-11
5-4.00 ITS PLANNING GUIDANCE	5-11
5-4.01 Closed Circuit Television (CCTV)	5-12
5-4.02 Dynamic Message Signs (DMS)	5-12
5-4.03 Highway Advisory Radio (HAR)	5-13
5-4.04 Road Weather Information Systems (RWIS)	5-13
5-4.05 Variable Speed Limits (VSL)	5-13
5-4.06 Dynamic Speed Display Signs (DSDS)	5-13
5-4.07 Ramp Meters	5-14
5-4.08 Curve Warning Systems	5-14
5-4.09 Intelligent Work Zones (IWZ)	5-14
5-4.10 Intersection Conflict Warning Systems (ICWS)	5-15
5-5.00 ITS SYSTEMS	5-15
5-5.01 Archived Data Management (AD)	5-18
5-5.02 Advanced Traveler Information Systems (ATIS)	5-18
5-5.03 Advanced Traffic Management Systems (ATMS)	5-19
5-5.04 Advanced Public Transportation Systems (APTS)	5-37
5-5.05 Commercial Vehicle Operations (CVO)	5-38
5-5.06 Emergency Management (EM)	5-39
5-5.07 Maintenance and Construction Management (MCM)	5-39
5-5.08 Advanced Vehicle Safety Systems (AVSS)	5-45
5-6.00 POWER, COMMUNICATIONS, AND CONTROL	5-46
5-6.01 Source of Power	5-46
5-6.02 Electronic Communications	5-46
5-6.03 System Control Software	5-47
5-7.00 ITS DEVELOPMENT	5-47
5-7.01 Role of the Office of Traffic, Safety, and Technology (OTST)	5-47
5-7.02 ITS Office and District Project Solicitation	5-48
5-8.00 INTERAGENCY AGREEMENTS	5-49
5-9.00 REFERENCES	5-49

List of Figures

Figure 5-1	Highway Advisory Radio (HAR) Sign (Iowa DOT)	5-19
Figure 5-2	CCTV Camera	5-20
Figure 5-3	Example Dynamic Message Sign	5-23
Figure 5-4	Dynamic Speed Display Sign	5-24
Figure 5-5	Intelligent Lane Control Signals	5-26
Figure 5-6	Intelligent Lane Control Sign Options	5-26
Figure 5-7	Ramp Meter	5-27
Figure 5-8	Variable Speed Limit (VSL) Signs	5-31
Figure 5-9	Curve Warning Systems	5-32
Figure 5-10	Loop Based Wrong Way Detection	5-36
Figure 5-11	WIM System	5-38
Figure 5-12	RWIS System	5-43
Figure 5-13	RICWS Minor Road Warning	5-45
Figure 5-14	RICWS Major Road Warning	5-45
Figure 5-15	IRIS DMS Display	5-47

List of Tables

Table 5-1	MN ITS Development Objectives	5-16
-----------	-------------------------------------	------

CHAPTER 6 - TRAFFIC SIGNS AND DELINEATION

Table of Contents

6-1.00 INTRODUCTION	5
6-1.01 Purpose	5
6-1.02 Scope	5
6-1.03 Chapter Organization	5
6-2.00 GLOSSARY	6
6-3.00 LEGALITY - LEGAL AUTHORITY FOR PLACEMENT OF TRAFFIC SIGNS	9
6-3.01 Traffic Signs Installed by MnDOT Maintenance Forces	9
6-3.02 Traffic Signs Installed by Contract	9
6-3.03 Traffic Signs Installed by Others by Maintenance Permit	9
6-4.00 GENERAL PRINCIPLES OF TRAFFIC SIGNING	9
6-4.01 Principles of Traffic Control Devices	9
6-4.02 Basic Considerations for Installation of Traffic Signs	9
6-4.03 Functional Classifications of Traffic Signs	10
6-4.04 Department Classification by Sign Design Type	11
6-4.05 Elements of Traffic Sign Design	14
6-4.06 Lateral Offset and Vertical Clearance Requirements	16
6-4.07 Sign Installation and Maintenance Practices	17
6-4.08 Implementation of Signing	19
6-5.00 APPLICATION GUIDELINES-REGULATORY SIGNS	21
6-5.01 Purpose	21
6-5.02 Typical Sign Placement	21
6-5.03 Bridge Speed and Load Restrictions	22
6-5.04 Bus Shoulder Sign (R4-X7)	24
6-5.05 BYPASS LANE Sign (R4-X8) and BYPASS AND TURN LANE Sign (R4-X8a)	24
6-5.06 DO NOT PASS Sign (R4-1)	24
6-5.07 Flashing LED STOP and YIELD Signs	24
6-5.08 In-Street Pedestrian Crossing signs (R1-6 series)	26
6-5.09 Intersection Stop Control	26
6-5.10 Lane Designations	27
6-5.11 Passing Lane Sections	27
6-5.12 RIGHT LANE MUST TURN RIGHT Sign (R3-7) and LEFT LANE MUST TURN LEFT Sign (R3-7)	27
6-5.13 SLOWER TRAFFIC MOVE RIGHT Sign (R4-3a)	28
6-5.14 Speed Zone Signing	28
6-5.15 TRUCK ROUTE (R14-1)	29
6-5.16 TRUCK STOPPING LANE (R4-X4) at Railroad Crossings	29
6-5.17 Two-Way Snowmobile Trail Signing	29
6-5.18 VEHICLE NOISE LAWS ENFORCED Sign (R16-X13)	30
6-6.00 APPLICATION GUIDELINES - WARNING SIGNS	31
6-6.01 Purpose	31
6-6.02 Acceleration Lane Signing (W6-X1, W6-X2, and W20-X3)	31
6-6.03 Advance Warning Signs on Local Road Approaches (W2-6a, W3-1, W3-2, and W3-3)	31
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)	32
6-6.05 Advisory Speed Plaque (W13-1P)	32
6-6.06 BRIDGE ICES BEFORE ROAD Sign (W8-13)	32

6-6.07	Channelized Intersections	32
6-6.08	Chevron Alignment Sign (W1-8)	33
6-6.09	Non-Vehicular and Vehicular Traffic Warning Signs	34
6-6.10	Low Clearance Sign (W12-2)	35
6-6.11	No Passing Zones	35
6-6.12	Passing Lane Sections	36
6-6.13	SCHOOL BUS STOP AHEAD Sign (S3-1)	36
6-6.14	SHARE THE ROAD Plaque (W16-1P) with BICYCLE WARNING Sign (W11-1)	36
6-6.15	SHOULDER NARROWS Sign (W5-X1) and NO SHOULDER Sign (W8-23).....	37
6-6.16	Speed Reduction Sign (W3-5).....	37
6-6.17	Truck Hauling Signs.....	38
6-6.18	Typical Signing for Transitions Between Divided Highway Section and Two-Lane, Two-Way Sections	38
6-6.19	Truck Rollover Warning Sign (W1-13)	38
6-6.20	WATCH FOR BUSES ON SHOULDER Sign (W14-X9)	38
6-6.21	WATCH FOR FALLEN ROCK (W14-X1)	38
6-6.22	WEIGHT RESTRICTION AHEAD Sign (W14-X3)	38
6-7.00	APPLICATION GUIDELINES - GUIDE SIGNING	39
6-7.01	Purpose	39
6-7.02	Freeways	39
6-7.03	Signing Destinations	39
6-7.04	Typical Junction Signing Layouts	41
6-7.05	Independent Route Marker Assemblies.....	42
6-7.06	Street Name Signs, Advance Street Name Signs, and 911 Address Signs.....	44
6-7.07	Boundary Signs	46
6-7.08	Designated Roadways.....	52
6-7.09	Supplemental Guide Signing Programs	54
6-7.10	External Sign Variance Committee	58
6-7.11	Dakota and Ojibwe Language Signing Program	59
6-8.00	APPLICATION GUIDELINES - MISCELLANEOUS SIGNS	62
6-8.01	Adopt-A-Highway Sign Program (I-X1).....	62
6-8.02	Adopt-A-Rest Area Sign Program.....	62
6-8.03	Community Wayfinding Sign Program	63
6-8.04	Emergency 911 sign	65
6-8.05	Reference Location Sign (D10-1, D10-2, and D10-3)	65
6-8.06	Rest Area Signing	66
6-8.07	Road/Weather Information System (R/WIS) sign	67
6-8.08	Seat Belt Sign (R16-X11 and R16-X12)	67
6-8.09	Enhanced Conspicuity of Standard Signs	67
6-8.10	Unauthorized Sign Attachments	67
6-8.11	Test Section Signing	67
6-9.00	OBJECT MARKERS	68
6-9.01	Purpose	68
6-9.02	Types of Object Markers.....	68
6-9.03	Applications and Guidelines	68
6-10.0	DELINEATORS	70
6-10.01	Purpose	70
6-10.02	Types of Delineators.....	70
6-10.03	Placement	70
6-10.04	Applications and Guidelines	70
APPENDIX A	MNDOT SUPPLEMENTAL GUIDE SIGNS	148

List of Figures

Figure 6.1 Sign Placement 72

Figure 6.2 Regulatory Signs on Divided Highways at Entrances 73

Figure 6.3 Regulatory Signs for Divided Highway - T Intersections 74

Figure 6.4 Regulatory Signs for Divided Highway Intersections - Medians Less than 30 Ft. Wide 75

Figure 6.5A Regulatory Signs on Divided Highways at Entrances 76

Figure 6.5B Regulatory Signs on Divided Highways at Entrances 77

Figure 6.6 Regulatory Signs on Divided Highway Intersections with Frontage Roads 78

Figure 6.7 Regulatory Signs on Divided Highway Intersections with a One-Way Street/Ramp 79

Figure 6.8 Extended Left Turn Lane 80

Figure 6.9 Highway Intersections with One-Way Street/Ramp 81

Figure 6.10 Regulatory Signs Right In - Right Out Intersections 82

Figure 6.11 3/4 Access Intersection Signing 83

Figure 6.12 Standard Sign Placement Wrong Way and Exclusion Signs on Interchange Ramps 84

Figure 6.13 Standard Sign Placement Wrong Way and Exclusion Signs on Interchange Ramps 85

Figure 6.14 Standard Sign Placement Exclusion Signs on Cloverleaf Interchange Ramps 86

Figure 6.15 Authorized Bus Only Shoulder Signing 87

Figure 6.16 Bypass Lanes 88

Figure 6.17A Advanced Intersection Lane Control Signs (1 of 2) 89

Figure 6.17B Advanced Intersection Lane Control Signs (2 of 2) 90

Figure 6.18 Acceleration Lane Signing/Striping Options 91

Figure 6.19A Channelized Intersection Signing Raised Median 92

Figure 6.19B Channelized Intersection Signing Painted Median 93

Figure 6.20 Pedestrian Crossing Signing at Uncontrolled Locations 94

Figure 6.21A Passing Lane Section Signing 95

Figure 6.21B Passing Lane Signing Near Low Volume Cross Road 96

Figure 6.22 Transition Signing Divided and Undivided Roadways 97

Figure 6.23A Signal Mast Arm Intersection Signing 98

Figure 6.23B Signal Mast Arm Intersection Signing 99

Figure 6.23C Signal Mast Arm Intersection Signing 100

Figure 6.23D Signal Mast Arm Intersection Signing 101

Figure 6.23E Signal Mast Arm Intersection Signing 102

Figure 6.23F Signal Mast Arm Intersection Signing 103

Figure 6.24A "T" Intersection Signing (2-Lane, 2-Way) 104

Figure 6.24B Recommended Spacing Distances "T" Intersection Signing (Divided Highway) 105

Figure 6.25 4-Leg Intersection Signing 106

Figure 6.26 Local Road/Street Intersection Signing 107

Figure 6.27 Single Lane Roundabout 108

Figure 6.28A Reduced Conflict Intersection > 1000 FT 109

Figure 6.28B Reduced Conflict Intersection < 1000 FT 110

Figure 6.29 Named County Road Signing on an Expressway 111

Figure 6.30 Single Lane Crossroad Signing for Diamond Interchanges 112

Figure 6.31 Multi-Lane Crossroad Signing for Diamond Interchanges 113

Figure 6.32 Multi-Lane Crossroad Signing for Folded Diamond Interchanges 114

Figure 6.33 Non-Freeway Crossroad Signing for Cloverleaf Interchanges..... 115

Figure 6.34A Signing for Auxiliary Lane on Freeway Lane Less Than 1/2 Mile Without Escape Lane 116

Figure 6.34B Signing for Auxiliary Lane on Freeway Lane Less Than 1/2 Mile With Escape Lane 117

Figure 6.34C Signing for Auxiliary Lane on Freeway Lane 1/2 Mile or Greater Without Escape Lane 118

Figure 6.34D Signing for Auxiliary Lane on Freeway Lane 1/2 Mile or Greater With Escape Lane 119

Figure 6.35 Community Recognition Signing 120

Figure 6.36A Specific Service Signing Typical Clarification Diagrams 121

Figure 6.36B Specific Service Signing Typical Clarification Diagrams 122

Figure 6.37 Wayside Rest Signing 123

Figure 6.38 Commonly Used Object Marker Types and Installation 124

Figure 6.39 Narrow Bridge Signing and Delineation 125

Figure 6.40 One Lane Bridge Signing and Delineation 126

Figure 6.41 Unprotected Large Culvert and Cattle Pass Marking 127

Figure 6.42 Commonly Used Delineator Types and Installation 128

Figure 6.43 Divided Highway Intersection Delineation 129

Figure 6.44 Diamond Interchange - Ramp Delineation Partial and Full Lighting 130

Figure 6.45 Diamond Interchange - Ramp Delineation Unlit..... 131

Figure 6.46 Cloverleaf Interchange - Ramp Delineation Full Lighting 132

Figure 6.47 Railroad Crossings with Truck Stopping Lane 133

List of Forms

Form 6.1 Community Wayfinding - Sample Resolution..... 134

Form 6.2 Ball Banking Form..... 135

List of Charts

Chart 6.1A Guidelines for Guide Signs..... 136

Chart 6.1B Guidelines for Guide Signs 137

Chart 6.1C Types of Guide Signs..... 138

Chart 6.1D Types of Guide Signs..... 139

Chart 6.1E Specific Services Application (3 of 4)..... 140

Chart 6.2 U-Post Structure Chart for Ground Mounted Signs 141

Chart 6.3 Type D Sign Post Spacing Chart 142

Chart 6.4 Warning Signs Advance Placement Chart..... 143

Chart 6.5 Ball Bank Angles for Safe Turn or Curve Speeds..... 144

Chart 6.6 Requester Pay Signing Costs..... 145

Chart 6.7 Stopping Sight Distance - Level Roadways and Grades..... 146

Chart 6.8 Finding the Degree of Curve for a Horizontal Curve 147

CHAPTER 7 - PAVEMENT MARKINGS

Table of Contents

7-1.00 INTRODUCTION	7-2
7-1.01 Purpose	7-2
7-1.02 Scope	7-2
7-1.03 Chapter Organization	7-2
7-2.00 GLOSSARY	7-2
7-3.00 LEGALITY	7-3
7-3.01 Legal Authority	7-3
7-3.02 Responsibility for Placement and Removal	7-3
7-3.03 Legal Effect	7-4
7-4.00 PAVEMENT MARKING MATERIALS	7-4
7-4.01 Materials Selection	7-4
7-4.02 Installation Guidelines	7-5
7-4.03 Statewide Provisions	7-5
7-4.04 Temporary Markings	7-5
7-4.05 Removal of Markings	7-5
7-5.00 GENERAL PAVEMENT MARKING APPLICATION GUIDELINES	7-6
7-5.01 Purpose	7-6
7-5.02 Marking Widths and Patterns	7-6
7-5.03 No-Passing Zone Markings	7-6
7-5.04 Centerline Markings	7-13
7-5.05 Lane Line and Channelizing Line Markings	7-13
7-5.06 Edge Line Markings	7-14
7-5.07 Extensions through Intersections	7-14
7-5.08 Lane Reduction Markings	7-15
7-5.09 Raised Pavement Markers (RPMs)	7-15
7-5.10 Transverse Pavement Markings	7-15
7-6.00 ROUNDABOUT MARKINGS	7-16
7-7.00 PREFERENTIAL LANE MARKINGS	7-17
7-8.00 REFERENCES	7-17

List of Tables

Table 7-1 Life Expectancy of Surface Applied Pavement Markings	7-4
Table 7-2 Life Expectancy of Recessed Pavement Markings	7-4
Table 7-3 Minimum Passing Sight Distances for No-Passing Zone Markings	7-7
Table 7-4 Minimum Length of No-Passing Zone in Advance of a Stop Condition	7-7
Table 7-5 Minimum Distance or Gap Between No-Passing Zones	7-7

List of Figures

Figure 7-1 Spotting Symbols for Pavement Striping	7-10
Figure 7-2 Establishing Marks for Identifying No-Passing Zone Locations	7-11
Figure 7-3 How Obstructions and Depressions Cause Vehicle to Become "Lost"	7-11
Figure 7-4 Height-of-Eye Paddle	7-12

CHAPTER 8 - TEMPORARY TRAFFIC CONTROL

Table of Contents

8-1.00 INTRODUCTION	8-3
8-1.01 Purpose	8-3
8-1.02 Scope	8-3
8-1.03 Relation to Other MnDOT Standards and Guidelines	8-3
8-1.04 Chapter Organization	8-3
8-2.00 GLOSSARY	8-3
8-3.00 RESPONSIBILITY	8-5
8-3.01 General Responsibility.....	8-5
8-3.02 Legal Responsibility.....	8-5
8-4.00 TEMPORARY TRAFFIC CONTROL PLANNING AND IMPLEMENTATION.....	8-6
8-4.01 Temporary Traffic Control Goals.....	8-6
8-4.02 Transportation Management Plans (TMPs).....	8-6
8-5.00 TEMPORARY TRAFFIC CONTROL STRATEGIES AND CONTROLLING CRITERIA	8-8
8-5.01 Lane Width	8-9
8-5.02 Crossovers and Bypasses (Diversion)s.....	8-9
8-5.03 Closures and Detours	8-10
8-5.04 Delay Time.....	8-12
8-5.05 Flagging Operations	8-13
8-5.06 Speed Limits in Work Zones.....	8-15
8-5.07 Positive Protection.....	8-15
8-5.08 Cable Median Barrier.....	8-16
8-5.09 Lighting	8-16
8-5.10 Drop-offs.....	8-18
8-5.11 Zipper Merge	8-18
8-5.12 Intelligent Work Zones.....	8-19
8-5.13 Innovative Contracting Methods	8-19
8-5.14 Other Travel Mode Considerations.....	8-19
8-5.15 Clear Zones	8-20
8-5.16 Business Impact Mitigation.....	8-21
8-5.17 Public Information.....	8-21
8-6.00 TEMPORARY TRAFFIC CONTROL DEVICES	8-22
8-6.01 General Requirements of Temporary Traffic Control Devices	8-22
8-6.02 Signs.....	8-24
8-6.03 Pavement Markings in Temporary Traffic Control Zones.....	8-33
8-6.04 Channelizing Devices	8-36
8-6.05 Ballast.....	8-36
8-6.06 Temporary Barriers	8-37
8-6.07 Portable Changeable Message Signs (PCMS)	8-37
8-7.00 TEMPORARY TRAFFIC CONTROL PLANS	8-38
8-7.01 General.....	8-38
8-8.00 TEMPORARY TRAFFIC CONTROL REVIEWS.....	8-38
8-8.01 General.....	8-38
8-8.02 Project Review.....	8-38
8-8.03 Temporary Traffic Control Periodic Reviews.....	8-38
8-8.04 Frequency of Reviews	8-38
8-8.05 Record Keeping of Temporary Traffic Control Deployment	8-39
8-9.00 REFERENCES	8-39

List of Tables

Table 8-1 Temporary Business Sign Structure Spacing 8-25
Table 8-2 Temporary Business Access Signs 8-27
Table 8-3 Temporary Business Services Signs 8-28
Table 8-4 Temporary Business Panel Signs 8-30
Table 8-5 Temporary Business Guide Signs 8-32

CHAPTER 9 - HIGHWAY TRAFFIC SIGNALS

Table of Contents

9-1.00 INTRODUCTION	9-3
9-1.01 Purpose	9-3
9-1.02 Scope	9-3
9-2.00 ACRONYMS	9-3
9-3.00 LEGALITY	9-4
9-3.01 Legal Authority	9-4
9-3.02 Jurisdiction	9-4
9-3.03 Meaning of Signal Indications	9-4
9-3.04 Tort Claims	9-5
9-4.00 GENERAL DESCRIPTION OF HIGHWAY TRAFFIC SIGNALS	9-5
9-4.01 Types of Highway Traffic Signals	9-5
9-4.02 Elements of Traffic Control Signals	9-8
9-4.03 Timing and Coordination of Traffic Control Signals	9-12
9-4.04 MnDOT Enforcement Light	9-13
9-4.05 Standard Design/Operation for MnDOT Signals with Railroad Preemption	9-13
9-5.00 TRAFFIC SIGNAL JUSTIFICATION PROCESS	9-15
9-5.01 Engineering Studies for Traffic Signals	9-15
9-5.02 Warrants and Justification for Traffic Control Signals and Flashing Beacons	9-15
9-6.00 TRAFFIC CONTROL SIGNAL PROJECT PROCEDURES	9-22
9-6.01 Traffic Control Signal Project Management Flowchart	9-22
9-6.02 Notes on Traffic Control Signal Project Management Flowchart	9-23
9-7.00 TRAFFIC CONTROL SIGNAL DESIGN	9-29
9-7.01 General Considerations	9-29
9-7.02 Intersection Geometry	9-29
9-7.03 Operational Characteristics	9-30
9-7.04 System (Arterial) Considerations	9-30
9-7.05 Signal Design Elements	9-31
9-8.00 TRAFFIC SIGNAL PLANS AND SPECIFICATIONS	9-32
9-8.01 General	9-32
9-8.02 Traffic Signal Control Plans	9-32
9-8.03 Special Provisions	9-32
9-8.04 Tabulation of Quantities	9-33
9-8.05 Standard Plates Manual	9-33
9-8.06 Standard Plan Manual	9-33
9-8.07 MnDOT Standard Specifications for Construction	9-33
9-8.08 Other Standards	9-33
9-9.00 TRAFFIC CONTROL SIGNAL CONSTRUCTION	9-33
9-9.01 State Furnished Material	9-33
9-9.02 Signal Turn-On Procedure	9-34
9-9.03 Post Turn-On Procedures	9-34
9-10.00 TRAFFIC SIGNAL OPERATIONS	9-34
9-10.01 General	9-34
9-10.02 Operational Timing Practices	9-35
9-11.00 TRAFFIC CONTROL SIGNAL MAINTENANCE	9-35
9-11.01 General	9-35

9-11.02 Malfunction Repair 9-35

9-11.03 Signal Indication Failures 9-36

9-11.04 Signal Maintenance Log 9-36

9-11.05 Automated Facilities Management System 9-36

9-12.00 TRAFFIC SIGNAL COMPUTER AIDS 9-37

9-12.01 General 9-37

9-12.02 Computer Software 9-37

9-12.03 Computer-Aided Drafting 9-37

9-13.00 REFERENCES 9-37

List of Figures

Figure 9-1 Blank-Out Signs 9-14

Figure 9-2 ICE Development Process 9-20

List of Charts

Chart 9-1 Typical State Let Traffic Signal Project Management Flowchart 9-22

CHAPTER 10 - LIGHTING OF TRAFFIC FACILITIES

Table of Contents

10-1.00 INTRODUCTION	10-2
10-1.01 Purpose	10-2
10-1.02 Scope	10-2
10-2.00 GLOSSARY	10-2
10-3.00 LIGHTING PROJECT PROCEDURES	10-5
10-3.01 Warrants	10-5
10-3.02 Programming	10-6
10-3.03 Negotiations.....	10-6
10-3.04 Work Authorities	10-6
10-3.05 Preparation of Plans	10-7
10-3.06 Preparation of Special Provisions.....	10-8
10-3.07 Preparation of Agreements.....	10-8
10-3.08 Project Letting.....	10-10
10-4.00 LIGHTING SYSTEM DESIGN	10-10
10-4.01 Typical Lighting Systems	10-11
10-4.02 Roadway Lighting System Components.....	10-14
10-4.03 Temporary Lighting	10-18
10-4.04 Sign Lighting.....	10-19
10-5.00 CONSTRUCTION	10-19
10-5.01 Field Placement of Light Poles.....	10-19
10-5.02 Documentation	10-19
10-6.00 OPERATION AND MAINTENANCE.....	10-20
10-6.01 General.....	10-20
10-6.02 Budgeting (MnDOT)	10-20
10-6.03 Maintenance (MnDOT).....	10-21
10-6.04 Obtaining Electrical Power from MnDOT Lighting or Signal Systems	10-21
10-7.00 REFERENCES	10-22
10-8.00 APPENDIX A: VOLTAGE DROP CALCULATIONS.....	10-30

List of Figures

Figure 10-1 Typical Luminaire Locations Partial Interchange Lighting Davit Arm Poles	10-24
Figure 10-2 Standard Illumination Plan for Intersections	10-25
Figure 10-3 Pole Type Designations	10-26
Figure 10-4 Typical Conduit Placement (Cloverleaf Interchange)	10-27
Figure 10-5 Typical Conduit Placement (Diamond Interchange)	10-28
Figure 10-6 Voltage Drop Calculation Values	10-33
Figure 10-7 Voltage Drop Calculation Examples	10-34

CHAPTER 11 - TRAFFIC SAFETY

Table of Contents

11-1.00 INTRODUCTION	11-2
11-1.01 Purpose	11-2
11-1.02 Chapter Organization	11-2
11-2.00 LIST OF ACRONYMS	11-2
11-3.00 TRAFFIC SAFETY PLANNING.....	11-3
11-3.01 Toward Zero Deaths (TZD).....	11-3
11-3.02 Strategic Highway Safety Plan (SHSP).....	11-4
11-3.03 Regional and Local Planning.....	11-4
11-4.00 CRASH REPORTING	11-5
11-4.01 Statutes	11-5
11-4.02 Motor Vehicle Crash Report Form	11-5
11-4.03 Crash Report Processing	11-5
11-5.00 CRASH DATA.....	11-6
11-5.01 Data Practices	11-6
11-5.02 Data Sources.....	11-7
11-5.03 Data Requests.....	11-8
11-6.00 SAFETY ANALYSIS	11-8
11-6.01 Network Screening	11-8
11-6.02 Analytical Tools	11-11
11-6.03 Project Selection.....	11-12
11-6.04 Project Evaluation.....	11-14
11-7.00 FUNDING AND PROJECT ELIGIBILITY	11-15
11-7.01 Highway Safety Improvement Program (HSIP).....	11-15
11-7.02 Safety Set-Aside Funds.....	11-16

List of Figures

Figure 11.1 Law Enforcement Accident Report Form	11-17
Figure 11.2 Law Enforcement Accident Report Form Overlay 1 of 2.....	11-18
Figure 11.3 Law Enforcement Accident Report Form Overlay 2 of 2.....	11-19
Figure 11.4 Typical Interchange Element Sketch.....	11-20
Figure 11.5 Typical Intersection Collision Diagram	11-21

CHAPTER 12 - TORT CLAIMS

Table of Contents

12-1.00 INTRODUCTION	12-2
12-1.01 Background	12-2
12-2.00 GLOSSARY	12-2
12-3.00 TORT LIABILITY	12-3
12-3.01 Basic Characteristics of a Tort	12-3
12-3.02 Legal Duty	12-3
12-3.03 Negligence.....	12-3
12-3.04 Causation	12-4
12-3.05 Liability.....	12-4
12-4.00 IMMUNITIES	12-4
12-4.01 Statutory Discretionary Immunity.....	12-4
12-4.02 Official Immunity	12-5
12-4.03 Other Immunities	12-5
12-5.00 RECORD KEEPING	12-6
12-6.00 REQUESTS FOR INFORMATION	12-6
12-6.01 Purpose	12-6
12-6.02 Procedure to Follow When Requests are Made.....	12-7
12-7.00 FILING A CLAIM	12-7
12-8.00 INVESTIGATIONS	12-7
12-8.01 Claim File	12-7
12-8.02 Investigating Claims	12-8
12-8.03 The Discovery Process.....	12-8
12-9.00 EFFECT OF LITIGATION ON MNDOT	12-8

CHAPTER 13 - NON-MOTORIZED FACILITIES

Table of Contents

13-1.00 INTRODUCTION	13-2
13-1.01 Purpose	13-2
13-1.02 Scope	13-2
13-2.00 PEDESTRIAN CROSSING FACILITATION	13-2
13-2.01 Curb Ramp Installation	13-2
13-2.02 Signalized Pedestrian Crossings	13-4
13-2.03 Prohibiting Pedestrian Crossing	13-5
13-3.00 CROSSWALK MARKINGS AND ENHANCEMENTS	13-6
13-3.01 Crosswalk Markings Installation Criteria	13-6
13-3.02 Additional Treatment Considerations	13-7
13-4.00 INSTALLATION AND REMOVAL GUIDELINES	13-8
13-5.00 APPROVAL OF LOCAL REQUESTS	13-8
13-6.00 REFERENCES	13-9

List of Figures

Figure 13-1 Goat Path	13-3
Figure 13-2 No Pedestrian Crossing Sign R9-3a	13-5
Figure 13-3 Crosswalk Marking Sign S1-1	13-7
Figure 13-4 Curb Ramps Along Parallel and Perpendicular Routes	13-10
Figure 13-5 Pedestrian Crossing Scheme at Signalized Intersection	13-11
Figure 13-6 Ramp Installation with Sidewalk on One Side of the Street	13-12
Figure 13-7 Ramp Installation with Sidewalk on Both Sides of the Street	13-13
Figure 13-8 Refuge Area Without Sidewalk	13-14
Figure 13-9 Shortest Path Sidewalk	13-15
Figure 13-10 Unsignalized Marked Crosswalk Installation Flowchart	13-16

List of Tables

Table 13-1 Pedestrian Facility Treatments	13-17
---	-------

CHAPTER 14 - MISCELLANEOUS TRAFFIC ITEMS

Table of Contents

14-1.00 INTRODUCTION.....	14-2
14-1.01 Purpose	14-2
14-1.02 Scope	14-2
14-1.03 Chapter Organization	14-2
14-2.00 GLOSSARY	14-2
14-3.00 SCHOOL CROSSING PROTECTION	14-5
14-3.01 Responsibility	14-5
14-3.02 Laws and Guidelines	14-5
14-3.03 School Safety Patrols and Crossing Guards	14-5
14-3.04 School Speed Limits.....	14-5
14-3.05 School Site Plan Review	14-5
14-4.00 REVIEW AND PERMITS.....	14-5
14-4.01 Geometric Reviews	14-5
14-4.02 Preliminary Layouts	14-6
14-4.03 Evaluation of New Facilities.....	14-6
14-4.04 Entrance Permits	14-6
14-4.05 Transportation Permits	14-6
14-4.06 Use of Trunk Highway Right-of-Way for Special Events.....	14-6
14-5.00 ROUTE NUMBERING AND REFERENCE POINT SYSTEM	14-10
14-5.01 General.....	14-10
14-5.02 Constitutional Routes	14-10
14-5.03 Legislative Routes	14-10
14-5.04 Names and Designation of Certain Highways	14-10
14-5.05 Interstate Routes	14-10
14-5.06 U.S. Highways	14-10
14-5.07 Trunk Highway Routes	14-11
14-5.08 Turnbacks.....	14-11
14-5.09 Reference Point System.....	14-11
14-5.10 Exit Numbering.....	14-12
14-6.00 SPECIAL INVESTIGATIONS AND STUDIES.....	14-12
14-6.01 Rumble Strips and Rumble Stripes	14-12
14-6.02 Experimental Traffic Control Devices	14-13
14-6.03 Speed Trend Studies.....	14-13
14-6.04 Sight Distances at Crossroads	14-14
14-6.05 Railroad Crossing Review	14-15
14-6.06 Advisory Curve Study.....	14-15
14-7.00 ENGINEERING AND TRAFFIC INVESTIGATION REQUIREMENTS TO ESTABLISH OR CHANGE REGULATORY SPEED LIMITS	14-16
14-7.01 Authority	14-16
14-7.02 Principles of Speed Zoning.....	14-16
14-7.03 General Administrative Requirements and Procedures.....	14-17
14-7.04 Investigation Procedures.....	14-18
14-7.05 Conditions Justifying Variations from the 85th Percentile Speed	14-18
14-7.06 Speed Zones on Gravel Roads	14-19
14-7.07 Checklist of Items Submitted with a Speed Report	14-20
14-8.00 REFERENCES.....	14-20

LIST OF ACRONYMS

A Injury	Incapacitating Injury	FAR	Fatal (K) and incapacitating injury (A) crash rate
AASHTO	Association of State Highway and Transportation Officials	FAST	Free and Secure Trade
ADM	Archived Data Management	FHWA	Federal Highway Administration
ADA	Americans with Disabilities Act	FIRST	Freeway Incident Response Safety Team
ADT	Average Daily Traffic	FMCSA	Federal Motor Carrier Safety Administration
AFMS	Automated Facilities Management System	FYA	Flashing Yellow Arrow
AMBER	America's Missing: Broadcast Emergency Response	GIS	Geographic Information System
APL	Approved Products List	GPS	Global Positioning System
APS	Accessible Pedestrian Signal	HAR	Highway Advisory Radio
APTS	Advanced Public Transportation System	HAZMAT	Hazardous Materials
ATIP	Annual Transportation Improvement Plan	HOT	High-Occupancy Toll
ATIS	Advanced Traveler Information System	HOV	High-Occupancy Vehicle
ATMS	Advanced Traffic Management System	HRI	Highway-Rail intersection
ATR	Automated Traffic Recorder	HSIP	Highway Safety Improvement Program
AVL	Automatic Vehicle Location	HSM	Highway Safety Manual
AVSS	Advanced Vehicle Safety System	ICE	Intersection Control Evaluation
AWF	Advance Warning Flasher	ICM	Integrated Corridor Management
AWOS	Automated Weather Observation System	IEEE	Institute of Electrical and Electronics Engineers
BCA	Bureau of Criminal Apprehension	IFTA	International Fuel Tax Agreement
CAD	Computer Aided Dispatch	IRP	International Registration Plan
CAES	Computer-Aided Engineering Services	ISP	Information Service Provider
CARS	Condition Acquisition and Reporting System	ITE	Institute of Transportation Engineers
CCTV	Closed Circuit Television	ITS	Intelligent Transportation Systems
CESU	Central Electrical Service Unit	IVR	Interactive Voice Response
CICAS	Cooperative Intersection Collision Avoidance System	IWZ	Intelligent Work Zone
CMF	Crash Modification Factor	LED	Light Emitting Diode
CR	Crash Rate	LPFM	Low Power FM Radio
CRF	Crash Reduction Factor	LRRB	Local Road Research Board
CVIEW	Commercial Vehicle Information Exchange Window	LTAP	Local Technical Assistance Program
CVISN	Commercial Vehicle Information Systems and Networks	MCM	Maintenance and Construction Management
CVO	Commercial Vehicle Operations	MCMIS	Motor Carrier Management Information System
DDS	Data Distribution Server	MDSS	Maintenance Decision Support System
DMS	Dynamic Message Sign	MDT	Mobile Data Terminal
DOT	Department of Transportation	MESU	Metro Electrical Service Unit
DPS	Department of Public Safety	MN	Minnesota Manual on Uniform Traffic Control Devices
DTN	Data Transmission Network	MUTCD	Manual on Uniform Traffic Control Devices
DVR	Digital Video Recording	MnCMAT	Minnesota Crash Mapping Analysis Tool
DVS	Department of Public Safety, Driver Vehicle Services Division	MnDOT	Minnesota Department of Transportation
EAS	Emergency Alert System	MPCA	Minnesota Pollution Control Agency
EOC	Emergency Operations Center	MSP	Minnesota State Patrol
EM	Emergency Management	MUTCD	Manual on Uniform Traffic Control Devices
EMS	Emergency Medical Services	NCHRP	National Cooperative Highway Research Program
EVP	Emergency Vehicle Preemption	NEMA	National Electrical Manufacturers Association
FAA	Federal Aviation Administration	NFPA	National Fire Protection Association
		NOAA	National Oceanic and Atmospheric Administration
		OS/OW	Oversize/Overweight
		OTST	Office of Traffic, Safety, and Technology (MnDOT)
		PDA	Personal Digital Assistant
		PRISM	Performance and Registration information Systems Management

LIST OF ACRONYMS, cont.

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