Transportation agencies use dynamic message signs (DMS) to warn motorists in real time about incidents, roadwork or congestion downstream that may be potential safety hazards or may cause delays. MnDOT has limited use of DMS for weather-related messages such as blizzard warnings or other unexpected or isolated conditions because of concerns about the timeliness and potential overuse of these messages. Generating weather-related messages on DMS in response to specific National Weather Service reports, maintenance decision support systems or roadside weather sensors could contribute to the safety and mobility of travelers on Minnesota roads and enhance the timeliness, accuracy and efficacy of these messages in the state.

To inform development of a MnDOT system that automatically deploys weather-related messages to DMS, researchers conducted two online surveys. The first survey gathered information from state departments of transportation about current agency DMS messaging practices. The second survey assessed the public’s awareness of and response to weather-related messages that appear on DMS. Findings from both surveys are supplemented with domestic and international resources obtained in a literature search.
The purpose of this TRS is to serve as a synthesis of pertinent completed research to be used for further study and evaluation by MnDOT. This TRS does not represent the conclusions of either the authors or MnDOT.
Road Weather and Creative Safety Messaging on Dynamic Message Signs

Executive Summary

Dynamic message signs (DMS) are frequently used by transportation agencies to provide drivers with real-time information about incidents, roadwork or congestion downstream that may be potential safety hazards or may cause delays. MnDOT has limited its use of DMS for weather-related messages such as blizzard warnings or other unexpected or isolated conditions because of concerns about the timeliness and potential overuse of these messages. Generating weather-related messages on DMS in response to specific weather reports and data could contribute to the safety and mobility of travelers on Minnesota roads and enhance the timeliness, accuracy and efficacy of these messages in the state.

To better serve Minnesota motorists, MnDOT is updating the software system that controls DMS on the state highway system to allow for automated deployment of blizzard warnings to existing DMS using National Weather Service, maintenance decision support systems or roadside weather sensor source data that is communicated to MnDOT’s DMS control software. To inform development of this new system capability, this study is gathering information from state departments of transportation (DOTs) about current agency DMS messaging practices and to assess the public’s awareness of and response to weather-related warnings that appear on DMS. Supplementing this inquiry is an examination of the “Message Monday” creative safety messaging on DMS coordinated by MnDOT’s Toward Zero Deaths program.

Information for this study was gathered in the three phases briefly described below.

Literature Search

The study began with an in-depth literature search of publications and other resources reporting on efforts to enhance and promote road weather technologies. This search uncovered resources associated with specific weather-responsive traffic management, and DMS practices related to road weather messages and to creative safety messages. National publications describe implementation of road weather technologies and summarize the methods used to warn travelers about road weather conditions. Other publications focus on management strategies and technologies, and DMS practices as part of planning efforts for intelligent transportation system (ITS) devices and technologies.

Thirteen state agency publications address DMS guidance and plans, including 2018 Iowa DOT reports about the use of DMS as part of the agency’s ITS platform and a 2017 case study about Kansas DOT’s road weather information system. Creative safety messages are discussed in a pooled fund study about the future of DMS messaging and in two Federal Highway Administration reports that assess the effectiveness and potential benefits of public service announcements (PSAs) in rural areas, and the impact of PSAs on driver behavior. Establishing safety message programs is the focus of 10 state agency reports.

State Department of Transportation Survey

State DOTs were surveyed about agency practices with road weather-related and creative safety messaging on DMS, including the technology used to automate this messaging. Twenty-one state transportation agencies completed the online survey. These agencies typically deploy road weather-related warnings for winter storm, high wind, dense fog, freezing rain and blizzard conditions. Survey results indicate varying practices among the responding states. Messages are delivered through a mostly manual process in more than half of these states; a
mostly automated process in one state (Mississippi); and a combination of manual and automated processes in seven states (Alabama, Maine, Maryland, Michigan, Nevada, Virginia and Wisconsin). Similarly, more than half of the states responding to the survey create messages using a combination of standard message templates and custom messages.

Only five states (Massachusetts, Michigan, Mississippi, Nevada and Wisconsin) use a standard message template, and two states (Arkansas and Illinois) develop custom messages for each weather-related event. Messages are displayed on DMS before an event in eight states (Delaware, Maine, Mississippi, Missouri, New York, Pennsylvania, South Dakota and Vermont); at event onset in two states (Delaware and Mississippi); and during the event in one state (Vermont). Factors that lead to successful road weather-related messages include accurate messaging, partnering with other agencies, preplanning guidance and timing. Challenges associated with these messages are primarily related to inaccurate forecasting or false alarms, inadequate assets in affected areas, messaging issues and timely updates.

Creative safety messages are posted by 18 state DOTs participating in the survey. Messages are posted weekly in five states (Colorado, Delaware, Massachusetts, Michigan and South Dakota); daily in four states (Delaware, Illinois, Missouri and Tennessee); and twice monthly in three states (Maine, Ohio and Virginia). Nearly one-half of the agencies display one message per scheduled cycle. More than half of the responding states limit the number of hours per day that a creative safety message can be displayed. Factors that limit message display time are related to the equipment used, specific safety campaigns and driver attention to message content. Nearly all the transportation agencies responding to the survey develop and deliver safety messages in partnership with other agencies, such as the state patrol and local, state and federal agencies. Almost all these agencies maintain a catalog of safety messages that are used and reused throughout the year. These catalogs range from simple logs and spreadsheets to more complex tools.

Public Perception Survey

A public perception survey sought information about respondents’ perception of blizzard warning and creative safety messaging on DMS, including the impact these messages have on traveler behavior. The survey was completed by 406 respondents ranging in age from 18 years to 75+ years. Respondents represented more than five racial groups and resided in the eight-county Twin Cities metropolitan area, Greater Minnesota or nearby states. Almost 60 percent of respondents use Minnesota roadways every weekday, while 23 percent use these roadways two or more times a week. Average use by the remaining respondents ranged from once a week to less than once a month.

Slightly more than half of these survey respondents reported seeing a blizzard warning message on DMS. Warning messages were most frequently viewed twice and were located in the Twin Cities metro area or along interstate highways. Most of these respondents were already aware of the blizzard warning before they began driving and had received weather information from news and weather websites, television and radio. These respondents were least likely to rely on social media, the 511 app or the MnDOT 511 travel information website. Viewing blizzard warning messages on DMS led more than half of these respondents to drive with extra caution.

Blizzard warnings on DMS were rated as helpful or very helpful by almost three-quarters of the respondents who were aware of the blizzard warning before they began driving and by slightly more than three-quarters of the respondents who were not aware of the blizzard warning before driving. The respondents who were aware of the blizzard warning before they began driving were more likely to rate road weather messages on DMS as either somewhat more effective or more effective than weather alerts delivered through other media types. Almost two-thirds of the respondents who were not aware of the blizzard warning before they began driving rated DMS as either much more effective or more effective than weather alerts from social media.
For respondents, the most useful time to get weather information is either while planning for a trip or immediately before leaving for a trip. Those who reported viewing blizzard warning messages on DMS were more likely to access information while planning for a trip; those who reported not viewing blizzard warning messages on DMS were more likely to access information immediately before leaving for a trip. Seeing a warning message on DMS is the preferred method for disseminating information about adverse road conditions among respondents who reported viewing blizzard warning messages on DMS.

More than three-quarters of respondents reported seeing MnDOT’s Message Monday creative safety messages. Only 86 respondents (21 percent) indicated that they never saw these messages. Most respondents who saw these messages reported viewing them every week, typically while driving to work or school, running errands or shopping, or traveling recreationally. Eighty-six percent of these respondents rated message comprehension as either very easy to understand or easy to understand. Highest ratings (very effective or effective) were given to messages related to DWI, drinking and driving, and work zone safety.

Message Monday messages on DMS were seen as more effective than similar messages delivered through other media. Almost 60 percent of respondents seeing a specific Message Monday message reported a change in both their immediate and long-term driving behavior. While 83 percent of respondents recommended continuing the current practice of delivering weekly creative safety messages on DMS, several respondents recommended delivering these messages more frequently, from two to three times a week to daily. Safety message topics that received the highest ratings were using cellular devices, not drinking or using drugs while driving, slowing down in work zones and buckling seat belts.
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<th>Description</th>
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<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Traffic Management System</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed-Circuit Television</td>
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<tr>
<td>CHART</td>
<td>Coordinated Highways Action Response Team</td>
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<tr>
<td>CMS</td>
<td>Changeable Message Sign(s)</td>
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<tr>
<td>DMS</td>
<td>Dynamic Messaging Sign(s)</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
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<tr>
<td>ESS</td>
<td>Environmental Sensor Stations</td>
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<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>HAR</td>
<td>Highway Advisory Radio</td>
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<tr>
<td>IMO</td>
<td>Integrated Mobile Observations</td>
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<tr>
<td>IRIS</td>
<td>Intelligent Roadway Information System</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation System</td>
</tr>
<tr>
<td>KC Scout</td>
<td>Kansas City Scout</td>
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<tr>
<td>MDSS</td>
<td>Maintenance Decision Support Systems</td>
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<tr>
<td>MnDOT</td>
<td>Minnesota Department of Transportation</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>NWS</td>
<td>National Weather Service</td>
</tr>
<tr>
<td>PSA</td>
<td>Public Service Announcement</td>
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<tr>
<td>SEMTOC</td>
<td>Southeast Michigan Transportation Operations Center</td>
</tr>
<tr>
<td>SHA</td>
<td>Maryland DOT State Highway Administration</td>
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<tr>
<td>TMC</td>
<td>Traffic Management Center/Transportation Management Center</td>
</tr>
<tr>
<td>TOC</td>
<td>Transportation Operations Center</td>
</tr>
<tr>
<td>TZD</td>
<td>Toward Zero Deaths</td>
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<tr>
<td>VDS</td>
<td>Vehicle Detection Station</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign(s)</td>
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<tr>
<td>WRTM</td>
<td>Weather-Responsive Traffic Management</td>
</tr>
<tr>
<td>Wx-TINFO</td>
<td>Weather Responsive Traveler Information</td>
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</tbody>
</table>
Introduction

Background

Transportation agencies use dynamic message signs (DMS) to warn motorists in real time about incidents, roadwork or congestion downstream that may be potential safety hazards or may cause delays. The Minnesota Department of Transportation (MnDOT) has limited use of DMS for weather-related messages such as blizzard warnings or other unexpected or isolated conditions because of concerns about the timeliness and potential overuse of these messages. Generating weather-related messages on DMS in response to specific National Weather Service (NWS) reports, maintenance decision support systems (MDSS) or roadside weather sensors could contribute to the safety and mobility of travelers on Minnesota roads and enhance the timeliness, accuracy and efficacy of these messages in the state.

The goal of this study was to gather information from state departments of transportation (DOTs) about current agency DMS messaging practices and to assess the public’s awareness of and response to weather-related warnings (both manual and automated) that appear on DMS. This information will be used to inform development of a system that automatically deploys weather-related messages to existing DMS using NWS, MDSS or roadside weather sensor source data that is communicated to MnDOT’s DMS control software, Intelligent Roadway Information System (IRIS). IRIS is an open source advanced traffic management system (ATMS) that provides an integrated platform for managing traffic monitoring and control devices. Supplementing this inquiry is an examination of the “Message Monday” creative safety messaging on DMS coordinated by MnDOT’s Toward Zero Deaths program.

Project Approach

Information for this study was gathered from a literature search and two surveys.

Literature Search

Investigators conducted a comprehensive search of publicly available domestic and international literature and other resources that examined transportation agency use of DMS to deliver road weather-related messages, including the technology associated with automated message deployment for blizzard warnings and the impact of this messaging on traveler behavior. Also reviewed was literature that examined the use of DMS to deliver creative safety messages similar to MnDOT’s Message Monday messages.

State Department of Transportation Survey

An online survey was distributed to state DOT members of two American Association of State Highway and Transportation Officials (AASHTO) committees: the Committee on Traffic Engineering and the Committee on Safety. The survey gathered information about current agency practices with regard to the manual or automated deployment of blizzard warnings and other road weather-related messages that appear on DMS located on state highway systems. Other topics addressed in the survey included operational parameters (manual or automated message generation), system successes and failures, the public’s perception of DMS and agencies’ future plans for DMS use. Additionally, state DOT respondents shared their experience with creative safety messaging.
Public Perception Survey

An online survey was distributed to a diverse group of primarily Minnesota residents to gauge the general public’s perception of traveler awareness and the usefulness of blizzard warning messaging and other safety messaging displayed on DMS. Topics examined in the survey included respondents’ experiences with blizzard warning messages appearing on DMS during the last two winter seasons and included the location and timing of DMS messages, respondents’ behavior before and after encountering the DMS, and the public’s perception of the more lighthearted Message Monday messages. The survey was completed by 406 respondents who ranged in age from 18 years to 75+ years. Respondents represented more than five racial groups and resided in the eight-county Twin Cities metropolitan area, Greater Minnesota or surrounding states.
**Literature Search**

Below are the findings from a literature search of domestic and international resources that examined DMS practices and guidance. These findings are organized into the following topic areas:

- Weather-related messages.
- Creative safety messages.

**Weather-Related Messages**

Below are documents and resources organized into the following categories:

- National research and guidance:
  - Management strategies and technologies.
  - Dynamic message sign practices.
- State research and guidance.
- Other related resources.

**National Research and Guidance**

The following publications address national efforts to enhance and promote road weather technologies. Included are resources associated with specific weather-responsive traffic management (WRTM) and DMS practices.


This report provides an update on the progress of the Federal Highway Administration (FHWA) Road Weather Management Program that serves as “a resource and outreach product to further advance the importance and widespread implementation of road weather technologies.” Measures of program performance are presented in four categories:

- Impacts of road weather management.
- Application of road weather management tools and technologies.
- Road weather management capacity building.
- Partnerships and stakeholder collaboration.

Along with the results of these performance measures, the report presents significant changes or improvements since the last update and recommends areas for future consideration.

Cited in the report is Michigan DOT’s Weather Responsive Traveler Information (Wx-TINFO) system (see Related Resources below) as a noteworthy improvement in delay-reducing strategies. According to the report, user delay costs decreased from 25 percent to 67 percent statewide during NWS advisory and warning alert periods. Chapter 3 presents an update on state transportation agency use of tools and technologies for road weather management (page 21 of the report, page 33 of the PDF). Figure 15 illustrates the increase in agencies that have deployed road weather information dissemination strategies statewide, such as using DMS to publicize road condition and atmospheric weather information (page 27 of the report, page 39 of the PDF).
**Related Resources:**


This four-page flyer summarizes the key findings from the 2017 final report cited above. Among the highlights are the benefits realized from Michigan DOT’s Wx-TINFO system.

**Michigan Department of Transportation (MDOT) Weather Responsive Traveler Information (Wx-TINFO) System Implementation Project**, Christopher Toth, Michael Waisley, Jeremy Schroeder, Murat Omay, Collin Castle and Steve Cook, Federal Highway Administration, January 2016.  

*From the abstract:* The MDOT Weather Responsive Traveler Information (Wx-TINFO) system brings together near real-time weather and environmental information collected from fixed and mobile data sources. The system processes the weather data and provides automated weather alerts and DMS message recommendations to Transportation Operations Center (TOC) operators. The goal of Wx-TINFO is to integrate multiple weather data sources into a collective program that provides more accurate, timely and effective messaging, thereby improving operating conditions during severe weather conditions. Overall, the evaluations indicate improved efficiency and effectiveness of traffic management activities during weather events. Furthermore, separate surveys of TOC operators and the traveling public indicate that improvements in the system and traveler information were favorably perceived.

**North/West Passage: Forecasting and Alerting Travelers About Critical Road Condition**, Project 11.2, North/West Passage Transportation Pooled Fund, June 2017.  

*From the introduction:* The goal of this project was to research and summarize the approaches that North/West Passage states are using, or are considering, to forecast and alert travelers about road weather conditions. To achieve this goal, research and a series of interviews were conducted to gather information from the departments of transportation (DOT) in each state regarding if and how they are approaching forecasted road conditions, what conditions are being targeted, how alerts are being reported and (if available) how travelers are responding to the information. This report presents an overview of road condition reporting practices in the states, summarizes the challenges agencies face with reporting, describes approaches being used to forecast road conditions and alert travelers, and concludes with insight on the future potential for forecasting road conditions for traveler information.

Section 3 of this report (page 4 of the report, page 6 of the PDF) summarizes approaches to forecasting road conditions and alerting travelers to weather conditions through two strategies featured in the Every Day Counts initiative: Pathfinder and Integrated Mobile Observations (IMO). Also highlighted are brief summaries of the approaches used or being considered for providing forecasted road conditions by four state DOTs from the North/West Passage pooled fund, including Wyoming DOT’s use of DMS.

**Related Resources:**


*From the executive summary:* The Pathfinder project was initiated in 2014 as a pilot project across four western States (California, Nevada, Utah and Wyoming) to document current State DOT interactions and working relationships.
with the weather enterprise (both NWS and private sector). The focus was on the I-80 corridor which represents a mix of metropolitan and rural areas and serves as a main commercial trucking route. The team documented best practices across the agencies to disseminate consistent messages about the weather and its impact on the roads, and the way in which the messages prompt travelers to change departure times, cancel trips, choose alternate routes, or select different modes of transportation in response to adverse weather conditions. This document serves as a guidance document for improving the collaboration between State DOTs and the weather enterprise.

A reference guide for establishing collaboration guidelines and procedures, including establishing standard terminology and creating shared resources such as DMS message templates, begins on page 28 of the report (page 40 of the PDF). Appendix C provides examples of shared impact messages, including DMS, during a winter storm in Wyoming (beginning on page 45 of the report, page 57 of the PDF). Appendix D includes a case study of Wyoming DOT’s Pathfinder project, which aimed to improve collaboration among the agency, local NWS offices and private weather providers to improve the quality of information shared with the traveling public primarily through DMS, highway advisory radio, and email and text message alert systems (beginning on page 53 of the report, page 65 of the PDF).


From the website: The [weather and road condition data from government fleet vehicles, such as snowplows] provides maintenance managers with an extremely detailed view of the weather and road conditions along the road network. This information supports a number of road weather management strategies, such as a winter maintenance decision support system that enables agencies to use only the necessary amounts of labor and equipment to pretreat roads with salt and other materials. It also supports traveler advisories and warnings, ultimately resulting in improvements in safety and mobility.

Management Strategies and Technologies


From the abstract:

Connected vehicle-enabled weather responsive traffic management (CV-WRTM) is an approach that leverages vehicle connectivity to develop new tools for WRTM. Agencies face significant challenges in translating an interest in CV-WRTM to real-world applications, as there are many unknowns in converting research activities into implementation, including integration with the broader operational decision-making frameworks. This document summarizes the work completed to strengthen the linkages between WRTM and connected vehicle (CV) technology. It also summarizes the guidance developed under this task to help State DOTs integrate the emerging CV technology with their road weather management practices.

Chapter 2 provides case studies of CV-WRTM pilot projects that have created traffic management tools using data collected from mobile vehicles:

- Wyoming DOT’s WRTM Road Condition Reporting App—a new software application that improved the way maintenance staff reported road conditions and enhanced traffic management center (TMC) operators’ updates to the traveler information system, such as providing more timely and accurate DMS change requests (page 6 of the report, page 20 of the PDF).
- Michigan DOT’s Wx-TINFO system (page 8 of the report, page 18 of the PDF).
Chapter 3 describes road weather messaging initiatives in several states, including the Kansas City (KC) Scout ATMS and the Dual Use Safety Technology severe weather warning system in Arizona (see citations for both systems in Section 2.1.2, State Research and Guidance, of this report); emerging technologies and trends in collecting, transmitting and delivering road weather condition information to travelers; and types and examples of road weather messages (beginning on page 29 of the report, page 41 of the PDF). Guidelines for deploying CV-WRTM strategies are discussed in Chapter 4 (beginning on page 35 of the report, page 47 of the PDF).

Appendix A presents a range of road weather messages organized by dissemination method, including DMS. The messages “provide drivers with information about current, on-road driving conditions as well as potentially dangerous future driving conditions so that they can be informed about upcoming weather hazards.” Guidelines for creating and disseminating messages are also provided.


From the abstract: This report provides a comprehensive overview of weather-responsive traffic management practices. It focuses on what WRTM strategies exist, where they have been used, the benefits realized, what improvements are needed, and how to implement and evaluate them as part of transportation operations. The report also contains concepts of operations and high-level requirements that an agency can use to design and develop advanced WRTM strategies. Guidance was also developed to assist in evaluating the benefits and performance of several WRTM strategies.


This four-page brochure provides an overview of WRTM research studies about the impacts of weather on the traveling public and on the ability of transportation agencies to manage road systems. The projects, some of which are presented in this literature search, address approaches, technologies and strategies related to four Road Weather Management Program initiatives:

- Traffic and weather data collection and integration.
- Traffic analysis, modeling and prediction.
- Behavioral/human factors analysis.
- Safety, mobility and performance evaluation.

Dynamic Message Sign Practices


This document summarizes the work of the ENTERPRISE pooled fund to establish planning guidance for deploying intelligent transportation system (ITS) devices and technologies, including DMS. Section 8.2 (page 24 of the report, page 26 of the PDF) presents eight common uses of DMS technologies, the first of which is to inform travelers of weather conditions. A step-by-step decision-making process provides a set of critical factors to consider when determining whether a DMS is needed and will serve the purpose at a specific location (pages 26-27 of the report, pages 28-29 of the PDF). Final recommendations for using DMS are then provided based on the responses to the critical factors.
Guidelines for Disseminating Road Weather Advisory and Control Information, Monica Lichty, Christian Richard, John Campbell and L. Paige Bacon, Federal Highway Administration, June 2012. 
https://rosap.ntl.bts.gov/view/dot/3362

Written for transportation agencies and other organizations that communicate road weather information to travelers, this report provides revised guidance for developing messages about road weather conditions and for selecting the appropriate method for disseminating the message. These revised guidelines are the product of the Testing and Evaluation of Preliminary Design Guidelines for Disseminating Road Weather Advisory and Control Information project, which built upon the findings of the Human Factors Analysis of Road Weather Advisory and Control Information project.

Chapter 2 addresses the content and format of road weather messages using DMS (beginning on page 9 of the report, page 19 of the PDF). Nine guidelines are presented with design considerations for each based on recent scientific studies, relevant literature and best practices:

- Structuring DMS message content.
- Determining DMS message length limits.
- Dividing information between display phases.
- Determining phase timing and other dynamic properties.
- Creating acceptable DMS abbreviations.
- Communicating travel or delay times.
- Communicating event location.
- Communicating degree of urgency.
- Communicating degree of certainty and enhancing message credibility.

Tutorials in Chapter 5 (beginning on page 71 of the report, page 81 of the PDF) supplement the guidelines with specific information about traveler behavior (Tutorial 5-1), travelers’ use of road weather information (Tutorials 5-2 and 5-3) and ways that travelers are impacted by road weather information (Tutorial 5-4).

Tutorial 5-5 (beginning on page 84 of the report, page 94 of the PDF) is a message design tool that provides information about safety and mobility impacts, dissemination methods, key travel decisions, traveler information needs and message layout and presentation.

Related Resources:

Testing and Evaluation of Preliminary Design Guidelines for Disseminating Road Weather Advisory and Control Information, John Campbell, Christopher Cluett, Deepak Gopalakrishna and Monica Lichty, Federal Highway Administration, June 2012. 
https://rosap.ntl.bts.gov/view/dot/3370

This report documents the evaluation methods and results that were used to gather information and develop the revised guidelines presented in the previous citation.

https://rosap.ntl.bts.gov/view/dot/4376

Researchers initiated this project to develop preliminary guidelines for transportation officials to use in communicating and disseminating effective, consistent and timely road weather information to travelers both before and during travel.
State Research and Guidance

Below are DMS guidelines and plans developed by transportation agencies in 13 states—Arizona, California, Iowa, Kansas, Michigan, New Jersey, New Mexico, New York, North Dakota, Pennsylvania, South Dakota, Texas and Wisconsin.

Arizona


From the abstract:

Currently, the Arizona Department of Transportation (ADOT) acquires information about predicted or in-progress dust events through National Weather Service forecasts and advisories and through field reports from motorists and ADOT personnel. ADOT then communicates this information to the public using a variety of methods, including roadway message signs, e-mail blasts and social media outlets (e.g., Twitter). In addition, ADOT has developed the “Pull Aside, Stay Alive” public outreach campaign, which is focused on increasing safe driver behavior during dust events. ADOT has also recently implemented a pilot dust monitoring system [the Dual Use Safety Technology (DUST) warning system] on a 26-mile stretch of I-10 in the Safford District. During this project, researchers developed a set of recommendations that ADOT can implement to identify the most effective means for acquiring data about windblown dust events, communicating information about these events to the public, and influencing driver behavior during dust storms in the future.

To gather information for this study, Arizona DOT conducted a survey and two focus groups with Arizona travelers about “their experiences with driving in dust storm events and with Arizona DOT’s efforts to communicate information about these events.” Based on the number of survey respondents who reported obtaining weather information from highway message boards (59 percent) and the concerns respondents expressed regarding the distribution and messaging of such signs, researchers recommended that Arizona DOT consider expanding the number of DMS used to identify dust “hot spots,” incorporating instructional information to existing warning messages about actions to take to stay safe and providing progressive DMS messages before the reduced visibility area.

California


These guidelines provide revised policies and guidance for deploying changeable message signs (CMS) on California highways. The guidelines are based on both national and state research, and address general use requirements (page 4 of the report, page 9 of the PDF); installation and placement (page 8 of the report, page 13 of the PDF); and messaging (page 12 of the report, page 17 of the PDF). Sample messages are provided in Appendix D (permanent CMS, page 34 of the report, page 39 of the PDF) and Appendix E (portable CMS, page 40 of the report, page 45 of the PDF).

Iowa

From the abstract: Transportation agencies spend significant portions of their annual budgets to facilitate safe and efficient travel under hazardous weather conditions. This project is a continuation of the project titled Evaluation of Dynamic Advisory Messaging–Phase I that further supports the Iowa Department of Transportation’s (DOT’s) desire to explore how a dynamic advisory system might work within the Iowa DOT Intelligent Transportation Systems (ITS) platform through data obtained for a segment of I-35. The evaluation contrasted sensor-driven messages (dynamically derived), based on an algorithm developed in Phase I, with measurements of speed data under various winter weather conditions. In addition, other data inputs such as friction sensors were considered by comparing their outputs to traffic sensor data. Overall, the dynamic advisory messaging system performed as desired by providing alerts of deteriorating conditions during severe winter events. The system can also identify other sources of traffic impacts outside of winter weather conditions, such as slow speeds that occur as a result of an incident. The signature of winter events was present in both the friction and traffic data; however, the friction data at times had more latency. This may be due to the different data reporting frequencies. The findings showed that speed sensors provided awareness of winter events as well as other non-weather related traffic slowdowns.

Related Resource:

Analysis of Dynamic Advisory Messaging—Phase II, Center for Transportation Research and Education, Iowa State University, August 2018.
This two-page brief summarizes the key findings of the Phase II project.

Intelligent Transportation Systems (ITS) and Communications Systems Service Layer Plan, Version 1.0, Iowa Department of Transportation, January 2018.
From the executive summary:

This Intelligent Transportation Systems (ITS) and Communications Systems Service Layer Plan provides a guide for the deployment of ITS technology and solutions along with the network communications system that underpins ITS and many other services in Iowa. This service layer plan is one of the eight service layers of the Iowa Department of Transportation’s (DOT) Transportation Systems Management and Operations (TSMO) program. The plan demonstrates how the specific objectives from the ITS and communications systems service layer correspond to and support the overall objectives of the TSMO program plan. The systems and technologies addressed in this service layer plan are divided into the following three general categories:

- Monitor—Assessing the real-time state of the transportation system, including traffic flow, disruptive incidents and environmental conditions.
- Manage—Communicate pertinent travel-related information to motorists and alleviate congestion and improve safety by advising and/or controlling traffic in real time.
- Connect—Providing network communications to connect people, devices and systems.

The report includes an inventory of DMS throughout the state and in metropolitan areas, and a gap analysis. Focused strategies for DMS use are presented in Section 4.3 (page 56 of the report, page 66 of the PDF). Researchers noted that “[t]he current state of mobile technology along with the anticipated introduction of connected vehicles will have a direct impact on the usefulness of fixed DMS. This is because each of these technologies provides the ability to send notifications directly to drivers in their vehicles. These messages can be customized for each driver based on location and other factors. It is recognized that as this in-vehicle technology becomes more widespread, the need to convey information using fixed DMS to drivers will diminish.” According
to some estimates, they added, “it may take up to 20 years before most vehicles on the roadway are equipped with connected vehicle technology. Therefore, because the benefits of DMS are sufficiently great and the needed in-vehicle technology is not adequately widespread among the traveling public, it is recommended to continue Iowa’s DMS program for the time being.”

**Multi-Purpose ESS/ITS Data Collection Sites**, Neal Hawkins and Chris Albrecht, Iowa Department of Transportation, May 2014.  
[https://lib.dr.iastate.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1083&context=intrans_reports](https://lib.dr.iastate.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1083&context=intrans_reports)

*From the abstract:*

This document presents the results of a state-of-practice survey of transportation agencies that are installing intelligent transportation sensors (ITS) and other devices along with their environmental sensing stations (ESS) also referred to as roadway weather information system (RWIS) assets. Details about the current state of the practice for combining traffic and atmospheric data collection technologies with DMS use are presented in two groups of case studies: icy conditions (page 16 of the report, page 28 of the PDF) and low-visibility conditions (page 20 of the report, page 32 of the PDF).

**Kansas**

*Note: Two citations below are from the 2017 FHWA publication *Best Practices for Road Weather Management*, which presents 27 case studies detailing state efforts to employ road weather management strategies in response to various weather threats. In the FHWA report, each study includes a brief description of the system, its components, operational procedures, resulting transportation outcomes and implementation issues.*


This case study outlines the development of KanDrive, “a one-stop gateway for travel information in Kansas and surrounding states.” KanDrive is an upgrade to Kansas DOT’s earlier traveler information system that provided road condition information through a website and a toll-free hotline. Features of the improved road weather information system include an interactive 511 map, camera views in locations throughout the state, current DMS messages and weather-related information for travelers.

**Related Resources:**

- **KanDrive**, Kansas Department of Transportation, undated.  
  [http://www.kandrive.org/kandrive/roads/#devices/I-35/-98.41/38.3957/7](http://www.kandrive.org/kandrive/roads/#devices/I-35/-98.41/38.3957/7)

  This website provides access to the interactive map of Kansas’s road weather information system.

- “**KDOT Launches KanDrive, a One-Stop Shop for Roadway Information and Weather Along the Road,**” News Release, Kansas Department of Transportation, December 16, 2009.  

  *From the news release: How are road conditions east of Topeka on I-70? Is there a traffic accident slowing my evening commute? Where are work zones on Kansas highways? These are some of the questions that drivers can find answers to, thanks to KanDrive ([www.KanDrive.org](http://www.KanDrive.org)). … Site features include:*
• An interactive map of Kansas roads, work zones, traffic incidents and surface-related weather conditions (http://511.ksdot.org).

• Snapshots from more than 30 closed-circuit cameras along I-70 between Topeka and Colorado and along other highways in the state, as well as camera views from the KC Scout system.

• Important messages displayed on roadside dynamic message signs that advise travelers of key weather-related driving issues, traffic accidents, work zones and AMBER Alerts.

• Links to related helpful transportation resources, including KC Scout; the future Wichita Traffic Management Center (TMC); state, county and city travel maps; [and] links to neighboring states’ travel information, Kansas Turnpike information, and resources on preparing for winter travel, rest area locations, Scenic Byways and more.


This case study summarizes the joint efforts of Kansas and Missouri DOTs to develop and operate Kansas City Scout (KC Scout), a comprehensive traffic congestion management and traveler information system. The system’s core platform, TransSuite Advanced Traffic Management System (ATMS), integrates weather information with traffic management data that is used to control and monitor the system’s closed circuit televisions (CCTVs), DMS and vehicle detection stations (VDS). ATMS allows the system “to integrate weather information into the user interface as another ‘layer’ utilizing the data available from external weather information sources, such as National Oceanic and Atmospheric Administration (NOAA), National Weather Service’s (NWS) National Digital Forecast Database (NDFD) and Meridian-511 providers.

From the report:

System Components: The KC Scout ... is an integrated system of 138 CCTVs, 38 DMS, 277 VDS, a highway advisory radio (HAR) system and a dynamic website offering users the capability of designing their own customized alert messaging profiles. The user-interface utilizes a series of “layers” that visually represent infrastructure (CCTVs, DMS, VDS), traffic incidents, scheduled events (roadwork) and special events (heavy traffic stadium/concert events). The new ATMS software binds the various sensing components, communications infrastructure, weather information, and user interfaces.

System Operations: The Windows/SQL-based TransCore product has streamlined all the processes associated with creating and monitoring traffic incidents, activating and updating DMS message boards and linking all pertinent incident information—including weather—into easily accessible databases and reporting tools.

As an example, when a weather condition exists that meets pre-selected alert threshold criteria, a “layer” will “activate” on the operator’s ATMS desktop map application, signaling creation of a weather event type “incident” with applicable DMS messaging and outputs to Scout’s website and subscriber-configured WebAlert applications.

Furthermore, during winter storm events, MoDOT’s traffic department staffs a separate workstation within the TMC, solely for the purpose of monitoring road conditions and reporting on the snowplow activity within its local coverage area. This is of great assistance to KC Scout operations because the information can be used to post DMS messages in advance of the plows, helping to keep those lanes clear of through traffic that would otherwise impede plowing activity.
Kansas City Scout Weather Integration Plan, Nancy Powell, Missouri Department of Transportation and Kansas Department of Transportation, March 2010.  

This report outlines the process followed by Kansas and Missouri DOTs to integrate weather information into KC Scout.

**Michigan**


From the project overview:

The Michigan Department of Transportation (MDOT) has embarked on a statewide evaluation aimed at evaluating the statewide road weather program. The purpose of this project is to take a comprehensive statewide look at existing and planned deployments of weather resources, summarize best practices from around North America, and evaluate new technologies or trends that may enhance the RWIS program. As a result of these tasks, a “stepped” deployment plan will be developed that identifies short-term and long-term initiatives MDOT should focus their resources on to maximize benefit from their Road Weather Information System (RWIS) program.

Existing or emerging technologies for Michigan DOT’s statewide road weather program are evaluated. Planning for Michigan DOT’s Wx-TINFO implementation project is featured, including project partners and details about the pilot’s location and data collection efforts. Figure 3-1 illustrates the system architecture (page 3-3 of the report, page 14 of the PDF), and Table 4-1 provides potential benefits and uses of DMS (page 4-2 of the report, page 27 of the PDF). Gaps in the technology—including a scarcity of DMS in outlying areas—are briefly discussed.

**New Mexico**

http://dot.state.nm.us/content/dam/nmdot/ITS/NMDOTDMSManual.pdf

The purpose of this comprehensive manual is to standardize the operation and placement of messages on statewide DMS, which are used “to inform motorists of road and traffic conditions, primarily as [they relate] to incidents and weather-related events” and intermittently for “safety-related, public service messages specific to transportation initiatives.” The manual presents operations policies and regulations, messaging design considerations and priorities, operating fundamentals and example messages.

**New York and New Jersey**


From the introduction:

The Port Authority of New York and New Jersey (PA) ITS Design Guidelines provide planning and design guidance for procurement and construction of Intelligent Transportation Systems (ITS) field devices. The purpose of these guidelines is to ensure the proper and consistent deployment of ITS to support PA transportation operations.
Chapter 4 of these guidelines provides design and structural considerations for developing and deploying DMS (beginning on page 8 of the report, page 12 of the PDF). Similar guidance for RWIS is provided in Chapter 9 (beginning on page 33 of the report, page 37 of the PDF). Chapter 12.5.2 provides information about the communications protocol used for DMS (beginning on page 50 of the report, page 54 of the PDF). A DMS design checklist is provided in Appendix A (beginning on page 57 of the report, page 61 of the PDF).

**North Dakota**


*From the executive summary:*

The main focus of the [ITS] plan is on statewide projects in non-urban areas. ... Since completion of the first Statewide ITS Plan nearly a decade ago, the NDDOT has been deploying various ITS systems and technologies. The main focus of ITS deployment has been in the ITS service areas of [n]etwork [s]urveillance: where a network of cameras and Road Weather Information Systems (RWIS) cover the major highways in the state; [w]inter [m]aintenance: where a maintenance decision support system (MDSS) is utilized to determine the course of action for dealing with a weather event; and [i]nformation [d]issemination: traveler information website for desktop and mobile devices and Dynamic Message Signs (DMS) at key locations that relay information about road conditions to travelers.

DMS, the primary roadside devices used for disseminating traveler information in the state, are briefly discussed in Section 5.1.3 (page 22 of the report, page 30 of the PDF).

**Pennsylvania**


*From the introduction:*

... *Intelligent Transportation Systems Design Guide* focuses on deployment guidelines and the design process for the deployment of [i]ntelligent [t]ransportation [s]ystems (ITS) projects. This publication supplements PennDOT Publication 647M, Civil and Structural Standards for Intelligent Transportation Systems. The purpose of this publication is to ensure the proper deployment of ITS field devices to support PennDOT transportation operations.

Chapter 3 of these guidelines (beginning on page 21) provides design and structural considerations for developing and deploying DMS. A DMS design checklist is provided in Chapter 10.2 (beginning on page 114).

**South Dakota**


The purpose of this project is to “integrate data from a number of road weather and traffic information sources into a strategy to provide pre-trip and en route guidance to travelers.” The Weather Responsive Travel Management implementation project supplements the current capabilities of South Dakota’s Advanced Traveler Information System (ATIS) by providing travelers with road condition data collected by South Dakota’s winter maintenance vehicles. Among the strategies explored in this project is evaluating formats for delivering road condition reports to drivers through DMS. However, “the constraints on message size, demand for use of the signs for other advisory message content, and hurdles in establishing a protocol [between Iteris and South
Dakota DOT] for supporting ATIS content may limit the potential for, or even preclude use of, DMS for weather-related messages. Nevertheless, content will be developed for DMS messages, though criteria for their use may not be settled during the timeframe of this project.”

**Texas**

https://static.tti.tamu.edu/tti.tamu.edu/documents/0-5278-1.pdf

*From the abstract*: The goal of this research was to help the Texas Department of Transportation (TxDOT) develop a structured, systematic approach for managing traffic during weather events. The focus in this research project was on common weather events—such as fog, high winds, heavy rains, and snow and ice storms—that impact traffic operations day-to-day. First, the authors conducted a survey of selected TxDOT districts to determine what information traffic management center (TMC) operators need to manage traffic operations during weather events. Through a review of the existing literature, the authors assessed systems and technologies that other states have deployed to manage traffic during weather-related events. They reviewed the current state of weather-related detection and monitoring technologies. Using historical traffic detector and weather information, they assessed the magnitude of the impact of different weather events on traffic operations. Using all this information, the authors developed concepts of operations for how TMC operators should respond to different types of weather-related events, including limited visibility conditions, ponding and flash flooding, high winds, severe thunderstorms, tornados and winter storms. They developed a catalog of advisory, control and treatment strategies (or ACTS) that operators could use to manage traffic operations during weather events. Specific criteria outline when TxDOT TMC operators should implement different types of responses. The authors proposed messages that TxDOT TMC operators can use on dynamic message signs (DMSs) to achieve different advisory and control strategies for different types of weather events. Finally, the authors provided a framework that TxDOT can use to integrate weather information from the National Weather Service and other private weather providers into its TMC operations software.

**Wisconsin**


*From the introduction*:

This document outlines the policies and procedures for the operation of WisDOT’s Traffic Management Center’s (TMC) Dynamic Message Signs (DMS), and was created for personnel in state, regional and local transportation agencies that have responsibility for the operation of and/or message design for permanent DMS.

Practices for relaying messages about adverse weather conditions begin on page 9 of the document. Guidelines for general message design begin on page 4 of the document.


*From the introduction*: The timing of the state’s latest round of winter weather coincides well with the announcement of a new partnership between the Wisconsin Department of Transportation (WisDOT) and the National Weather Service (NWS) serving Wisconsin.
“WisDOT will use its 511 travel information resources and statewide dynamic message signs (DMS) to alert Wisconsin travelers of various winter storm events,” said Paul Keltner, State Traffic Operations supervisor. “These are storms that NWS predicts will have significant impacts on highway traffic safety, such as: winter storm warnings, blizzard warnings, ice storm warnings and lake effect snow warnings.”

**Other Related Resources**

Below are domestic and international resources that address DMS practices and policies. Among the topics addressed in this section are DMS messaging and the impact of DMS messaging on traveler behavior.

**Domestic**

This document summarizes comments from transportation department officials about their agencies’ policies for posting safety messages and traffic fatality counts on DMS and CMS. Safety messages—either creative or compliant with the National Highway Traffic Safety Administration—are posted in addition to real-time traffic information, such as weather advisories.

Citation at [https://trid.trb.org/view/1241025](https://trid.trb.org/view/1241025)  
*From the abstract*: The paper describes the state-of-the-practice in weather-responsive traffic management in the US and Europe including the types of strategies, systems and tools being used, their similarities, and their effectiveness in traffic operations. The paper also describes the relevant research activities being undertaken in both countries and how they can coordinate and benefit from each other’s efforts. ... [G]aps in current practices and research related to weather-responsive traffic management are identified, and recommendations on how these gaps can be filled are described.

[https://www.ugpti.org/resources/reports/downloads/mpc09-211b.pdf](https://www.ugpti.org/resources/reports/downloads/mpc09-211b.pdf)  
*From the abstract*:  
Traveler Information Systems, a part of the larger field of Intelligent Transportation Systems (ITS), were originally utilized in urban areas to reduce congestion. Traveler information has become increasingly important in rural areas, especially in areas with adverse weather conditions such as Wyoming. Dynamic message signs (DMS) are often used to provide information during a traveler’s trip. Current research literature does not contain guidance for the rural use of DMSs. This report analyzes the effectiveness of traveler information, with a focus on the use of DMSs on the I-80 corridor between Laramie and Cheyenne in southeast Wyoming, using several different methods including surveys of both frequent and random travelers and a statistical analysis of the correlation between speed, weather and DMS data. The current message decision system utilized by the Wyoming Department of Transportation (WYDOT) is also described and evaluated.

Traveler surveys were among the strategies used to analyze the consistency and effectiveness of DMS. Survey results indicated that DMS were the most common method for drivers to learn about current road conditions.
When asked what actions they took in response to DMS, most drivers reported that they drove more slowly and carefully after reading the message.

*Related Resource:*

Citation at [https://www.ugpti.org/resources/reports/details.php?id=620&program=mpc](https://www.ugpti.org/resources/reports/details.php?id=620&program=mpc)
Findings from Phase I of the previous citation are presented in this report.

*International*


*From the abstract:*

Intelligent transport systems have a huge importance during adverse weather conditions. These systems call the drivers’ attention to possible dangers by the use of variable message signs [VMS] installed along the motorways. Several researchers have dealt with the connection of weather and traffic safety in the last decades, but they have not investigated the effects of weather-related messages. This paper examines the impact of weather-related warning messages on traffic in adverse weather circumstances on the Hungarian motorways. Three independent databases were analyzed in order to compare the speed-reducing effect of specific signs during different weather events and precipitate intensities.

Researchers concluded that in response to VMS, drivers reduced their vehicle speed by 5 to 10 kilometers per hour and increased their attention to driving behaviors (such as using mirrors more frequently).

**Creative Safety Messages**

Below are documents and resources about creative safety message practices in two categories:

- National research and guidance.
- State practices.

*National Research and Guidance*


*From the abstract:*

This project conducted an online search to gather state, provincial, local and federal policies and guidelines for DMS messaging. The search also included documenting related DMS studies or efforts. Transportation agencies were also contacted to provide additional details on information gathered through the online search. In addition, ENTERPRISE members provided input throughout the duration of the project to enhance the search for DMS messaging related documents and guidelines. A survey was distributed to state, local and provincial transportation agencies to gather additional details on the DMS message requests received by transportation agencies as well as the policy or process for handling DMS message requests. The project also researched the potential for public-private partnerships for DMS deployment and operations and documented a few potential future scenarios for connected and automated vehicle implications on DMS.

From the abstract: The objective of this project was to assess the effectiveness and potential benefits of posting public service announcements (PSAs) in rural areas by surveying a variety of travelers in those areas, including local residents, tourists and long-haul truck drivers. This project addressed a number of questions related to safety awareness and PSA messages on dynamic message signs (DMS), including driver awareness, driver understanding, changes in driver behavior and drivers’ opinions. Study findings provide an understanding of the usefulness and effectiveness of using DMS for safety and PSA campaigns, providing a basis for recommendations to influence and/or improve agencies’ guidelines, policies, and operations on using DMS as a tool for safety and public service campaigns.


This study evaluated how safety and public service announcement (PSA) messages influence driver behavior. Researchers surveyed drivers in Chicago; Houston; Orlando, Fla.; and Philadelphia about safety and PSA messages for each respective city. From the executive summary:

Most respondents reported that they do see safety and PSA messages on DMS while driving, at least sometimes. The majority also noted that safety and PSA messages on DMS are useful, with some even noting that those messages are more effective on DMS as compared to other media (such as television).

Furthermore, the survey asked about safety and PSA messages that have a more threatening connotation. The majority of respondents indicated that such messages like “Click it or ticket or get $100 fine” or “100 deaths this year on Texas road,” would impact their driving behavior. In Chicago, respondents indicated that they would change their driving behavior for messages that relate to slowing down for emergency vehicles and in construction zones. Houston respondents indicated that messages that would most affect their driving are those with more assertive language (e.g., “Drunk driving, over the limit, under arrest”). Orlando motorists were most likely to change their driving behaviors for all safety and PSA messages; while, Philadelphia motorists were neutral on the effects of safety and PSA messages on their driving.

In addition, the perceived usefulness of safety and PSA messages was examined in a binary logit model. The model showed that the messages were considered useful if the driver encountered them often. Respondents also thought that those messages could be effective in changing behavior. Hence, greater exposure to such messages impacts the perceptions of the messages.

In three of the locations, drivers that considered driving under the influence (DUI) messages (Philadelphia, Chicago, Houston) and speeding messages (Orlando, Chicago, Houston) important also found safety and PSA messages to be useful. In two of the locations, individuals younger than 30 years old did not think that safety and PSA messages were useful.

Similarly, the perceived effectiveness was analyzed in a binary logit model, where all responses were aggregated together, ignoring locational factors. Safety and PSA messages were considered more effective when they were encountered often. They were considered useful for respondents older than 60 years old.
and respondents who had some graduate school or a post-graduate degree. Males with an income less than $25,000 per year and individuals younger than 30 years old did not perceive safety and PSA messages on DMS to be effective.

The general recommendation based on the surveys was that safety and PSA messages need to be considered useful and effective to maximize their influence on driver behaviors. Certain socioeconomic characteristics influence drivers’ perceptions of these messages. For instance, younger respondents were less likely to consider the messages effective, and future efforts should be focused on promoting awareness targeted toward this group. Respondents also indicated that they took assertive safety and PSA messages seriously, but further examination should consider the magnitude of this impact.

State Practices

Delaware


As part of a statewide strategic safety plan, Delaware DOT plans to use DMS to post creative safety messages related to weather, construction, crashes and other issues.

Florida


From the introduction: Florida’s Turnpike Enterprise (FTE) continually seeks to identify new ways to make its roadways safer. Recently, FTE Traffic Operations, Incident Management and staff from the Public Information Office have been coordinating with the Florida Highway Patrol (FHP) to increase outreach and awareness of safe driving behaviors, focusing their promotion in advance and throughout this busy holiday travel season. This effort has resulted in a myriad of outreach options and creative ways to bring the message to motorists.

FTE has been focusing on reducing distracted driving with catchy dynamic message sign (DMS) slogans. ... In October, the messaging cited, “It’s Scary Enough Out Here, Don’t Text and Drive.” Feedback from this effort has been overwhelmingly positive, as seen by recent Twitter input received by statewide Florida 511.

Illinois


To inform travelers about weather, safety, travel times and other driving issues, Illinois DOT hosted a DMS contest and invited Illinois residents to submit clever messages that would help make state roads safer for everyone. Winning messages would appear on approximately 100 DMS throughout the state. Winner perks included a personalized sign and a shout-out on the agency’s social media sites.
Iowa

This American Traffic Safety Services Association (ATSSA) blog post chronicles the creation of Iowa DOT’s Message Monday program, which began as an effort by the agency’s traffic and safety staff to post traffic fatality counts on DMS. The agency later broadened its scope to include creative safety messages, working with communications staff to craft messages. As part of the research for this effort, Iowa DOT spoke with approximately 30 state transportation agencies about their experience using creative safety messages on DMS. (See Section 2.1.3.1, Other Related Resources—Domestic, for the ATSSA summary document that presents the results of these interviews.)

Kentucky

Kentucky Transportation Cabinet’s use of “unconventional safety messages” on the state’s DMS is discussed as a new way to reach the driving public. While the state’s 75 total signs (48 overhead boards and 27 side-mount boards) “will continue to display amber alerts, golden alerts or advanced warnings of construction/accidents, each will also have safety messages.”

Maryland

“Overhead Signs on Maryland Highways Add Humor to Local Commutes,” Michelle Evans, Baltimoremagazine.com, February 27, 2018.
According to Maryland DOT’s Coordinated Highway Action Response Team (CHART), “a little bit of humor goes a long way” when using creative safety messages on DMS during off-peak hours. CHART members meet monthly to develop innovative, meaningful messages that grab drivers’ attention and enhance safety. From the article:

There are 85 DMS signs across the state of Maryland with more appearing every year in strategically placed locations. Each message—humorous or not—is attached to specific safety campaigns that typically run a week at a time and can range from seatbelt safety to driving under the influence. Although the fun messages are eye-catching, media relations manager of MDOT Charlie Gishclar says that during rush hour people are more interested in the important things like travel times and incident reports.

Nebraska

Friday Safety Message Idea Submission, Nebraska Department of Transportation, undated.
This website allowed citizens to submit a “Friday Safety Message” idea to raise safety awareness across Nebraska. The web page included brief suggestion guidelines (message length and appropriate content); suggested topics (such as winter driving safety, distracted and impaired driving prevention, seat belt use and work zone safety); and example messages.
Related Resource:

**NDOT Seeks Witty, Creative Friday Safety Messages**, Nebraska Department of Transportation, May 1, 2018.  
This news release announced Nebraska DOT’s invitation to residents to submit “Friday Safety Messages” for posting on the state’s DMS. From the news release:

After a successful launch last year followed by even more interest in January of 2018, the [Nebraska DOT], in partnership with the Nebraska State Patrol, wants to continue that effort, reaching out to the public for witty, creative messages to display on Dynamic Message Signs (DMS) across the state. A new safety message is posted every Friday, for 24 hours from 12:00 a.m. Friday to 12:00 a.m. Saturday, on overhead DMS along I-80 and I-29, reminding motorists to consider all aspects of driving and safety.

**Tennessee**

The Tennessee DOT’s Dynamic Message Sign Contest is aimed at raising awareness about highway safety. Fifteen winners are selected annually, and the winning messages are placed on DMS located throughout state. In this article, the agency invited residents to vote online for their favorite creative safety message from nearly 3,000 entries.

**Utah**

*From the article:* Each Monday, a different eye-catching slogan is shared on about half of the 160 variable message signs, or VMS boards, around the state. And Message Mondays is being held in conjunction with another campaign, called “Fatality Fridays,” wherein the message boards list the number of fatality-free days in the past week.

**Virginia**

This resource details the guidelines and policies for Virginia DOT’s use of CMS. (The authors note that CMS, DMS and VMS are “often used interchangeably in the transportation industry” and that “CMS best represents VDOT’s use of these signs and is therefore used consistently throughout this document.”)

Acceptable CMS use for safety campaigns is discussed in Chapter 2.1.16 (page 9 of the report, page 10 of the PDF). Unacceptable CMS use for PSAs is discussed in Chapter 2.2.3 (page 11 of the report, page 13 of the PDF) and described below:

Messages designed to relay a public service announcement (catch phrases, greetings, jingles, general safety statements, non-VDOT public meetings, etc.) are not permitted on CMS. Safety campaign messages, as described in Section 2.1.16 and VDOT public hearings as described in Section 2.1.18 may be acceptable.
From the abstract: This study investigated the impacts of existing message strategies to determine messages that maximize diversion for specific circumstances and to develop new messages for future deployment. An analysis was done for various message types and split into two diversion scenarios: (1) an incident on the primary freeway, I-95, encourages diversion of I-95 traffic to an alternate route, I-295; and (2) an incident on an intersecting freeway, I-295, encourages exiting I-295 traffic to remain on I-95 as an alternate route. The results showed trends where the use of particular words in messages is more effective than the use of others in achieving diversion when percentage of diverted traffic was used as the performance measure.

The effects on traffic flow by drivers’ reactions to non-traffic messages were also investigated. Transportation agencies are frequently asked to post public service announcements on DMS when they are not being used for traffic-related purposes. It has been suggested that these messages are a distraction to drivers and result in queuing, creating mobility and safety hazards. An analysis that used speed as the performance measure showed minimal impacts on traffic flow from the display of non-traffic messages during weekday non-peak hours.
Survey of State Departments of Transportation

A survey of state DOTs sought information about the manual or automated deployment of blizzard warnings or other road weather-related messages that appear on DMS located on highway systems. In addition, the survey examined state agencies’ use of DMS to deliver creative safety messages similar to those associated with the Message Monday initiative coordinated by MnDOT’s statewide TZD program.

The survey was distributed to members of two AASHTO committees: the Committee on Traffic Engineering and the Committee on Safety. The survey questions are provided in Appendix A; contact information for survey respondents is provided in Appendix B.

Twenty-two state transportation agencies completed the survey. Of these, one agency—Florida DOT—does not use DMS to post weather-related or creative safety messages. Key findings from the remaining 21 state agencies responding to the survey are summarized below in two categories:

- Weather-related messages.
- Creative safety messages.

Weather-Related Messages

The following 21 state transportation agencies responding to the survey deploy weather-related messages on DMS:

- Alabama.
- Arkansas.
- Colorado.
- Delaware.
- Illinois.
- Indiana.
- Maine.
- Maryland.
- Massachusetts.
- Michigan.
- Mississippi.
- Missouri.
- Nevada.
- New York.
- Ohio.
- Pennsylvania.
- South Dakota.
- Tennessee.
- Vermont.
- Virginia.
- Wisconsin.

Survey results from these state DOTs are summarized below in the following categories:

- Generating weather-related messages on DMS.
- Assessing road weather messaging practices.

Generating Weather-Related Messages on Dynamic Message Signs

In this portion of the survey, respondents discussed the type of weather events that will trigger the use of road weather-related messages on DMS; the process that agencies use to deliver these messages; message composition (whether standard message templates, custom messages or a combination of standard and custom messages are used); and the timing of a DMS message.

Weather Events

Survey respondents were asked to choose the options below that best describe the type of weather events that trigger the deployment of road weather-related messages on their agencies’ DMS:

- Severe thunderstorm warning.
- Tornado warning.
- Flash flood warning.
- Dense fog warning.
• High wind warning.
• Freezing rain.
• Winter storm warning.
• Blizzard warning.

• Any snowfall amount will trigger a DMS message.
• Other.

The weather events most frequently selected by survey participants were winter storm warning (19), high wind warning (17), dense fog warning (16), freezing rain (15) and blizzard warning (14). The least likely weather events to trigger deployment of a road weather-related message were any snowfall amount (8) and severe thunderstorm warning (5).

One state—Alabama—uses road weather-related messages on DMS for all of these weather events. Two states—Maine and Missouri—deploy messages for nine of the ten weather events. In four states—Maryland, Massachusetts, Pennsylvania and Vermont—messages are displayed for eight of the ten weather events. Table 1 summarizes survey responses.

<table>
<thead>
<tr>
<th>State</th>
<th>Severe Thunderstorm Warning</th>
<th>Tornado Warning</th>
<th>Flash Flood Warning</th>
<th>Dense Fog Warning</th>
<th>High Wind Warning</th>
<th>Freezing Rain</th>
<th>Winter Storm Warning</th>
<th>Blizzard Warning</th>
<th>Any Snowfall Amount</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>10</td>
</tr>
<tr>
<td>Arkansas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>2</td>
</tr>
<tr>
<td>Colorado</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>7</td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>5</td>
</tr>
<tr>
<td>Illinois</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>5</td>
</tr>
<tr>
<td>Indiana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>4</td>
</tr>
<tr>
<td>Maine</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>9</td>
</tr>
<tr>
<td>Maryland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>8</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>8</td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>7</td>
</tr>
<tr>
<td>Mississippi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>7</td>
</tr>
<tr>
<td>Missouri</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>9</td>
</tr>
<tr>
<td>Nevada</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>6</td>
</tr>
<tr>
<td>New York</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>4</td>
</tr>
<tr>
<td>Ohio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>2</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>8</td>
</tr>
<tr>
<td>South Dakota</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>3</td>
</tr>
<tr>
<td>Tennessee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>4</td>
</tr>
<tr>
<td>Vermont</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>8</td>
</tr>
</tbody>
</table>
Other Weather Events

Several respondents provided information about other weather events that trigger the deployment of road weather-related messages in their states. The respondent from Maryland DOT State Highway Administration (SHA) noted that in addition to running triggered messages based on sensor information, operators can also either manually create a message or use ATMS plans, which are premade message libraries for DMS. In the past, the agency has been asked to run messaging based on the severity of an upcoming storm. These requests typically come from the Maryland DOT SHA Secretary’s Office, the National Oceanic and Atmospheric Administration (NOAA) for snow squall area messages or the Maryland Emergency Management Agency.

In New York, messages are generally displayed only during severe winter weather. However, messages are also deployed for winds near bridges or areas where there is a risk of trucks blowing over.

The respondent from Tennessee DOT provided eight common scenarios for displaying road weather-related messages (see Table 8 for descriptions of these scenarios along with examples of typical messages for each scenario).

Table 2 summarizes responses from survey participants who provided information about other weather events.

Table 2. Other Weather Events That Trigger Deployment of Road Weather-Related Messages

<table>
<thead>
<tr>
<th>Weather Event</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme rain or high water conditions</td>
<td>Maine, Maryland</td>
<td>Maine. Extreme rains resulting in hydroplaning.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maryland. Road closures due to high water, especially during heavy rainfall.</td>
</tr>
<tr>
<td>Fire danger</td>
<td>Colorado</td>
<td>“Red flag” warnings (high winds and high fire danger).</td>
</tr>
<tr>
<td>Fog</td>
<td>Wisconsin</td>
<td>Localized fog at certain bridges.</td>
</tr>
<tr>
<td>Freeze warnings</td>
<td>Colorado, Tennessee</td>
<td>Colorado. Warm or sunny days with melting followed by refreezing overnight.</td>
</tr>
<tr>
<td>Hurricane and tropical storm warnings</td>
<td>Alabama, Mississippi</td>
<td>N/R</td>
</tr>
<tr>
<td>Icy road conditions</td>
<td>Tennessee, Vermont, Virginia, Wisconsin</td>
<td>Tennessee. See messaging in Table 8.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vermont. Black ice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Virginia. Icy roadways.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wisconsin. Slippery conditions from rain and/or ice.</td>
</tr>
<tr>
<td>Weather Event</td>
<td>State</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NWS watches or warnings</td>
<td>Colorado</td>
<td>N/R</td>
</tr>
</tbody>
</table>
| Severe wind conditions              | Colorado, New York, Tennessee, Wisconsin | \* Colorado. High wind advisories or restrictions.  
\* New York. Wind near bridges or high-risk areas for trucks.  
\* Tennessee. See messaging in Table 8.  
\* Wisconsin. High wind gusts at certain bridges. |
| Severe winter weather               | Indiana, New York, Tennessee  | \* Indiana. Winter weather advisory.  
\* Tennessee. See messaging in Table 8. |
| Significant weather changes         | Colorado                     | Incoming storms, if forecast.                                               |

N/R: No response.

**Message Delivery Process**

The process used by each agency to deliver road weather-related messages was described as one of the following:

- Mostly manual.
- Mostly automated.
- Combination of manual and automated processes.

More than half of the states responding to the survey use a mostly manual process. Only one state—Mississippi—uses a mostly automated process. Seven states—Alabama, Maine, Maryland, Michigan, Nevada, Virginia and Wisconsin—use a combination of manual and automated processes.

The software and hardware used to deliver road weather-related messages varied considerably among survey participants. Responses from survey participants who provided information about these products along with the data sources used by their agencies are summarized below in Table 3 (mostly manual processes), Table 4 (mostly automated processes) and Table 5 (a combination of manual and automated processes). When available, products and vendors used by survey participants are cited in Related Resources following the tables.

**Table 3. Road Weather-Related Message Delivery Process: Mostly Manual**

<table>
<thead>
<tr>
<th>State</th>
<th>System</th>
<th>Vendor</th>
<th>Description</th>
</tr>
</thead>
</table>
| Arkansas  | • Delcon ATMS  
• Iteris weather service | • Delcon  
• Iteris, Inc. | Data from Iteris weather service.                                          |
<p>| Colorado  | Variable message sign (VMS) control software | Kritek LLC        | Data from in-house meteorologist, NWS, field reports, remote weather stations, MDSS software. |</p>
<table>
<thead>
<tr>
<th>State</th>
<th>System</th>
<th>Vendor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts</td>
<td>N/R</td>
<td>N/R</td>
<td>Library of template messages that operators adjust (if needed) and post.</td>
</tr>
<tr>
<td>South Dakota</td>
<td>Vanguard</td>
<td>Daktronics Inc.</td>
<td>N/R</td>
</tr>
<tr>
<td>Tennessee</td>
<td>In-house development</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Vermont</td>
<td>JamLogic</td>
<td>Ver-Mac Inc.</td>
<td>N/R</td>
</tr>
</tbody>
</table>

N/R: No response.

Table 4. Road Weather-Related Message Delivery Process: Mostly Automated

<table>
<thead>
<tr>
<th>State</th>
<th>System</th>
<th>Vendor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mississippi</td>
<td>Intelligent NETworks</td>
<td>Parsons Corporation</td>
<td>ATMS imports weather advisories and warnings directly from NOAA.</td>
</tr>
</tbody>
</table>

Table 5. Road Weather-Related Message Delivery Process: Combined Manual and Automated

<table>
<thead>
<tr>
<th>State</th>
<th>System</th>
<th>Vendor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>N/R</td>
<td>Parsons Corporation</td>
<td>N/R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Daktronics Inc.</td>
<td></td>
</tr>
<tr>
<td>Maine</td>
<td>Compass</td>
<td>Southwest Research Institute</td>
<td>N/R</td>
</tr>
<tr>
<td>Maryland</td>
<td>• In-house, custom-built ATMS&lt;br&gt;• Custom module by General Dynamics Information Technology</td>
<td>General Dynamics Information Technology, Inc.</td>
<td>• Custom module provides database view from state-owned Lufft weather sensors.&lt;br&gt;• Hardware procured via standard state procurement methods.</td>
</tr>
<tr>
<td>Michigan</td>
<td>N/R</td>
<td>N/R</td>
<td>• Specific plan for most regions and districts that best fits area needs and is based on local knowledge and available tools.&lt;br&gt;• In most cases, Michigan DOT either uses an automated response plan in ATMS that utilizes data from Environmental Sensor Stations (ESS) or manually implements a predetermined response plan based on observed weather conditions.</td>
</tr>
<tr>
<td>Nevada</td>
<td>• Software: KITS</td>
<td>Kimley-Horn and Associates, Inc.</td>
<td>KITS is used to operate all of the agency’s ITS equipment.</td>
</tr>
<tr>
<td>State</td>
<td>System</td>
<td>Vendor</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| Virginia | OpenTMS | Q-Free ASA | • ATMS primarily automated using OpenTMS.  
|        |         |            | • For weather-related messaging, some manual manipulation for device selection and message format. |
| Wisconsin | N/R    | IBI Group  | • IBI currently developing upgraded ATMS.  
|          |         |            | • Data from NWS and other weather sources.  
|          |         |            | • Weather events added by county/region.  
|          |         |            | • Automated process: DMS selected based on event location (all DMS within county); message content based on weather warning type and scheduled time frames.  
|          |         |            | • Ability to add unique messaging to an approved library.  
|          |         |            | • Manual message can override other messages. |

N/R: No response.

**Related Resources**

Resources about the products and vendors used by survey participants for road weather-related messaging are provided below when available.

**Alabama and South Dakota**

**Vanguard v4 Control Software**, Daktronics Inc., undated.  

*From the website:* Vanguard Version 4 Central Control Software continues Daktronics’ tradition of releasing robust Dynamic Message Sign (DMS) software since 1988.

**Arkansas**

https://www.iteris.com/services/weather-and-meteorological-support

*From the website:* Iteris’ Weather Services Operations focuses heavily on the delivery of technologically-advanced weather and pavement condition forecasts for any highway or bridge location within an agency’s responsibility.
Colorado

**Kritek LLC**, Kritek LLC, undated.
http://kritek.org/

*From the website:* Kritek, LLC provides an innovative Advanced Traffic Management System (ATMS) capable of comprehensive device and data management as well as integration with other services and an Advanced Transportation Information System (ATIS) by which that data is communicated to the public.

Indiana

https://www.crc-corp.com/

*From the website:* Castle Rock was founded in 1984 and remains a leader in the development, integration, deployment, and hosting of ITS (Intelligent Transportation Systems) solutions. While we have been at the forefront of many cutting-edge ITS developments throughout our company’s history, the CARS and MODES platforms are now at the very heart of our business. CARS is a modular system that provides 511, ATIS, open data sharing, and other traffic- and transportation-related functions. MODES is a platform that allows transit agencies of any size to create and maintain GTFS [General Transit Feed Specification] and GTFS-real time data.

Maine

**Advanced Transportation Management System (ATMS)**, Southwest Research Institute, undated.

This two-page brochure includes a reference to the New England Compass, the ATMS software used by Maine DOT.

Maryland

**General Dynamics Information Technology**, General Dynamics Information Technology, Inc., undated.
https://gdit.com/

*From the website:* [GDIT integrates] state-wide highway traffic management systems and data enabling State Operations Centers to manage roadway accidents, conditions, lane closures, camera video, and information sharing via highway signs and radio frequencies.

Mississippi

**Intelligent NETworks**, Parsons Corporation, undated.

This two-page brochure provides an overview of Intelligent NETworks’ features and capabilities.

Nevada

https://www.kimley-horn.com/service/technology/software-development/kits-advanced-traffic-management/

*From the website:* KITS integrates our proven arterial control functionality with a wide variety of ITS devices and analysis tools supported by our proven Freeway Management System (FMS). In addition to traditional signal and freeway device support, KITS integrates the latest technologies for ATMS including transit priority integration, congestion management, and multiple protocol support.
Vermont

**JamLogic Fleet Management Software**, Ver-Mac Inc., undated.

This two-page brief summarizes the capabilities of JamLogic.

Virginia

**Advanced Traffic Management System (ATMS)**, Q-Free ASA, undated.
[https://www.q-free.com solution/traffic-management-centre/](https://www.q-free.com solution/traffic-management-centre/)

*From the website:* OpenTMS, Q-Free’s off-the-shelf, cloud-enabled ATMS, is a platform-independent, extensible, ATMS solution built around an open, modular architecture. OpenTMS runs in a web browser and is designed to support the dynamic traffic management marketplace where configurability and customization [are] of primary concern as enterprise architectures, GIS and database technology, and ITS devices are continually evolving.

Wisconsin

**Advanced Traffic Management**, IBI Group, undated.
[https://www.ibigroup.com expertise/mobility/](https://www.ibigroup.com expertise/mobility/)

*From the website:* Our comprehensive system gives operators a real-time view of network conditions and incidents, featuring controllable video coverage and message display output.

**Messaging**

The DMS messages created for weather-related events are developed using one of the following:

- Standard message templates.
- Custom DMS messages developed for each weather-related event.
- Combination of standard message templates and custom messages.

**Standard Message Templates**

Five states—Massachusetts, Michigan, Mississippi, Nevada and Wisconsin—use a standard message template. Some survey respondents reported on the standard message templates stored in their agencies’ ATMS, including Mississippi DOT, which creates response plans for most DMS messaging within the agency’s system. Nevada DOT stores message templates in KITS for access at any time. Both Mississippi and Nevada DOT respondents noted that custom messages are rarely used but can be created if more information about a weather event is needed. The respondent from Massachusetts DOT reported on the use of an extensive library of weather messages developed with other New England states for consistency. In Wisconsin, the goal for DMS is to provide accurate weather warning information in one phase using a three-line message. The first line of the message defines the warning type; the second, the event time frame; and the third, the action travelers should take.

**Custom Messages**

Two states—Arkansas and Illinois—develop custom DMS messages for each weather-related event. These messages are developed by TMCs in Arkansas and by district offices in Illinois. Both agencies rely on agency-specific DMS guidelines to develop messages. The respondent from Illinois DOT provided the following excerpt from the agency’s policy on DMS use regarding weather messages:
DMSs may be used to display adverse weather, environmental or roadway conditions. Information must be confirmed either from personnel on-scene, roadway weather data, or the National Weather Service. In general, weather information should be location specific and not readily apparent to motorists. Proper messaging may include fog, flooding, major snowstorms, icy roadway, high cross winds and severe weather warnings. The DMS may also be used to advise of specific recommendations due to the weather or roadway conditions.

**Combination of Standard and Custom Messages**

More than half of the states responding to the survey use a combination of standard message templates and custom messages. Responsibility for message development was varied among these states, and included statewide transportation management center (TMC) staff, an interagency working group and DOT maintenance and operations staff. In South Dakota, any authorized user can create a custom message, including some central office and region traffic engineers, project engineering supervisors, project engineers, project technicians, area engineers, transportation research engineers, the director of operations, construction and maintenance engineers, region operations engineers, region bridge engineers, region engineers, highway maintenance supervisors and workers, equipment shop foremen and beautification/billboard technicians.

Frequently agencies with a combined process use standard templates for most messages and custom messages for unique weather or location-specific events (Colorado, Delaware, Missouri, Pennsylvania and Virginia). Both New York State and South Dakota DOT respondents reported trying to standardize the messages used; New York State DOT is also trying to limit the messages used. The respondent from Alabama DOT noted that the agency uses standard templates on most permanent DMS, while temporary DMS are entered with each event.

In Maryland, the Coordinated Highways Action Response Team (CHART) system governs traffic management. The following excerpt is from the Maryland DOT SHA’s CHART policy on DMS use:

1.1 Triggers

CHART ATMS allows triggers to be defined that activate and deactivate based on one or more conditions which they contain. An example of a condition would be “pavement sensor from weather station XYZ is reading a temperature of less than 32 degrees Fahrenheit.” When all conditions within a trigger evaluate to true, the trigger is considered to be active. Otherwise the trigger is considered to be inactive. While triggers don’t perform any other action besides becoming active or inactive, they can be used in other areas of the system which perform actions based on the trigger’s current state (see Automatic Weather Messages below). Users can view the list of triggers defined in the system including all conditions contained within the trigger and can view the current state of each condition and the overall state of the trigger. Users with the appropriate rights can add, edit and remove triggers, or enable and disable triggers.

1.2 Automatic Weather Messages

CHART ATMS allows messages related to weather conditions to be automatically displayed on DMS devices, played on HAR [Highway Advisory Radio] devices, or in the case of an on/off device, activate a weather related device (such as a Fog Horn). This is accomplished through triggered messages (DMS/HAR) and triggered activations (On/Off Devices). Triggered messages and activations are added to and removed from the device arbitration queue based on the current status of an associated Trigger. When the associated trigger becomes active, the device adds the triggered message/activation to its Arbitration Queue and when the trigger becomes inactive the device removes the triggered message/activation from its arbitration queue. A setting in each triggered message specifies the Arbitration Queue bucket where the message is to be added. For On/Off Devices where Arbitration Queue priority is not relevant, a system profile setting...
specifies the Arbitration Queue bucket where all triggered activations will be placed for all On/Off Devices. The system profile also contains settings to allow triggered messages and activations to be enabled/disabled system wide.

When a triggered message or activation is on a device’s Arbitration Queue, the normal Arbitration Queue prioritization and message combination rules will determine which message is placed on the device (DMS/HAR). As mentioned previously, the presence of any entry on the queue of an On/Off Device will cause the On/Off Device to be activated.

3B. A working group comprised of Operations Management, Integration and Program Management from both MDOT SHA and MDOT MDTA [Maryland Transportation Authority] developed the weather messaging triggers and message content. Yearly reviews of the program are done each summer.

3C. The automated triggers are meant to be geographically focused first response to winter conditions. Operations may at any time improve the messaging. The CHART ATMS uses a concept of message arbitration that automatically prioritizes message display based on defined business rules. Winter weather messaging resides in the Very High arbitration queue bin. Essentially the automated messages (weather messaging, travel time and toll rates) are automatically accounted for in our business logic to either over-ride or not display based on its position in the arbitration queue (no user involvement).

Survey responses are summarized in Table 6 (standard message templates), Table 7 (custom messages) and Table 8 (a combination of standard and custom messages). Information about agency business areas responsible for developing messages, guidance for message development and example messages is included when provided by respondents.

Table 6. Agency Process for Message Delivery: Standard Message Templates

<table>
<thead>
<tr>
<th>State</th>
<th>Responsibility</th>
<th>Description and Sample Messages</th>
</tr>
</thead>
</table>
| Massachusetts | Highway Operations Center with Highway Administrator’s office | • An extensive library of weather messages developed with other New England states for consistency.  
• Messages run as needed. |  
| Michigan      | N/R                                                 | Sample messages provided in MDOT Dynamic Message Sign Guidelines and regional messaging plans (see Section 3.1.2.5, Supporting Documents). |  
| Mississippi   | N/R                                                 | • Response plans created within ATMS for most DMS messaging.  
• Agency business rules used to create message based on TMC operator’s data entry.  
**Example:** TORNADO WARNING/HINDS COUNTY/UNTIL 7 PM |  
| Nevada        | N/R                                                 | • Message templates saved in KITS for access anytime.  
• Custom messages rarely used, but operators can create to provide more detail about weather event.  
**Example** (snow but no chain control): WINTER DRIVING CONDITIONS/REDUCE SPEED |  
| Wisconsin     | Bureau of Traffic Operations                        | • Goal: Provide accurate weather warning in one phase.  
  o Line 1: Warning type (winter storm, blizzard and ice).  
  o Line 2: Time frame from NWS alert. |
Table 7. Agency Process for Message Delivery: Custom Messages for Each Weather-Related Event

<table>
<thead>
<tr>
<th>State</th>
<th>Responsibility</th>
<th>Description and Sample Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td>TMC</td>
<td>Develop custom messages using DMS guidelines.</td>
</tr>
<tr>
<td>Illinois</td>
<td>District offices</td>
<td>See DMS policy excerpt on page 41.</td>
</tr>
</tbody>
</table>

Table 8. Agency Process for Message Delivery: Combined Standard and Custom Messages

<table>
<thead>
<tr>
<th>State</th>
<th>Responsibility</th>
<th>Description and Sample Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>N/R</td>
<td>Standard templates on most permanent DMS; temporary DMS for each event.</td>
</tr>
</tbody>
</table>
| Colorado| Combined feedback from staff meteorologist, maintenance lead and operations personnel | • Messaging tailored for specific roads or areas depending on forecast.  
• VMS guidelines include suggested message content; operations personnel modify or edit messages for weather event.  
**Examples:** HEAVY SNOW/ICY CONDITIONS EXPECTED THURSDAY THROUGH SATURDAY HEAVY SNOW/ICY CONDITIONS EXPECTED AFTER 10PM SNOW FORECAST AFTER 8AM/EXPECT CHANGING CONDITIONS HEAVY SNOW/HIGH WINDS OVERNIGHT/VISIBILITY MAY BE LIMITED |
| Delaware| Statewide TMC staff develops message; TMC supervisory staff initiates message broadcasting. | • Standard language for winter weather events.  
• More location-specific information for wind, fog or rain events. |
| Indiana | N/R            | • Several standard custom messages.  
**Example:** WINTER STORM WARNING (or BLIZZARD WARNING or ICE STORM WARNING)/REDUCE YOUR SPEED/DO NOT TAILGATE |
<table>
<thead>
<tr>
<th>State</th>
<th>Responsibility</th>
<th>Description and Sample Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>N/R</td>
<td>Try to use standard messages so staff can use auto-fill instead of typing new messages.</td>
</tr>
</tbody>
</table>
| Maryland    | Maryland DOT SHA and Maryland Transportation Authority operations management, integration and program management | - Working group develops weather messaging triggers and message content.  
- Program reviewed annually (each summer).                                              |
| Missouri    | N/R                                                                            | - Templates used for most messages.  
- Custom messages created for unique or severe storms (e.g., if dangerous conditions such as large amounts of ice on roadway, message may ask motorists to stay home). |
| New York    | Office of Traffic Safety and Mobility (in the Operations Division)              | - Trying to standardize messages and limit to HEAVY SNOW EXPECTED/AVOID TRAVEL and POOR DRIVING CONDITIONS/REDUCE SPEED  
- Currently revising its guidance.                                                      |
| Ohio        | N/R                                                                            | N/R                                                                                                                                                         |
| Pennsylvania| N/R                                                                            | - Department develops custom message if needed.  
- Every weather situation assessed differently because of varied weather events in state. |
| South Dakota| Any authorized user                                                             | - Trying to standardize messages but custom messages used frequently, depending on situation.  
- Guidance and sample messages provided in Guidelines for the Operation of Dynamic Message Signs (see Section 3.1.2.5, Supporting Documents). |
| Tennessee   | N/R                                                                            | **Example scenarios and messages:**  
- Roads are not yet covered or partially covered, but winter weather is being experienced:  
  ROAD CONDITIONS/REDUCE SPEED/MAY CHANGE DURING USE/CAUTION/WET CONDITIONS/ICY CONDITIONS/ICE AND SNOW POSSIBLE/USE CAUTION/TAKE IT SLOW  
- Mainline roads are covered or partially covered:  
  ICE AND SNOW COVERED ROADWAYS/TAKE IT SLOW/REDUCE SPEED/USE CAUTION |
<table>
<thead>
<tr>
<th>State</th>
<th>Responsibility</th>
<th>Description and Sample Messages</th>
</tr>
</thead>
</table>
| Vermont      | TMC operators and supervisory staff                    | • Typically use custom templates for weather and all other events.  
• Custom templates created in JamLogic.  
• Try to stay within Manual on Uniform Traffic Control Devices (MUTCD) guidelines.  
**Examples:**  
WINTER WEATHER/WATCH YOUR SPEED  
DENSE FOG/USE CAUTION  
WINTER TRAVEL TODAY/WATCH YOUR SPEED |
| Virginia     | Standard messages developed by state; regional management can modify. | Templates may be customized to:  
• Address weather conditions and estimated time of impact (transportation operations centers (TOCs) will develop slightly modified versions of standard messages).  
• Fit on a given device.  
• Meet area-specific impacts (provide more specific data rather than a general “Use Caution” message).  
**Examples:**  
WINTER STORM/WARNING/TONIGHT, BLACK ICE/POSSIBLE/USE CAUTION |

N/R: No response.
**Timing of Message Delivery**

Survey respondents described a range of practices related to the timing of a DMS message generated to address a forecasted blizzard or other type of significant storm event. In addition to these practices, some of the respondents provided the sources of information they relied on to determine the timing of a winter weather event, primarily NWS but also NOAA and DOT operations and maintenance staff. Table 9 summarizes these weather information sources (when provided).

When messages are displayed varied among respondents who provided information (see Table 10). DOTs in eight states—Delaware, Maine, Mississippi, Missouri, New York, Pennsylvania, South Dakota and Vermont—display messaging before an event. Delaware and Mississippi DOTs also display messages at event onset, and Vermont Agency of Transportation displays messages during the event. Missouri and New York State DOTs begin displaying warning messages during the peak travel period before the event. Both South Dakota and Virginia DOTs only display advance messaging after events have been verified.

Illinois and Indiana DOTs typically only display messages when adverse conditions exist, not before a weather event; however, Indiana DOT will post blizzard warning messages approximately one day ahead of the storm.

Colorado DOT conducts pre-event conference calls with maintenance leads from all regions, the public information office, operations and other relevant areas. During these calls, the message format (VMS, news releases, 511, social media) is determined along with messaging coverage. Nevada DOT maintenance staff notify road operation center operators when to display winter messages.

<table>
<thead>
<tr>
<th>State</th>
<th>NWS</th>
<th>NOAA</th>
<th>DOT Staff</th>
<th>Other</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>Private road-weather forecast service.</td>
</tr>
<tr>
<td>Arkansas</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>Nonautomated, event-driven human decision.</td>
</tr>
<tr>
<td>Indiana</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Primarily NWS but also radar, traffic speeds from INRIX and Google Maps traffic, and agency CCTV cameras.</td>
</tr>
<tr>
<td>Massachusetts</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>Highway Operations Center provides weather warnings, watches and alerts (primarily county-based).</td>
</tr>
<tr>
<td>Mississippi</td>
<td>X</td>
<td></td>
<td></td>
<td>N/R</td>
<td></td>
</tr>
<tr>
<td>Nevada</td>
<td>X</td>
<td></td>
<td></td>
<td>N/R</td>
<td></td>
</tr>
<tr>
<td>Ohio</td>
<td>X</td>
<td></td>
<td></td>
<td>N/R</td>
<td></td>
</tr>
<tr>
<td>Virginia</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>On-scene personnel, roadway weather data or NWS.</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>X</td>
<td></td>
<td>X</td>
<td>N/R</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

N/R: No response.
<table>
<thead>
<tr>
<th>State</th>
<th>Before Event</th>
<th>Event Onset</th>
<th>During Event</th>
<th>Other</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>• Advance messaging for forecasted events.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Pop-up road weather event messages only on site-by-site basis.</td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>• Conference calls with relevant areas, including maintenance leads from all regions, public information office and operations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Message format (VMS, news releases, 511, social media) determined along with messaging coverage.</td>
</tr>
<tr>
<td>Delaware</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>• Winter weather event advisories displayed ahead of event.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• More direct condition messages at onset of storm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Other uses: Case by case or event by event, based on conditions.</td>
</tr>
<tr>
<td>Illinois</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>Messages typically only displayed at time of adverse conditions (not before event).</td>
</tr>
<tr>
<td>Indiana</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>• Display corresponds with actual precipitation occurring (not necessarily when NWS warning in effect).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Blizzard warning messages posted approximately 1 day before event.</td>
</tr>
<tr>
<td>Maine</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Warning message posted day before event.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MAJOR STORM TOMORROW/PLAN AHEAD</td>
</tr>
<tr>
<td>Massachusetts</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Messages posted according to agency policy.</td>
</tr>
<tr>
<td>Mississippi</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Messages posted based on NOAA warning until warning expires or onset of adverse weather.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Examples:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• <em>Pre-event:</em> DENSE FOG ADVISORY/IN EFFECT/UNTIL 9 AM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• <em>Onset:</em> CAUTION/LOW VISIBILITY/REDUCE SPEED</td>
</tr>
<tr>
<td>Missouri</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>• Messages timed to maximize number of viewers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Warning messages begin during peak period before event; messages change as event gets closer.</td>
</tr>
<tr>
<td>State</td>
<td>Before Event</td>
<td>Event Onset</td>
<td>During Event</td>
<td>Other</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>--------------</td>
<td>-------------</td>
<td>--------------</td>
<td>-------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Nevada</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Before weather event, maintenance staff notify road operation center operators when to display winter messages.</td>
</tr>
<tr>
<td>New York</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>Messages displayed within one commute of the event. Example: If a storm anticipated overnight, message displayed during the evening commute the day before.</td>
</tr>
<tr>
<td>Ohio</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Message timing scheduled based on weather alerts received via email from NWS.</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>• Messages displayed well in advance of blizzards, high wind storms, heavy rain and similar weather events.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Time and day storm expected affect message timing and delivery.</td>
</tr>
<tr>
<td>South Dakota</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>• Advance messaging for forecasted events only after events verified.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Messages often displayed just before event or when event shifts from watch to warning.</td>
</tr>
<tr>
<td>Tennessee</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Messages displayed as needed, observed or reported, and verified.</td>
</tr>
<tr>
<td>Vermont</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>• Advisory posted 1-2 days before planned major snow event.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Then warning displayed during event.</td>
</tr>
<tr>
<td>Virginia</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Messaging for weather conditions only considered after event verified by on-scene personnel, roadway weather data or NWS.</td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>• Timing determined from NWS alert.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Messages updated if alert adds counties or changes time frames.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Messages contain type of warning, begin and end time of warning, and an action.</td>
</tr>
</tbody>
</table>

**Assessing Road Weather Messaging Practices**

**Traveler Response to Dynamic Message Sign Messaging**

Four states participating in the survey—Maryland, Massachusetts, Michigan and Pennsylvania—have attempted to assess travelers’ opinions and/or behaviors associated with road weather-related DMS messaging.

In Maryland and Michigan, formal assessments have either been conducted or are underway. Maryland DOT SHA’s programming, planning and development team utilizes a consultant task order to conduct an annual study.
of travelers’ and citizens’ opinions concerning DMS effectiveness and messaging. Michigan DOT is currently conducting a research study that is evaluating the impact of safety messaging (including a weather messaging component) on driver behavior and public perception.

The Massachusetts and Pennsylvania DOT respondents reported on anecdotal evidence from travelers to DMS messaging. Massachusetts DOT reviews and responds to public feedback made on the agency’s web page or to its call center. Pennsylvania DOT has a resource account where the public can express questions or concerns. It also has an internal system, called Idealink, where the public can suggest improvements to the agency’s traveler information outreach.

The Mississippi DOT respondent noted that the agency conducted a survey several years ago, and although it was focused solely on weather messaging, the DMS messaging overall received very positive feedback.

**Successful Practices With Dynamic Message Sign Weather Messaging**

Survey respondents provided practices that their agencies have found to be successful in delivering road weather-related messages via DMS. Respondents most commonly cited practices related to accurate messaging, partnering with other agencies, preplanning guidance and timing.

Weather messaging practices with concise, relevant, up-to-date information were mentioned by respondents from Indiana, Nevada, Pennsylvania and Tennessee DOTs. Other measures to ensure accurate messaging include coupling weather messaging with PSAs (Michigan), using triggers to deliver appropriate weather conditions (Maryland and Massachusetts) and providing location-specific weather information (Virginia).

Both Alabama and Wisconsin DOTs find partnering with other agencies leads to successful engagement with travelers. Alabama DOT partners with NWS, Baron weather services and the University of Alabama’s Center for Advanced Public Safety to deliver near real-time information. Wisconsin DOT monitors three online weather sources for up-to-date information.

Preplanning guidance is another key area for success. Four states participating in the survey—Delaware, Maryland, Missouri and Pennsylvania—support efforts to warn drivers well in advance of a weather event. In Colorado, where “traction laws” require passenger vehicles to have adequate snow tires, chains or four-wheel drive, the agency has found that adding “Traction laws are likely” to weather-related messaging gets drivers to consider whether their vehicles are ready for changing weather.

Message timing—providing advance notice of a weather event and removing messages when conditions no longer exist—was also reported by transportation agency respondents from Arkansas, Maine, South Dakota and Vermont. As several respondents noted, drivers tend to ignore signs they see all the time.

While the Ohio DOT respondent did not share specific successful practices, he noted that motorists are slowing down and using caution as a result of weather-related DMS messages.

Table 11 summarizes survey responses.

<table>
<thead>
<tr>
<th>Practice</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accurate messaging</strong></td>
<td>Indiana, Maryland, Massachusetts, Michigan, Nevada, Indiana. Providing accurate information about the nature and timing of winter weather event. Maryland. Using triggers, which adjust with weather conditions.</td>
<td></td>
</tr>
<tr>
<td>Practice</td>
<td>State</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Pennsylvania, Tennessee, Virginia</td>
<td><em>Massachusetts.</em> Developing standard operating procedures that use thresholds and triggers to deliver appropriate messaging.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Michigan.</em> Coupling weather messaging with a PSA.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Examples:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- ICE AND SNOW DON’T CAUSE CRASHES/DRIVING TOO FAST FOR CONDITIONS CAUSES CRASHES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- LIGHT RAIN NEAR GAYLORD EXIT 282/TURN OFF CRUISE CONTROL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- HEAVY RAIN NEAR GAYLORD EXIT 282/KEEP ALL LIGHTS IN WORKING ORDER</td>
</tr>
<tr>
<td></td>
<td>Nevada</td>
<td><strong>Nevada:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Using up-to-date, relevant messages.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Avoiding two-page messages unless absolutely necessary.</td>
</tr>
<tr>
<td></td>
<td>Pennsylvania, Tennessee</td>
<td><strong>Pennsylvania, Tennessee:</strong> Offering concise messaging.</td>
</tr>
<tr>
<td></td>
<td>Virginian</td>
<td><strong>Virginia:</strong> Providing location-specific weather information that is not readily apparent to motorists.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Partnering with other agencies</strong></td>
</tr>
<tr>
<td></td>
<td>Alabama, Wisconsin</td>
<td><em>Alabama.</em> Partnering with NWS, Baron weather forecasting and University of Alabama Center for Advanced Public Safety to deliver near real-time information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Wisconsin.</em> Monitoring the following websites to provide up-to-date information:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Daily State Weather Briefing for Wisconsin (NWS) <a href="https://www.weather.gov/media/grb/DSS/State-WarmSeasonWxBriefing.pdf">https://www.weather.gov/media/grb/DSS/State-WarmSeasonWxBriefing.pdf</a></td>
</tr>
<tr>
<td></td>
<td>Colorado, Delaware, Maryland, Missouri,</td>
<td><em>Colorado.</em> Adding “Traction laws are likely” to weather-related messaging prompts drivers to ensure vehicles are ready for changing weather.</td>
</tr>
<tr>
<td></td>
<td>Pennsylvania</td>
<td><em>Delaware.</em> Issuing preweather advisories in addition to messages during weather events.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Maryland.</em> Using aggressive message forewarning for any large-scale storms expected to affect drivers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Missouri.</em> Warning drivers well in advance of weather event.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Pennsylvania.</em> Giving travelers the most advanced notice possible.</td>
</tr>
<tr>
<td>Practice</td>
<td>State</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| Timing   | Arkansas, Maine, South Dakota, Vermont | *Arkansas*. Deploying messaging quickly and more accurately.  
*Maine*. Deploying and removing messages on time.  
*South Dakota*. Ensuring messages reflect current conditions.  
*Vermont*. Using signs only when absolutely necessary. |

**Challenges With Delivering Road Weather-Related Messages Via Dynamic Message Signs**

Respondents reported challenges with delivering road weather-related messages in four key areas: inaccurate forecasting or false alarms, inadequate assets in affected areas, issues with messaging and timely message updates.

Respondents from Colorado, Maryland and Vermont transportation agencies reported that getting consistently accurate forecasts is a primary challenge. Inaccurate forecasts can lead agencies to display advisories for major storms that turn out to be normal or insignificant storm systems. As the Vermont Agency of Transportation respondent noted, agencies “don’t want to cry wolf but we don’t want to leave motorists unprepared for what is coming. It’s a balancing act.” Maryland DOT SHA has also had issues with pavement detectors giving false alarms; most of these issues, however, have been resolved since operators can enable or disable triggers until the sensors are repaired.

Arkansas and Missouri DOTs reported challenges with inadequate assets in affected areas. The Missouri DOT respondent noted that the density of DMS in some areas is not sufficient to warn all or most motorists about conditions. As a result, messages may not be seen until after the motorist experiences the adverse conditions.

Several states reported issues related to messaging, including clear and accurate messages (Delaware, South Dakota and Virginia) and length limitations of messages (Delaware and Mississippi). Alabama and Michigan DOT respondents reported issues with message continuity and consistency among districts and regions. In Michigan, however, region involvement in developing DMS messaging guidelines helped to “greatly improve consistency of weather-related messaging.” In Indiana, messaging needs at night can be challenging because system operators at Indiana DOT’s two TMCs (Indianapolis and Gary) are not authorized to work with custom messages. (Only five DOT employees can create, access, modify and schedule custom messages.) As a result, “educated estimates” are made of winter weather events that are expected to begin overnight and the appropriate messages are scheduled in advance. The respondent added that operators can generate messages for specific roadways at specific locations for “icy pavement” or “severe storm,” if necessary.

Massachusetts and Ohio DOT respondents reported issues with updating messaging while incidents are occurring or when conditions change quickly. In Maine, discontinuing messages in a timely manner can be challenging. Other challenges reported by respondents include determining the impact area (Nevada and Pennsylvania) and reliable communications (Alabama). Table 12 summarizes survey responses.
Table 12. Challenges With Dynamic Message Sign Weather Messaging

<table>
<thead>
<tr>
<th>Challenge</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
</table>
| Inaccurate forecasting/false alarms    | Colorado, Maryland, New York, Vermont, Wisconsin | *Colorado, Vermont.* Warning of major storms that turn out to be typical storm systems.  
*Maryland.* Pavement detectors that give a false alarm.  
*New York.* Clear message for weather event.  
*Wisconsin:* Continual monitoring of weather event. |
| Inadequate assets in affected areas    | Arkansas, Missouri         | *Missouri.* DMS density insufficient in some areas to warn all or most motorists of conditions.                                           |
| Messaging issues                       | Alabama, Delaware, Indiana, Michigan, Mississippi, South Dakota, Virginia | *Alabama.* Message continuity.  
*Delaware:* Clear, accurate message within length limitations.  
*Indiana:* Nighttime messaging needs (with limited staff).  
*Michigan:* Consistency in weather-related messaging among regions and districts.  
*Mississippi:* Space limitations.  
*South Dakota:* Accurate advance warning messages that affect driver behaviors and travel routes.  
*Virginia:* Helpful messages that provide information that is not readily apparent. |
| Timely updates                         | Maine, Massachusetts, Ohio | *Maine:* Discontinuing messages in a timely manner.  
*Massachusetts:* Adjusting messaging when conditions change quickly.  
*Ohio:* Updating messages while incidents are occurring. |
| Other                                  | Alabama, Nevada, Pennsylvania, Wisconsin | *Alabama:* Reliable communications.  
*Nevada:* Determining the impact area where signs should be posted.  
*Pennsylvania:* Determining where the most hazardous weather will occur and then informing travelers with the best possible message.  
*Wisconsin:* Speed at which weather can change. |

**Other Agency Information Delivery Options**

Survey participants provided information about their agencies’ DMS road weather messaging program and how it relates to other information delivery options within the agencies, such as the agency website, a phone app or an in-vehicle navigation system. Table 13 summarizes the information delivery options and details about agencies’ processes and practices when provided by respondents. Some state agencies are not included in the table, such as Illinois DOT, which keeps weather-related DMS messages independent from other delivery options. The Indiana DOT respondent reported that while there is some commonality between its DMS road weather messaging program and other agency information delivery options, the “nature of creating messages within the constraints of a DMS (three lines of 20 characters) can make that a bit difficult.” Agency websites referenced by respondents are cited in Related Resources following the table.
## Table 13. Relationship of Dynamic Message Sign Road Weather Messaging Program With Other Agency Information Delivery Options

<table>
<thead>
<tr>
<th>State</th>
<th>Agency Website</th>
<th>511/Traveler Information System</th>
<th>Mobile Phone App</th>
<th>Social Media</th>
<th>Text/Email Alert</th>
<th>Other</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>ATMS collects data from multiple sources, then disseminates messaging to DMS, Highway Advisory Radio (HAR) and other information delivery options.</td>
</tr>
<tr>
<td>Arkansas</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>DMS messaging typically consistent with information on iDriveArkansas.com and Twitter.</td>
</tr>
</tbody>
</table>
| Colorado    | X              | X                               | X                | X            | X               | X     | • Messaging coordinated during prestorm conference call.  
• Once content (extent and expected impact) of changing weather is established, operations and public information staff members leverage information for agency website, social media, press release, text/email alerts and 511. |
| Delaware    | X              |                                 | X                | X            | X               | X     | Other delivery option: statewide AM radio station (1380 AM). |
| Maine       |                |                                 |                  |              |                 | X     | Cell modems relay messaging; considering using RWIS stations to turn on DMS. |
| Maryland    | X              | X                               |                  |              | X               |       | ATMS incidents and device information (DMS, CCTV, HAR and 511) fed live to agency's website. |
| Massachusetts |               |                                 |                  |              |                 | X     | Incident information delivered in XML format and made available to developers and providers. |
| Michigan    |                |                                 | X                | X            | X               |       | • DMS messaging complemented by agency’s GovDelivery notifications (email/texts), Mi-Drive postings (MDOT’s traffic app) and other social media outlets such as Twitter.  
• Weather messaging receives similar response as crash or construction events. |
| Mississippi | X              |                                 | X                |              | X               |       | • Traffic alerts sent to agency website subscribers.  
• Consistent messaging maintained across all communication outlets. |
| Missouri    | X              |                                 | X                |              |                 | X     | • Messaging available on statewide and regional roadway condition map websites and mobile app.  
• During weather events, Community Relations and TMC staff coordinates |
<table>
<thead>
<tr>
<th>State</th>
<th>Agency Website</th>
<th>511/Traveler Information System</th>
<th>Mobile Phone App</th>
<th>Social Media</th>
<th>Text/Email Alert</th>
<th>Other</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nevada</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>messaging content and timing through statewide Emergency Operations Center calls.</td>
</tr>
<tr>
<td>New York</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DMS messages can be read live on agency’s 511 website.</td>
</tr>
<tr>
<td>New York</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• In many cases, agency delivers alerts on 511 website.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Website also displays road conditions (dry, wet, snow-covered).</td>
</tr>
<tr>
<td>Ohio</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>Public access to <a href="http://ohgo.com">ohgo.com</a> available for incidents, construction, CCTVs, travel delay and weather.</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>Social media heavily used because it delivers message faster and provides more detail about event.</td>
</tr>
<tr>
<td>South Dakota</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Agency strives to provide same information in DMS messages as in 511/traveler information systems.</td>
</tr>
<tr>
<td>Tennessee</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Only occasional use of 511.</td>
</tr>
<tr>
<td>Vermont</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Messages sent manually from the TMC. Advisory posted simultaneously on DMS, 511 system, WAZE and social media.</td>
</tr>
<tr>
<td>Virginia</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Active DMS shared with agency’s 511 application.</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TMC issues messaging to DMS; 511 website, phone and app alerts; and Twitter.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>10</strong></td>
<td><strong>8</strong></td>
<td><strong>8</strong></td>
<td><strong>3</strong></td>
<td><strong>6</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Related Resources**

*Alabama*

**ALGO Traffic**, Alabama Department of Transportation, undated. [https://algotraffic.com/](https://algotraffic.com/)

*From the website:* ALGO Traffic provides live traffic camera feeds, updates on Alabama roads and access to exclusive ALDOT information.
Arkansas

IDrive Arkansas, Arkansas Department of Transportation, undated. www.iDriveArkansas.com
This website provides highway information to Arkansas travelers.

Maryland

Maryland 511, Maryland State Highway Administration Department of Transportation, undated. https://chart.maryland.gov/
From the website: Maryland 511 is Maryland’s official travel information service. Maryland 511 provides travelers with reliable, current traffic and weather information, as well as links to other transportation services.

Ohio

Ohgo, Ohio Department of Transportation, undated. http://ohgo.com/
From the website: Ohgo reports current road activity, speeds, incidents, travel delays, closures and severe weather conditions for all of Ohio’s highways.

Supporting Documents

Below are state and national resources provided or cited by survey participants. Policy and guidance for Alabama, Delaware and Nevada are either in development or not current. The Nevada DOT respondent, who is currently drafting state DMS policy, noted that the guidelines will develop message escalation tiers and processes for approving and using safety-related messages, and will establish a DMS committee that will meet annually to discuss DMS use in the state. Mississippi DOT’s policy was unavailable for publication in this report but is available from the agency.

Multiple States

Many states participating in the survey, including Massachusetts and Wisconsin, cite this chapter as a resource for DMS guidance (beginning on page 325 of the manual, page 365 of the PDF).

Colorado

CDOT Guidelines on Variable Message Signs (VMS), Colorado Department of Transportation, November 2017. See Attachment A.
From the overview: The purpose of these guidelines is to ensure that Variable Message Sign (VMS) messages are used to inform and direct motorists of variable situations in a consistent and orderly manner. The messages are for the purpose of traffic control, management and timely traveler information.

Massachusetts

Winter Storm Procedure, Highway Operations Center Policy, Procedures and Guidelines 20-171018, Massachusetts Department of Transportation, 2017. See Attachment B.
VMS guidelines and sample winter weather messages are included in this document.
See Attachment C.
This policy directive provides guidance for VMS use in Massachusetts.

Michigan

See Attachment D.
Included in these general guidelines for DMS use is a section on weather messaging guidance and messages (beginning on page 17).

See Attachment E.
Weather-related messages are included in this messaging plan for western Michigan.

Michigan SEMTOC Winter Performance Messages, Michigan Department of Transportation, undated.
See Attachment F.
This spreadsheet includes weather-related messages used by the Southeast Michigan Transportation Operations Center (SEMTOC).

Missouri

http://epg.modot.org/index.php/910.3_Dynamic_Message_Signs_(DMS)
The Missouri DOT policy includes guidelines for message priorities, creation and termination, content and format, as well as general use. Section 910.3.2.13 provides guidance for weather messages.

South Dakota

See Attachment G.
Specific guidance for adverse weather begins on page 10 of the report (page 13 of the PDF). Sample road weather-related messages begin on page 18 of the report (page 21 of the PDF).

Virginia

This policy provides guidance for the appropriate use of DMS and guidelines for the design, display and content of messages. Section 1.2.10 briefly addresses DMS use with adverse weather conditions (page 8 of the report, page 9 of the PDF). Sample messages are provided in Appendix A (beginning on page 28 of the report, page 29 of the PDF).

Wisconsin

Section 4.16, NWS Weather Warning, Standard Operating Procedures, Wisconsin Department of Transportation, November 2018.
See Attachment H.
The TMC’s adverse weather policy includes guidance and sample messages.
Creative Safety Messages

Eighteen state DOTs participating in the survey use DMS to post creative safety messages:

- Arkansas.
- Colorado.
- Delaware.
- Illinois.
- Maine.
- Maryland.
- Massachusetts.
- Michigan.
- Mississippi.
- Missouri.
- Nevada.
- Ohio.
- Pennsylvania.
- South Dakota.
- Tennessee.
- Vermont.
- Virginia.
- Wisconsin.

Four states—Alabama, Florida, Indiana and New York—do not support this practice, although the New York State DOT respondent reported that the agency may be directed to post creative messages on DMS in the near future.

Below are survey results from the 18 state DOTs using DMS to post creative safety messages. Results are presented in two topic areas:

- Generating creative safety messages on DMS.
- Assessing creative safety messaging practices.

Generating Creative Safety Messages on Dynamic Message Signs

In the second half of the survey, respondents discussed their agencies’ cycle for posting creative safety messages on DMS; the frequency in which agencies change messages displayed; limitations placed on creative safety messages, including the number of hours and time periods during which a message is displayed; other state agency partners that support message development and delivery; and the use of a creative safety message catalog.

Scheduled Cycle for Posting Creative Safety Messages

Survey respondents were asked to choose the options below that best describe their agencies’ cycle for posting creative safety messages on DMS:

- Daily.
- Once a week.
- Several times a week.
- Once a month.
- Twice a month.
- Every holiday.
- Weekends.
- Other.

Five states—Colorado, Delaware, Massachusetts, Michigan and South Dakota—post creative safety messages weekly. Four states—Delaware, Illinois, Missouri and Tennessee—post messages daily, and three states—Maine, Ohio and Virginia—post messages twice monthly. None of the states participating in the survey post messages several times each week or monthly. Several states post messages that are tied to safety campaigns or guidance from other federal or state agencies, which dictate when messages are posted. Table 14 summarizes survey responses.
<table>
<thead>
<tr>
<th>State</th>
<th>Daily</th>
<th>Weekly</th>
<th>Several Times/Week</th>
<th>Monthly</th>
<th>Twice/Month</th>
<th>Every Holiday</th>
<th>Weekends</th>
<th>Other</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/R</td>
</tr>
</tbody>
</table>
| Colorado   |       |        | X                  |         |             | X             |          |      | • Every Wednesday.  
• Target messaging for events, state patrol enforcement programs (e.g., “Click It or Ticket”), high fire danger or fire bans, animal migration. |
| Delaware   | X     | X      |                    |         |             |               |          |      | • Daily: Creative safety messages.  
• Weekly: Fatality numbers.                                                                                                               |
| Illinois   | X     |        |                    |         |             |               |          |      | N/R                                                                                                                                          |
| Maine      |       | X      |                    |         |             |               |          |      | N/R                                                                                                                                          |
| Maryland   |       |        |                    |         |             | X             |          |      | • Messages tied to guidance from FHWA, Department of Homeland Security, Maryland DOT SHA, State Highway Safety Office, state traffic engineers and Secretary’s office.  
• Each message type reviewed annually to determine value to traveling public.  
• Messages supposed to follow MUTCD standards.                                                                                           |
| Massachusetts | X     |        |                    |         |             |               |          |      | N/R                                                                                                                                          |
| Michigan   | X     |        |                    |         |             |               |          |      | N/R                                                                                                                                          |
| Mississippi |       |        |                    |         |             | X             |          |      | Currently running first daily safety message.                                                                                              |
| Missouri   | X     |        |                    |         |             |               |          |      | N/R                                                                                                                                          |
| Nevada     |       |        |                    |         |             | X             |          |      | • Messages tied to national safety campaigns.  
• Calendar developed annually with guidance from National Highway Traffic Safety Administration communications calendar and Nevada DOT public information office. |
| Ohio       |       |        |                    |         |             |               |          |      | N/R                                                                                                                                          |
| Pennsylvania |     |        |                    |         |             |                | X        |      | DMS safety calendar with specific messages throughout the year.                                                                         |
| South Dakota | X     |        |                    |         |             |               |          |      | N/R                                                                                                                                          |
### Message Rotation

Agencies using DMS to post creative safety messages change the actual message displayed on the DMS with varying frequency. Nearly one-half of the agencies participating in the survey display one message per scheduled cycle, however, the respondents from Colorado and Pennsylvania DOTs noted the agencies can display more than one message per cycle if requested. Two states—Maine and Nevada—display multiple messages per cycle. Maine DOT typically has three to four messages on DMS, with a different message every third or fourth board. Nevada DOT typically has two message options for each campaign cycle. Each district road operation center can use the messages at its discretion.

Four states—Delaware, Michigan, Missouri and South Dakota—change the DMS weekly. Delaware DOT displays a fatalities totals message each Monday, followed by a creative message Tuesday through Sunday. South Dakota DOT displays a safety message each Thursday; the message is displayed on all Interstate DMS unless the DMS is running a higher priority message, such as a work zone, weather- or incident-related message. Missouri DOT develops several messages with a similar theme that are posted on consecutive DMS and displayed when other relevant traveler information is not available.

Mississippi DOT is the only agency participating in the survey that is currently changing its creative safety messages daily. The agency recently began its first creative safety campaign with a daily holiday-themed safety message.

Seven of the 18 states—Colorado, Illinois, Michigan, Missouri, Ohio, Pennsylvania and Vermont—post creative safety messages on an as-needed basis to ensure a deployed sign reflects continual messaging. Table 15 summarizes survey responses.

### Table 15: Creative Safety Message Rotation

<table>
<thead>
<tr>
<th>State</th>
<th>Daily</th>
<th>Weekly</th>
<th>Several Times/Week</th>
<th>Monthly</th>
<th>Twice/Month</th>
<th>Every Holiday</th>
<th>Weekends</th>
<th>Other</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tennessee</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/R</td>
</tr>
<tr>
<td>Vermont</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>At request of agency directors or executive staff.</td>
</tr>
<tr>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>N/R</td>
</tr>
<tr>
<td>Wisconsin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>PSAs scheduled on various days. Typical frequency: 7-9 PSAs per month, each running from 1-3 days continuously.</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

N/R: No response.
<table>
<thead>
<tr>
<th>Frequency</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
</table>
| **One message/cycle** | Colorado,¹ Illinois,¹ Maryland, Massachusetts, Ohio,¹ Pennsylvania,¹ Tennessee,¹ Vermont¹ | *Colorado.* Can change as desired.  
*Massachusetts.* 1 message/display run.  
*Pennsylvania:* Unless instructed to display more frequently. |
|                    | Main*            | Maine:  
- 3-4 messages on DMS.  
- Different message every third or fourth DMS.  
*Nevada:*  
- 2 message options/campaign cycle.  
- District road operation centers use at their discretion. |
| **Daily**           | Mississippi      | N/R                                                                 |
| **Weekly**          | Delaware, Michigan,¹ Missouri,¹ South Dakota | *Delaware:*  
- Monday: Fatalities totals message.  
- Tuesday-Sunday: Creative message.  
*Missouri:*  
- 1 safety message/DMS/week, with several theme-based messages in a set posted on consecutive DMS.  
- Only displayed when other relevant traveler information unavailable (e.g., travel times, weather or congestion warnings).  
*South Dakota:* Displayed on Thursday on all Interstate DMS unless higher priority message (e.g., work zone, weather- or incident-related message). |
| **Other**           | Arkansas, Nevada, Virginia, Wisconsin | *Arkansas.* 1 PSA/DMS/operational day.  
*Virginia:*  
- Twice/month: 2 message options/mini-campaign.  
- Messages consistent for length of mini-campaign (typically 2-3 days).  
*Wisconsin:*  
- Messages selected from pool of approved messages, and rotated or adjusted to avoid repetition.  
- New messages added to pool as needed. |

N/R: No response.  
¹ Creative safety messages posted as needed to ensure a deployed sign reflects continual messaging.
Limitations on Use of Creative Safety Messaging

Message Display Hours Per Day

Agencies in 10 states—Arkansas, Colorado, Maryland, Ohio, Pennsylvania, South Dakota, Tennessee, Vermont, Virginia and Wisconsin—limit the number of hours per day that a creative safety message can be displayed. The number of hours that scheduled messages are displayed varied significantly among these states, ranging from the first two hours of the day to 24 hours. Other factors that limited message display time related to equipment used, specific safety campaigns and driver attention to message content. Survey results are summarized below:

- **Two hours**: Ohio, where safety messages are run during the first two hours of the day.
- **Four hours**: Virginia, however, regional operations directors can authorize longer display times.
- **Six hours**: Arkansas and Tennessee.
- **24 hours**: Colorado, Mississippi, South Dakota and Wisconsin:
  - Colorado has not set a limit on display time; however, messages are generally displayed for 24 hours. The Colorado DOT respondent added that on commuter roads, the agency’s broader guidance is to avoid displaying the same messages to the same travelers for long periods of time. However, messages may run longer on noncommuter-oriented roadways such as weekend routes with higher traffic volumes.
  - While Mississippi DOT does not impose a time limit, the respondent reported that during the agency’s first attempt at safety messaging, it is running a different message every 24 hours.
  - South Dakota DOT displays safety messages on all Interstate DMS for 24 hours on Thursdays.
  - Wisconsin DOT displays messages continuously for 24 hours each day scheduled.

- **Other factors**:
  - In Maryland, all safety message campaigns are typically set to run during nonpeak or nonrush hour periods unless higher priority messages are running (such as incidents, planned closures and toll rate messaging). Some messages, such as DUI or “Click It or Ticket” campaigns, run only during hours of police enforcement.
  - Several agencies noted concerns with overusing creative safety messages. In Colorado, multiple signs have been placed in areas with long corridors of commuter traffic (for example, from Colorado Springs or Fort Collins to Denver). To avoid displaying repeat signs, the agency may space creative messages so that drivers don’t see the same content numerous times during the drive. Massachusetts DOT reserves creative messages for periods of the year when it wants to capture the public’s attention and better drive home the intended message. The respondent noted that this practice may change in the coming year because the agency has hired a consultant to rebrand the Highway Division and try to make better use of the safety PSA time afforded on both the digital billboards and the message boards. Pennsylvania DOT also displays messages during times that they are warranted instead of continuously to avoid oversaturating travelers.
  - Display time in Vermont varies for permanent-mount and portable DMS. No limitations are placed on permanent-mount, 120-volt systems. Portable DMS are limited in winter by the lack of solar power required to charge sign batteries.

Time Periods

DOTs in six states—Arkansas, Maryland, Missouri, Tennessee, Virginia and Wisconsin—impose limitations on the time periods each day that creative safety messages can be displayed:
• In Arkansas, Maryland and Tennessee, creative safety messages are displayed from 9 a.m. to 3 p.m.

• Virginia DOT generally displays safety messages during peak periods. The respondent reported that the state’s regions are “quite diverse” when it comes to volume and peak travel periods across the state, so there is some flexibility about the defined hours of a peak period.

• Missouri DOT displays safety messages only when other relevant traveler information (such as travel times, weather warnings and congestion warnings) is unavailable. In urban areas, this usually only occurs overnight and early morning.

• Wisconsin DOT does not display PSAs on congested roadways or within work zones to avoid distracting drivers.

**Number of Messages**

Agencies in five states—Arkansas, Massachusetts, Nevada, South Dakota and Wisconsin—limit the number of creative safety messages that can be displayed during a specific time period. Most of these five states allow one message per time period. Other considerations include messages that are tied to specific safety campaigns and DOT staff effort required to develop messages. Survey results are summarized below:

• Arkansas, Massachusetts and South Dakota DOTs typically limit messages to one per time period. The Massachusetts DOT respondent added that the agency doesn’t limit the number of messages, but aims to use only one message per theme at a time to avoid driver confusion and keep messaging consistent. In South Dakota, one new message is displayed each Thursday; fatality statistics are run with the safety message on the first Thursday of the month.

• In Nevada, the number of DMS messages is not limited, but messaging must follow the yearly calendar, which ties safety-related messages to a national safety campaign.

• According to the Wisconsin DOT respondent, the agency observes a “practical limit” based on the manual effort of creating and scheduling PSAs.

**Partnering With Other State Agencies**

Nearly all the state DOTs posting creative safety messages on DMS partner with other agencies to develop and deliver safety messages. These partnerships are primarily with the state police and state agencies but also include local or federal agencies and other state DOTs. Only five states—Massachusetts, Michigan, Nevada, Ohio and Tennessee—do not participate in these partnerships.

Arkansas DOT is among the survey participants that partner with state police, displaying national safety campaign PSAs, such as the “Click It or Ticket” campaign, from the Arkansas State Police. In Missouri, safety messages for state highway patrol campaigns are created by Missouri DOT and then submitted monthly to the state patrol for review. The Maryland DOT SHA respondent noted that the agency coordinates with state police during Amber, Silver, Blue or Yellow alerts.

Some states rely on other intra-agency partnerships to develop and approve creative safety messaging. The Wisconsin DOT respondent reported that representatives from the agency’s public affairs and traffic operations departments partner with safety and law enforcement to review PSAs before final approval. Maryland DOT SHA partners with the Maryland Transportation Authority, which oversees the state’s toll facilities, to ensure uniform messaging on signage and duration runtime across the state. Pennsylvania DOT has received requests from
other state agencies to display messages. Virginia DOT shares messages with in-state partner agencies, including the department of motor vehicles, to be delivered through social media and other outlets.

Maryland DOT SHA also coordinates with local, state and federal agencies during large-scale or high-publicity events, such as presidential inaugurations, papal visits, marches and sporting events.

Respondents from four states—Colorado, Illinois, Mississippi and Virginia—noted that the public information offices within their agencies either coordinate with other state DOTs to generate message ideas and content or they review and adopt specific messages used by other states.

Table 16 summarizes survey responses.

**Table 16. Partnerships With Other Agencies in Creative Safety Messaging**

<table>
<thead>
<tr>
<th>Partner</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
</table>
*Maine*. Department of Public Safety.  
*Pennsylvania*. Requests from other state agencies to display messages.  
*South Dakota*. Department of Public Safety (within the Office of Public Safety) safety campaigns and messaging.  
*Wisconsin*. Safety message review by representatives from public affairs, traffic operations, safety and law enforcement. |
| State police             | Arkansas, Delaware, Maryland, Missouri, South Dakota, Vermont, Wisconsin | *Arkansas, South Dakota*. Safety campaigns and messaging.  
*Maryland*. Amber and other alert systems.  
*Missouri*. Safety message review monthly by state highway patrol.  
*Vermont*. Department of Public Safety (state police).  
*Wisconsin*. Safety message review by representatives from public affairs, traffic operations, safety and law enforcement. |
| Other government agencies | Maryland                                    | • Local, state and federal agencies during large-scale or high-publicity events.  
• Maryland Transportation Authority. |
*Mississippi, Virginia*. Creative safety message sharing. |
Maintaining a Catalog of Creative Safety Messages

Nearly all state DOTs using DMS to post creative safety messages maintain a catalog of safety messages that are used and reused throughout the year. Among the state DOTs responding to this portion of the survey, only two—Illinois and Mississippi DOTs—do not support this practice. (The Tennessee DOT respondent did not respond to this portion of the survey.)

These catalogs range from simple logs and spreadsheets (Colorado, Delaware, Maine, Ohio, South Dakota, Virginia and Wisconsin) to more complex ATMS tools (Maryland and Missouri). Several respondents shared descriptions of these catalogs:

- **Maryland.** Operators enter messages from all recurring and nonrecurring events in the agency’s ATMS. The system allows the DOT to schedule and make pending events or plans for anticipated safety message campaigns. The agency also has a reporting tool that can be used to run performance metrics and/or review past events and messaging.
- **Massachusetts.** The Highway Operations Center has access to more than 100 approved messages covering road conditions, travel advisories, weather and safety PSAs.
- **Michigan.** The respondent noted that coupling weather messaging with a PSA has been an effective practice, although its success in terms of impacting driver behavior has only been measured anecdotally.
- **Missouri.** The agency’s catalog of messages is stored within the ATMS. Written copies of the message plan are archived monthly.
- **Ohio.** The agency’s advisory board keeps a log of creative safety messages.
- **Pennsylvania.** In March or April, the agency’s central office issues a schedule of messages to each district with messages that are applicable to the time of year.

Sample messages provided by survey participants are summarized in Table 17.

<table>
<thead>
<tr>
<th>State</th>
<th>Sample Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware</td>
<td>EYES ON ROAD/HEAD OUT OF YOUR APPS</td>
</tr>
<tr>
<td></td>
<td>SANTA IS WATCHING/SLOW DOWN</td>
</tr>
<tr>
<td></td>
<td>SLOW DOWN/EASTER BUNNY CROSSING</td>
</tr>
<tr>
<td></td>
<td>MAY THE 4TH BE WITH YOU</td>
</tr>
<tr>
<td></td>
<td>TEXT AND DRIVE I WILL NOT</td>
</tr>
<tr>
<td>Michigan</td>
<td>ICE AND SNOW DON’T CAUSE CRASHES/DRIVING TOO FAST FOR CONDITIONS CAUSES CRASHES</td>
</tr>
<tr>
<td></td>
<td>LIGHT RAIN NEAR GAYLORD EXIT 282/TURN OFF CRUISE CONTROL</td>
</tr>
<tr>
<td></td>
<td>HEAVY RAIN NEAR GAYLORD EXIT 282/KEEP ALL LIGHTS IN WORKING ORDER</td>
</tr>
<tr>
<td>Nevada</td>
<td>BUZZED DRIVING IS DRUNK DRIVING</td>
</tr>
<tr>
<td></td>
<td>HALLOWEEN IS NEAR/DON’T BE A CRASH DUMMY</td>
</tr>
<tr>
<td></td>
<td>DON’T VEER FOR DEER</td>
</tr>
<tr>
<td></td>
<td>DRIVE HIGH/GET A DUI</td>
</tr>
<tr>
<td></td>
<td>DROWSY IS LOUSY/REST IS BEST</td>
</tr>
</tbody>
</table>

Sample messages provided by survey participants are summarized in Table 17.
<table>
<thead>
<tr>
<th>State</th>
<th>Sample Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvania</td>
<td>SAVE A LIFE/SLOW DOWN IN WORK ZONES</td>
</tr>
<tr>
<td>Vermont</td>
<td>CLICK IT OR TICKET/BUCKLE UP</td>
</tr>
<tr>
<td></td>
<td>XX ROAD DEATHS IN 2018/OUR GOAL NO MORE/BUCKLE UP</td>
</tr>
<tr>
<td></td>
<td>DRIVE SOBER -OR-/GET PULLED OVER</td>
</tr>
<tr>
<td></td>
<td>DRIVE SAFE/OBEY THE SPEED LIMIT</td>
</tr>
<tr>
<td></td>
<td>WANT TO LIVE THROUGH A CRASH?/WEAR YOUR SEATBELT/SAFETY CORRIDOR</td>
</tr>
</tbody>
</table>

**Related Resources**

Below are creative message spreadsheets used by Colorado and Wisconsin DOTs.

**Colorado**

**Colorado DOT Creative VMS Messages, 2016-2018**, Colorado Department of Transportation, undated. See Attachment I.

This spreadsheet lists the creative safety messages used from 2016 through 2018. The first DMS panel provides the number of traffic deaths to date; the second panel displays the safety message.

**Wisconsin**

**WisDOT 2018 DMS Approved**, Wisconsin Department of Transportation, undated. See Attachment J.

Creative messages are provided in several categories, including impaired driving, driver awareness and bicycle safety.

**Assessing Creative Safety Messaging Practices**

Of the 18 state DOTs using DMS to post creative safety messages, nine states have attempted to assess travelers’ opinions and/or behaviors associated with creative safety DMS messaging: Illinois, Maine, Maryland, Massachusetts, Michigan, Missouri, Tennessee, Virginia and Wisconsin. These assessments have been both formal and informal.

Respondents from Michigan, Missouri, Virginia and Wisconsin DOTs provided details about formal assessment efforts:

- In Michigan, a research study is underway that is evaluating the impact of safety messaging on driver behavior and public perception. The study includes a weather messaging component.
- Missouri and Wisconsin DOTs participated in a 2016 TMC pooled fund study that evaluated the effectiveness and potential benefits of posting PSAs in rural areas (see Related Research below). In 2014, Missouri DOT participated in another TMC pooled fund study that evaluated the usefulness and effectiveness of safety messages and PSAs (see Related Research below).
- Virginia DOT collaborates with Virginia Tech researchers in an ongoing assessment effort.

Maryland DOT SHA has conducted both formal and informal assessments of travelers’ opinions. The agency has used a consultant to assess DMS effectiveness and also has a customer care management system on its website where the public can provide ideas and feedback about transportation issues.
Informal assessments were reported by respondents from Illinois, Maine, Massachusetts and Tennessee DOTs. In Illinois, “driver response appears to be mostly positive,” according to the respondent. Both Massachusetts and Tennessee DOTs have run contests with the members of the general public who submit creative safety messages. Winning entries are then run on the message boards. The Massachusetts DOT respondent noted that the agency reviewed and evaluated the feedback that was provided during the contest.

**Related Research**

Missouri and Wisconsin DOTs were among the states participating in this pooled fund study that evaluated the effectiveness and potential benefits of posting PSAs in rural areas.

*From the abstract:* The report assesses the usefulness and effectiveness of safety and public service announcement (PSA) messages through surveys conducted in four urban areas in the United States: Chicago, IL; Houston, TX; Orlando, FL; and Philadelphia, PA. The surveys were designed to specifically address the types of safety and PSA messages for each respective city. A total of 2,088 survey responses were received and analyzed. The report further captures findings and recommendations based on the analysis of the survey responses.

**Additional State Resources**

Survey participants provided the following creative safety messaging resources.

**Maryland**

**2018 MVA/MHSO Overhead DMS Messaging**, Maryland Department of Transportation State Highway Administration, February 2019.  
See Attachment K.  
Monthly safety campaigns and corresponding DMS messages are provided in this document.

**Massachusetts**

**MassDOT VMS PSA Defaults**, Massachusetts Department of Transportation, undated.  
See Attachment L.  
Messaging for various safety campaigns is included in this document, with examples for portable and overhead signs.

**Michigan**

See Attachment M.  
Safety messages representing various topics are included in this messaging plan for northern Michigan.
Nevada

Nevada DOT Draft DMS Schedule 2019, Nevada Department of Transportation, undated.
See Attachment N.
A schedule of 2018 safety campaigns and messages is provided in this document.

Nevada DOT Message Bank, Nevada Department of Transportation, undated.
See Attachment O.
This spreadsheet provides a list of approved messages for safety campaigns, alerts and ATMS signs.

Ohio

See Attachment P.
This brief document provides guidelines for using traffic death and safety messages on DMS.

Ohio DOT Past Messages, Ohio Department of Transportation, undated.
See Attachment Q.
Sample safety messages from 2016 through 2018 are provided in this document.

Pennsylvania

2018 Scheduled Safety Message Calendar for DMS Boards, Pennsylvania Department of Transportation, undated.
See Attachment R.
This document provides safety campaigns and messaging for April through December 2018. Options for small and large boards are included.

South Dakota

See Attachment G.
Specific guidance for creative safety messages begins on page 11 of the report (page 14 of the PDF).

Tennessee

Tennessee DOT Message Listing, Tennessee Department of Transportation, undated.
See Attachment S.
This schedule lists safety messages displayed from July 2018 through January 2019.

Wisconsin

DMS Creative Messaging—December 2018, Wisconsin Department of Transportation, undated.
See Attachment T.
This document includes Wisconsin DOT’s message plan for December 2018.
Public Perception Survey

To gauge the general public’s perception of traveler awareness and the usefulness of blizzard warning messaging and other safety messaging displayed on DMS, the research team worked with the MnDOT Office of Public Engagement and Constituent Services to engage Market Cube LLC, an online sample and research operations company, to distribute an online survey to Minnesota residents. The research team’s online survey was distributed to a Market Cube distribution list; survey responses were monitored to meet the following quotas based on U.S. Census Bureau population estimates provided by the MnDOT Office of Public Engagement and Constituent Services:

- **Race:**
  - 20 percent people of color and American Indians.
  - 80 percent non-Hispanic white.

- **Age:**
  - 18-24: 9 percent.
  - 25-34: 14 percent.
  - 35-44: 13 percent.
  - 45-54: 13 percent.
  - 55-64: 13 percent.
  - 65-74: 9 percent.
  - 75+: 6 percent.

- **Gender:**
  - 50 percent male.
  - 50 percent female.

- **Geography:**
  - Eight-county Twin Cities metropolitan area: 65 percent.
  - Greater Minnesota: 35 percent.

(Participants younger than 18 years old, non-Minnesota residents and potential respondents who do not own a vehicle were excluded from the survey. The survey remained in the field until the target of 400 complete responses that reasonably approximated the quotas listed above was met.)

The survey was completed by 406 residents ranging in age from 18 years to 75+ years residing in the eight-county Twin Cities metropolitan area and Greater Minnesota (portions of the state outside the Twin Cities metropolitan area).

The survey examined respondents’ experiences with blizzard warning messages appearing on DMS during the winters of 2017 and 2018, including where and when respondents viewed the DMS blizzard warning messaging, and their experiences and behavior before and after encountering the messaging. In addition, respondents addressed the use of creative safety messaging—specifically, MnDOT’s Message Monday messages, which are associated with the agency’s TZD initiative.

The survey questions are provided in Appendix C.

Key findings from survey respondents are summarized below in the following topic areas:

- Profile of survey respondents.
- Blizzard warning messages on DMS.
- Creative safety messages on DMS.
- Final comments.
Profile of Survey Respondents

Demographic information provided by survey participants is summarized below in four categories:

- Gender.
- Age.
- Racial origin.
- Region.

A detailed comparison of the demographic characteristics of survey participants is provided in Appendix D.

Gender

Of the 406 survey respondents, 228 self-identified as female (56 percent), 172 as male (42 percent), three as transgender (0.74 percent), one as nonbinary (0.25 percent) and two preferred not to answer (0.49 percent). Figure 1 summarizes the gender identity of respondents.

![Figure 1. Gender Identity of Survey Respondents](image)

Age

Survey respondents represented seven age groups: 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 to 74 and 75 and older. Only one respondent preferred not to select an age range. Five of the seven age ranges were fairly evenly represented with fewer respondents in the youngest and old age groups. Table 18 summarizes the age ranges of survey participants.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Number of Respondents</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>41</td>
<td>10%</td>
</tr>
<tr>
<td>25-34</td>
<td>80</td>
<td>20%</td>
</tr>
<tr>
<td>35-44</td>
<td>71</td>
<td>17%</td>
</tr>
<tr>
<td>45-54</td>
<td>63</td>
<td>16%</td>
</tr>
</tbody>
</table>

Table 18. Age Ranges of Survey Participants
### Age Range

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Number of Respondents</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-64</td>
<td>78</td>
<td>19%</td>
</tr>
<tr>
<td>65-74</td>
<td>57</td>
<td>14%</td>
</tr>
<tr>
<td>75+</td>
<td>15</td>
<td>4%</td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>1</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

### Racial Origin

The majority of survey participants self-identified as white (331 respondents, or 82 percent), followed by black/African American/African (27, or 7 percent); Asian (14, or 3 percent); Hispanic (12, or 3 percent); Native American/Alaskan Native (5, or 1 percent); two or more races (10, or 2 percent); and of another race (2, or less than 1 percent). Five respondents (1 percent) chose not to provide racial origin information.

### Region

As expected, nearly all respondents lived in either the eight-county Twin Cities metro area or Greater Minnesota; respondents were fairly evenly split between the two regions. The remaining respondents lived outside of Minnesota. Table 19 summarizes the reported residence of survey participants.

**Table 19. Residence of Survey Participants**

<table>
<thead>
<tr>
<th>Respondent Residence</th>
<th>Number of Respondents</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Minnesota</td>
<td>194</td>
<td>48%</td>
</tr>
<tr>
<td>Twin Cities metro area</td>
<td>199</td>
<td>49%</td>
</tr>
<tr>
<td>Neighboring state</td>
<td>4</td>
<td>1%</td>
</tr>
<tr>
<td>Elsewhere</td>
<td>9</td>
<td>2%</td>
</tr>
</tbody>
</table>

### Blizzard Warning Messages on Dynamic Message Signs

Nearly 300 DMS deployed across Minnesota are used to display real-time information warning motorists of incidents, roadwork or congestion downstream, as well as blizzard warnings or other unexpected or isolated weather conditions. In this section, respondents describe their experiences with blizzard warning messages appearing on DMS.

### Travel Frequency

Respondents were asked to describe how frequently they travel on Minnesota’s roadways based on the following options:
• Every weekday.
• Two or more times a week.
• Once a week.
• Two or more times a month.
• Once a month.
• Less than once a month.

As Figure 2 illustrates, almost two-thirds of respondents (60 percent) reported using Minnesota roadways every weekday; nearly one-quarter (23 percent) reported using Minnesota roadways two or more times a week.

![Figure 2. Travel Frequency on Minnesota Roadways](image)

These results are similar when travel frequency is analyzed by region. Most respondents from Greater Minnesota travel roadways every weekday (58 percent) or two or more times a week (25 percent). Most Twin Cities metro area respondents use the roadways every weekday (64 percent) or two or more times a week (22 percent). Most respondents from other states reported using the roadways less than once a month (50 percent), or either two or more times a week (25 percent) or once a month (25 percent).

**Blizzard Warning Messages**

Slightly more than one-half of survey respondents (220, or 54 percent) reported seeing a blizzard warning message on DMS as they traveled on Minnesota roadways during the last two winter seasons, while the remaining respondents did not see a blizzard warning message.
Analyzing these findings by region produced similar results. When analyzing these results by age range, respondents 18 to 54 years produced similar results while respondents 55 years and older more frequently reported not seeing a blizzard warning message on DMS.

The remainder of this section summarizes survey responses in two general categories:

- Blizzard warnings viewed on DMS.
- Blizzard warnings not viewed on DMS.

**Blizzard Warnings Viewed on Dynamic Message Signs**

The 220 respondents who noticed blizzard warning messages on DMS provided additional information about the messages, which is summarized below in the following categories:

- Blizzard warning message viewings.
- Source of weather advisory information.
- Impact on driving plans.
- Assessment of weather messaging on DMS.
- Access to weather information.
- Preferred dissemination methods.

**Blizzard Warning Message Viewings**

Respondents who noticed the blizzard warnings on DMS reported:

- Frequency of viewing warning messages (once, twice, three times, more than three times or couldn’t remember).
- Location of warning messages viewed (Twin Cities metro area; Greater Minnesota; an Interstate highway, such as Interstate 35 (I-35), I-90, I-94, I-394, I-494 and I-694; a state highway; or couldn’t remember).

**Frequency of Viewing Warning Messages**

Respondents most frequently reported viewing the messages twice, more than three times or couldn’t remember. Figure 3 illustrates respondents’ viewing frequency.
When analyzing the results by age range or region, respondents typically reported viewing the messages twice or they couldn’t remember.

**Location of Warning Messages Viewed**

As indicated in Figure 4, messages were most frequently viewed in the Twin Cities metro area (46 percent) or along Interstate highways (46 percent), followed by Greater Minnesota (32 percent) and state highways (16 percent). Seven percent could not remember where they viewed these messages.

This viewing pattern was similar among younger respondents (18 to 24 years and 25 to 34 years). Respondents ages 35 to 64 reported viewing messages most frequently along Interstate highways, followed by the Twin Cities metro area and Greater Minnesota. Respondents ages 65 to 74 reported viewing messages most frequently along Interstate highways, followed by Greater Minnesota and the Twin Cities metro area. Respondents 75 years and older viewed messages equally in the Twin Cities metro area and Greater Minnesota, followed by Interstate highways.
Source of Weather Advisory Information

Slightly more than two-thirds of the 220 respondents who reported viewing warning messages on DMS were aware of the blizzard warning before they began driving. Figure 5 illustrates drivers’ awareness of the blizzard before driving.

The 149 respondents who were aware of the blizzard warning before they began driving received the weather advisory information from the following sources:

- Calling 511 or using the 511 app.
- Cellphone app other than 511.
- MnDOT website (511 travel information).
- News and weather websites.
- Television.
- Radio.
- Social media.

As indicated in Figure 6, respondents most often received this information from news and weather websites and television.
Analyzing the results by age range and region produced similar results, with most respondents looking to news and weather websites or television as their primary sources.

Impact on Driving Plans

The 220 respondents who reported viewing warning messages on DMS were then asked about the impact that blizzard warning messages had on their driving plans. Respondents were asked to choose from the following options:

- I delayed the remainder of my trip by returning home.
- I delayed the remainder of my trip by finding refuge at a local mall, hotel, rest area, etc.
- I took an alternate route I determined on my own.
- I drove with extra caution.
- I don’t recall making any changes in my driving plans or route.

After seeing the DMS blizzard warning messages, most of the 149 survey respondents who were aware of the warning before driving reported driving with extra caution (58 percent). Some respondents delayed the remainder of their trip by either returning home (28 percent) or finding refuge at a local mall, hotel, rest area or other location (15 percent). Figure 7 summarizes all survey responses.
Results were somewhat similar for the 71 respondents who were not aware of the blizzard warning before driving or couldn’t remember if they were aware of the warning. Of these respondents, 79 percent drove with extra caution or returned home. Figure 8 summarizes all survey responses.

**Assessment of Weather Messaging on Dynamic Message Signs**

Respondents were asked to rate the following aspects of weather messages on DMS:

- Helpfulness of blizzard warnings.
- Effectiveness of road weather messages on DMS compared to weather alerts delivered through other media types, such as radio, television, weather-related websites and social media.
Helpfulness of Blizzard Warning Messages

Helpfulness of the blizzard warning messages that respondents saw on DMS were rated using a scale of not at all helpful, not helpful, somewhat not helpful, somewhat helpful, helpful and very helpful.

Of the respondents who were aware of the blizzard warning before they began driving, 88 percent rated the messages as helpful. Figure 9 presents all survey responses. Analyzing these results by age group or by region produced similar results.

![Figure 9. Helpfulness of Blizzard Warning Messages Among Respondents Aware of Blizzard Warning Before Driving](image)

Results were somewhat similar for the 71 respondents who were unaware or couldn’t remember if they were aware of the blizzard warning before driving (see Figure 10). Most rated the messages as very helpful (39 percent) or helpful (38 percent). Analyzing this data by age group or region produced somewhat similar results.
Effectiveness of Road Weather Messages

The effectiveness of road weather messages on DMS compared to weather alerts delivered through other media types were rated using a scale of much less effective, less effective, somewhat less effective, somewhat more effective, more effective and much more effective.

As Figure 11 indicates, more than two-thirds (70 percent) to over three-quarters (78 percent) of respondents who were aware of the blizzard warning before they began driving rated the DMS more effective than other media types. Analyzing these results by respondent age or region produced similar results.

Figure 11. Effectiveness of Road Weather Messages on DMS Compared to Weather Alerts From Other Media Among Respondents Aware of Blizzard Warning Before Driving
In comparison, most respondents who were not aware of the blizzard warning before they began driving also rated the messages on DMS as either somewhat more effective or more effective than weather alerts from other media types except social media; most respondents rated DMS as either much more effective or more effective than weather alerts from social media (see Figure 12). Analyzing this data by respondent age and region produced similar results.

Figure 12. Effectiveness of Road Weather Messages on DMS Compared to Weather Alerts From Other Media Among Respondents Unaware of Blizzard Warning Before Driving

Access to Weather Information

According to respondents who were aware of a blizzard warning before they began driving, the most useful time to get weather information is when planning for a trip (46 percent) or immediately before leaving for a trip (44 percent). Figure 13 summarizes all survey responses.

Figure 13. Most Useful Time for Weather Information Among Respondents Aware of Blizzard Warning Before Driving
Results were similar for respondents who were not aware of the blizzard warning before they began driving, with 44 percent reporting the most useful time to get weather information is when planning for a trip or immediately before leaving for a trip (38 percent). Figure 14 summarizes all survey responses.

![Figure 14. Most Useful Time for Weather Information Among Respondents Unaware of Blizzard Warning Before Driving](image)

**Preferred Dissemination Methods**

Respondents then ranked dissemination methods when seeking information about adverse road conditions (with 1 as the most preferred method and 7 the least preferred method). Rankings of the dissemination methods among respondents who were aware of a blizzard warning before they began driving were:

- Seeing a message on DMS (score: 4.66).
- News and weather websites (score: 4.60).
- Cellphone app other than 511 (score: 4.57).
- Television or radio (score: 4.33).
- MnDOT 511 travel information website (score: 3.81).
- Calling 511 or using the 511 app (score: 3.46).
- Social media (score 2.64).

Analyzing this data according to age ranges of respondents produced similar results except among older respondents (55 years and older) whose preferred methods of dissemination were seeing a message on DMS, news and weather websites and television or radio.

Respondents who were not aware of a blizzard warning before they began driving ranked the dissemination methods as follows:

- Seeing a message on DMS (score: 4.87).
- News and weather websites (score: 4.65).
- Television or radio (score: 4.54).
- Cellphone app other than 511 (score: 4.38).
- MnDOT 511 travel information website (score: 4.18).
- Calling 511 or using the 511 app (score: 3.14).
- Social media (score 2.40).
Analyzing the preferred dissemination methods according to age ranges follows:

- **18 to 24 years, 35 to 44 years and 45 to 54 years**: News and weather websites, seeing a message on DMS and cellphone app other than 511.
- **25 to 34 years**: Seeing a message on DMS, cellphone app other than 511 and social media.
- **55 to 64 years**: Television or radio, seeing a message on DMS and cellphone app other than 511.
- **65 to 74 years**: Television or radio, news and weather websites and seeing a message on DMS.
- **75+ years**: News and weather websites, television or radio and cellphone app other than 511.

According to region, the preferred methods of these respondents were:

- **Greater Minnesota**: Seeing a message on DMS, cellphone app other than 511 and television or radio.
- **Twin Cities metro area**: News and weather websites, seeing a message on DMS and television or radio.

**Blizzard Warnings Not Viewed on Dynamic Message Signs**

Of the 406 respondents surveyed, 186 reported that they did not notice blizzard warning messages on DMS. These respondents provided additional information about the most useful time to receive weather information and the preferred type of dissemination method for information about adverse road conditions, which is summarized below in the following categories:

- Access to weather information.
- Preferred dissemination methods.

**Access to Weather Information**

According to respondents who did not notice blizzard warning messages on DMS, the most useful time to get weather information is immediately before leaving for a trip (52 percent) or when planning for a trip (39 percent). Figure 15 summarizes all survey responses. Analyzing the responses according to age ranges of respondents produced similar results.

![Figure 15. Most Useful Time for Weather Information Among Respondents Who Did Not Notice Warning Messages on DMS](image)

**Preferred Dissemination Methods**

Respondents who did not notice blizzard warning messages on DMS ranked dissemination methods when seeking information about adverse road conditions. This group of respondents offered the following rankings:
Prepared by CTC & Associates LLC

- News and weather websites (score: 5.35).
- Television or radio (score: 4.82).
- Cellphone app other than 511 (score: 4.01).
- MnDOT 511 travel information website (score: 4.01).
- Seeing a message on DMS (score: 3.89).
- Calling 511 or using the 511 app (score: 3.39).
- Social media (score 2.62).

Respondents who did not notice blizzard warning messages on DMS ranked “seeing a message on DMS” lower than those respondents who had seen a blizzard warning message on DMS (3.89 and 4.66/4.87, respectively). Both groups of respondents provided relatively high rankings for news and weather websites as a dissemination method for adverse road condition information.

Creative Safety Messages on Dynamic Message Signs

The Message Monday program, launched in November 2016, uses DMS to relay safety messages each week. These messages are intended to start conversations that could positively change the state’s traffic safety culture and modify driver behaviors. In this section, respondents describe their experiences with creative safety messages displayed on DMS.

Viewing Frequency

All respondents were surveyed about their experiences viewing Message Monday messages, beginning with a description of the frequency with which they saw the Message Monday message on DMS while driving:

- Never.
- Once every two or three months.
- Once a month.
- Two to three times a month.
- Every week.

More than three-quarters of respondents reported seeing the creative safety messages at some regular interval, with 23 percent of respondents seeing messages every week. Figure 16 summarizes survey responses.

![Figure 16. Frequency of Viewing Message Monday Messages](image-url)
When analyzing the responses by age of respondents, three age groups—18 to 24, 35 to 44 and 45 to 54—most frequently reported seeing the messages weekly; 25 to 34 years old, two to three times a month; 55 to 64 years old, once every two or three months; and older respondents (65 and older), never. When analyzing the responses by region, most respondents in the Twin Cities metro area reported seeing the messages every week, and most respondents in Greater Minnesota and other states reported never seeing the messages.

The remainder of this section summarizes survey responses of all respondents—320 respondents who reported seeing the Message Monday messages and 86 respondents who did not. Results for respondents who reported seeing the messages are presented in four categories:

- Message Monday viewings.
- Assessment of Message Monday messages.
- Impact on driving behavior.
- Future plans.

Feedback from respondents who reported never seeing Message Monday messages displayed on DMS follows these sections (beginning on page 93). These respondents were asked to rate the effectiveness of sample messages as a tool to encourage safe driving.

**Message Monday Viewings**

The 320 respondents who reported seeing the Message Monday messages at some regular interval typically see these messages when they are driving to work or school (46 percent), when they are running errands or shopping (43 percent) or during recreational travel (36 percent). Figure 17 summarizes all survey responses. Analyzing the responses according to age and region produced similar results.

**Assessment of Message Monday Messages**

Respondents rated the following aspects of Message Monday messages on DMS:

- Message comprehension.
- Message effectiveness.
**Message Comprehension**

Respondents rated how easy it is to understand Message Monday messages using a scale of not at all easy to understand, not easy to understand, somewhat not easy to understand, somewhat easy to understand, easy to understand and very easy to understand.

As Figure 18 indicates, almost all respondents (97 percent) rated the messages positively with regard to comprehension: very easy to understand (44 percent), easy to understand (42 percent) or somewhat easy to understand (11 percent). Analyzing the responses according to age and region produced similar results.

![Figure 18. Monday Message Comprehension](image)

**Follow-Up on Negative Ratings**

Some respondents who selected not at all easy to understand or not easy to understand provided additional information about their responses. Most were not sure or were unable to explain the difficulty of understanding Message Monday messages. Other respondents from this group commented on the positive aspects of the messages. Comments from these respondents are summarized below:

- I must see these messages in a few seconds to be helpful to myself.
- [They’re] OK to understand.
- Simple and easy.
- Very self-explanatory.
- It’s big and orange so it’s easy to see and read.
- It’s very straightforward.

**Message Effectiveness**

Also assessed was the effectiveness of Message Monday messages as tools to encourage safe driving and in comparison to similar messages delivered through other media types.
Safe Driving Tool

Respondents rated the ability of the following eight Message Monday messages to encourage safe driving:

- You had me at I don’t text and drive.
- Not wearing your seat belt? What’s holding you back?
- Love to ride? Use your head and your helmet.
- Drive to lake: $100. Case of beer: $24. DWI: $10,000.
- Drinking and driving can kill a friendship.
- Cutting off trucks can cut life short.
- Only cats have nine lives. Buckle up.
- Work zone safety. Don’t speed through their office.

To rate each message, respondents used a scale of not at all effective, not effective, somewhat not effective, somewhat effective, effective and very effective. When considering only the highest rating (very effective) and when combining the two highest ratings (effective and very effective), the three most highly rated messages were:

- Drive to lake: $100. Case of beer: $24. DWI: $10,000.
- Drinking and driving can kill a friendship.
- Work zone safety. Don’t speed through their office.

Figure 19 and Table 20 summarize survey responses.

(Note: Respondents who reported never seeing a Message Monday message displayed on DMS were also asked to rate the ability of these messages to encourage safe driving. Results from this group of respondents begin on page 93.)
<table>
<thead>
<tr>
<th>Message Monday Message</th>
<th>Not At All Effective</th>
<th>Not Effective</th>
<th>Somewhat Not Effective</th>
<th>Somewhat More Effective</th>
<th>More Effective</th>
<th>Very Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>You had me at I don’t text and drive.</td>
<td>4.40%</td>
<td>4.72%</td>
<td>9.12%</td>
<td>30.19%</td>
<td>31.45%</td>
<td>20.13%</td>
</tr>
<tr>
<td>Not wearing your seat belt? What’s holding you back?</td>
<td>3.17%</td>
<td>2.86%</td>
<td>5.08%</td>
<td>24.76%</td>
<td>33.97%</td>
<td>30.16%</td>
</tr>
<tr>
<td>Love to ride? Use your head and your helmet.</td>
<td>1.25%</td>
<td>3.44%</td>
<td>9.06%</td>
<td>31.56%</td>
<td>30.31%</td>
<td>24.38%</td>
</tr>
<tr>
<td>Drive to lake: $100. Case of beer: $24. DWI: $10,000.</td>
<td>4.08%</td>
<td>2.19%</td>
<td>5.33%</td>
<td>16.93%</td>
<td>28.84%</td>
<td>42.63%</td>
</tr>
<tr>
<td>Drinking and driving can kill a friendship.</td>
<td>2.19%</td>
<td>2.82%</td>
<td>5.96%</td>
<td>19.44%</td>
<td>31.03%</td>
<td>38.56%</td>
</tr>
<tr>
<td>Cutting off trucks can cut life short.</td>
<td>1.26%</td>
<td>2.83%</td>
<td>5.35%</td>
<td>27.36%</td>
<td>33.96%</td>
<td>29.25%</td>
</tr>
<tr>
<td>Only cats have nine lives. Buckle up.</td>
<td>2.82%</td>
<td>3.45%</td>
<td>5.02%</td>
<td>25.71%</td>
<td>31.03%</td>
<td>31.97%</td>
</tr>
<tr>
<td>Work zone safety. Don’t speed through their office.</td>
<td>0.94%</td>
<td>3.45%</td>
<td>5.33%</td>
<td>20.38%</td>
<td>36.99%</td>
<td>32.92%</td>
</tr>
</tbody>
</table>

**Message Delivery Through Other Media**

The effectiveness of Message Monday messages on DMS compared to similar messages delivered through other media types was rated using a scale of much less effective, less effective, somewhat less effective, somewhat more effective, more effective and much more effective.

As Figure 20 indicates, most respondents rated the Message Monday messages as somewhat more effective, more effective or much more effective than similar messages from all four media types. Analyzing the results by age and region produced similar results.

![Figure 20. Effectiveness of Message Monday Messages on DMS Compared to Similar Messages From Other Media](image-url)
Impact on Driving Behavior

Respondents assessed the impact of Message Monday messages on both their immediate driving behavior and on their driving behavior over time.

Immediate Impact on Driving Behavior

For almost 60 percent of respondents, seeing a specific Message Monday message either changed their immediate driving behavior (21 percent) or changed their immediate driving behavior somewhat (38 percent). Figure 21 summarizes survey responses.

Respondents residing in the Twin Cities metro area or Greater Minnesota reported similar results. Respondents from other states indicated that the message had no immediate effect or they did not know. Two age groups reported somewhat different results:

- **25 to 34 years**: Almost half of respondents (46 percent) reported that the message changed their immediate driving behavior somewhat and 25 percent reported that the message changed their immediate driving behavior.
- **75+ years**: Forty-four percent of respondents reported that the message changed their immediate driving behavior and 33 percent reported that they did not know if the message changed their immediate driving behavior.

Long-Term Impact on Driving Behavior

Similarly, when asked about the long-term impact on driving behavior, almost 60 percent of respondents reported that seeing Message Monday messages over time either changed their driving behavior (21 percent) or changed their driving behavior somewhat (37 percent). Figure 22 summarizes all survey responses.
Respondents residing in the Twin Cities metro area and Greater Minnesota reported similar results. Respondents from other states indicated that the messages had no effect over time or they did not know. Three age groups reported somewhat different results:

- **18 to 24 years**: Thirty-two percent of respondents reported that the messages did change their driving behavior over time; 29 percent reported that their driving behavior changed somewhat.
- **25 to 34 years**: Thirty-eight percent of respondents reported that the messages changed their driving behavior somewhat, and 25 percent reported that the message did change their driving behavior.
- **75+ years**: Forty-four percent of respondents reported that the messages changed their driving behavior somewhat; 33 percent did not know.

**Future Plans**

**Message Frequency**

More than three-quarters of respondents (83 percent) agreed that the current practice of delivering creative safety messages on DMS once each week (on Mondays) should be continued. The remaining respondents indicated that the practice should not be continued or suggested the practice possibly be continued with changes. Figure 23 summarizes survey responses. Analyzing these results by age and region produced similar results.
Below are comments from respondents who recommended changing the weekly practice:

- Increase message frequency.
  - Display messages daily. (4 responses)
  - Display more often during the week. (2 responses)
  - Display messages two or three times a week.
  - Display both Mondays and Fridays.
  - Vary the day of the week when messages are delivered. (2 responses)
  - Increase frequency to hit a larger audience (rush hour every day, for example).

- Address additional safety topics.
  - Address laws like lights with wipers, stop for buses and give a lane to pullovers.
  - Use “Slow traffic keep out of left lane/it’s the law.”

- Update messages more frequently.
  - Update messages more frequently (although reading them can be a distraction).
  - Provide new messages to keep drivers alert.
  - Update messages as needed.

- Update message content.
  - Be more concise. Long messages are too distracting. (3 responses)
  - Get the message across without being too cutesy.

**Message Topics**

Seven topics for Message Monday safety messaging were rated using a scale of not at all important, not important, somewhat not important, somewhat important, important and very important:

- Buckling your seat belt.
- Driving the speed limit.
- Using cellular devices.
- Slowing down in construction areas.
- Not drinking or using drugs while driving.
- Watching for motorcycles.
- Driving too close to another vehicle.

For each message topic, “very important” received the highest percentage of responses from among the rating choices. The most important topics among respondents were using cellular devices (64 percent), not drinking or using drugs while driving (63 percent) and slowing down in construction areas (61 percent), followed by buckling your seat belt (51 percent), driving too close to another vehicle (48 percent), watching for motorcycles (48 percent) and driving the speed limit (39 percent). Figures 24 through 30 summarize survey responses for each message topic. Analyzing these results by age and region produced similar results.
Figure 24. Importance of Messaging Related to Buckling Your Seat Belt

Figure 25. Importance of Messaging Related to Driving the Speed Limit
Figure 26. Importance of Message Related to Using Cellular Devices

Figure 27. Importance of Messaging Related to Slowing Down in Construction Areas
Figure 28. Importance of Messaging Related to Not Drinking Or Using Drugs While Driving

Figure 29. Importance of Messaging Related to Watching for Motorcycles
Feedback From Nonviewers of Message Monday Messages

The 86 respondents who reported never seeing a Message Monday message displayed on DMS were also asked to rate the ability of the eight messages to encourage safe driving. Respondents used a scale of not at all effective, not effective, somewhat not effective, somewhat effective, effective and very effective.

As Figure 31 indicates, most respondents rated these messages as somewhat effective or very effective. The work zone safety message received the highest effective/very effective rating. The no-texting message received the lowest effective/very effective rating.

Figure 30. Importance of Messaging Related to Driving Too Close to Another Vehicle

Figure 31. Nonviewer Ratings of Message Monday Messaging Effectiveness
Final Comments

All respondents had the opportunity to provide additional comments after completing the survey. Respondent comments are summarized below by topic.

Support for Messaging on Dynamic Message Signs

- I love these messages. Would love to see them more often. (6 responses)
- I think they are using clever methods of interventions to get drivers to think about how their actions affect themselves or other drivers.
- The message boards caught my attention when they first went up and it has been a helpful reminder to me to be a safer driver. I’ve used my phone less and have increased my awareness of workers due to these message boards.
- Signs are very noticeable.
- I like the traffic and weather messages. I change my driving habits based on signage.
- The messages are very important to make drivers aware of what is ahead—safety issues for our own good. (2 responses)
- Great messages. My 15-year-old daughter sees them while driving with her permit and we talk about them.
- I think the messages are great and weather warnings are necessary to help drivers know of hazardous road conditions.
- I rarely drive the highways that have the DMS signs but do appreciate the information that I occasionally see on them.
- Keep it up! Exposure is everything!
- All forms of communication are helpful.
- Anything you do is greatly appreciated in order to save lives!

Message Content

- Keep messages witty and helpful.
- Keep them short. They go by quickly and could be considered distracting.
- “Exit closed. Use alternate route.” What route? That would be terrifically helpful information on a sign. We aren’t all familiar with Twin Cit[ies] roads! We don’t all have GPS. We don’t know what to do!

Message Scheduling

- Fridays would be a good [day] for messages for when people go out of town. (2 responses)
- Use the boards daily. (2 responses)

Safety Concerns

- The signs are distracting.
- Looking at a message board is the same as looking at a text message. They both can be a distraction.
- Signs in my opinion make the driver take their eyes off the road yet makes them think about what could make them safe.

Other

- I absolutely love the 511 website. The info is mostly spot on.
- I think there needs to be a bigger amount of money being taken away for texting and driving.
Conclusions and Next Steps

Key findings and results from each phase of this study are summarized below.

Literature Search

A literature search examined DMS practices and guidance in two topic areas:

- Weather-related messages
- Creative safety messages

Weather-Related Messages

Several publications address national efforts to enhance and promote road weather technologies, including resources associated with WRTM and DMS practices. A 2017 FHWA report provides an update on the progress of the agency’s Road Weather Management Program and is considered a resource and outreach product for advancing road weather technology implementation. A 2017 report summarizes the approaches taken or considered by states participating in the North/West Passage pooled fund to forecast and alert travelers about road weather conditions.

Other publications focus on management strategies and technologies, including a 2018 FHWA report about leveraging vehicle connectivity to develop new WRTM tools. The report provides case studies and messaging initiatives underway in several states. Other resources evaluate DMS practices as part of planning efforts for ITS devices and technologies. A 2012 FHWA publication, written for transportation agencies and other organizations that communicate road weather information to travelers, provides guidance for developing road weather-related messages and for selecting the appropriate dissemination method.

Publications from 13 state agencies address DMS guidance and plans, including several 2018 Iowa DOT reports about the use of DMS as part of the agency’s ITS platform, a 2017 case study about the development of a road weather information system in Kansas, and ITS plans and design guides from North Dakota and Pennsylvania DOTs that include DMS deployment.

Creative Safety Messages

National publications related to creative safety messages include a pooled fund study about the future of DMS messaging, and two FHWA reports that assess the effectiveness and potential benefits of posting PSAs in rural areas, and the impact of PSAs on driver behavior. The creation of creative safety message programs along with policies and practices are the focus of reports from 10 state agencies, including a 2015 Florida DOT campaign, a 2017 blog post about Iowa DOT’s creative safety message program and two publications from Virginia DOT.

Survey of State Departments of Transportation

Twenty-one state transportation agencies completed the online survey, sharing their agencies’ experience with road weather-related and creative safety messages appearing on DMS located on their highway systems.

Weather-Related Messages

The weather events that trigger the deployment of road weather-related messages on state agencies’ DMS are winter storm, high wind, dense fog, freezing rain and blizzard warnings. The least likely weather events to trigger deployment of a road weather-related message are any snowfall amount and severe thunderstorm warnings.
More than half of the states responding to the survey use a mostly manual process to deliver these messages. Only one state (Mississippi) uses a mostly automated process, and seven states (Alabama, Maine, Maryland, Michigan, Nevada, Virginia and Wisconsin) use a combination of manual and automated processes. Similarly, more than half of the states responding to the survey use a combination of standard message templates and custom messages. Five states (Massachusetts, Michigan, Mississippi, Nevada and Wisconsin) use a standard message template that is sometimes stored in agencies’ ATMS and two states (Arkansas and Illinois) develop custom DMS messages for each weather-related event.

A range of practices are supported by these agencies to determine the timing that a DMS message is displayed. Eight states (Delaware, Maine, Mississippi, Missouri, New York, Pennsylvania, South Dakota and Vermont) display messaging before an event; Delaware and Mississippi DOTs also display messages at event onset, and Vermont Agency of Transportation displays messages during the event.

Best practices supported by these agencies in delivering road weather-related messages via DMS are related to accurate messaging, partnering with other agencies, preplanning guidance and timing. Respondents also reported challenges with delivering road weather-related messages, primarily related to inaccurate forecasting or false alarms, inadequate assets in affected areas, issues with messaging and timely message updates.

Creative Safety Messages

Eighteen state DOTs participating in the survey use DMS to post creative safety messages. Five states (Colorado, Delaware, Massachusetts, Michigan and South Dakota) post creative safety messages weekly while four states (Delaware, Illinois, Missouri and Tennessee) post messages daily, and three states (Maine, Ohio and Virginia) post messages twice monthly. None of the states participating in the survey post messages several times each week or monthly. Several states post messages that are tied to safety campaigns or guidance from other federal or state agencies, which dictate when messages are posted.

The number of messages used and the frequency with which they are changed vary among survey respondents. Nearly one-half of these agencies display one message per scheduled cycle; two states (Maine and Nevada) display multiple messages per cycle. Seven states (Colorado, Illinois, Michigan, Missouri, Ohio, Pennsylvania and Vermont) post creative safety messages on an as-needed basis to ensure a deployed sign reflects continual messaging. Four states (Delaware, Michigan, Missouri and South Dakota) change the DMS weekly. Mississippi DOT is the only agency participating in the survey that is currently changing its creative safety messages daily.

Ten states (Arkansas, Colorado, Maryland, Ohio, Pennsylvania, South Dakota, Tennessee, Vermont, Virginia and Wisconsin) limit the number of hours per day that a creative safety message can be displayed, ranging from the first two hours of the day to 24 hours. Other factors that limit message display time are related to the equipment used, specific safety campaigns and driver attention to message content. Six states (Arkansas, Maryland, Missouri, Tennessee, Virginia and Wisconsin) impose limitations on the time periods each day that creative safety messages can be displayed. Five states (Arkansas, Massachusetts, Nevada, South Dakota and Wisconsin) limit the number of creative safety messages that can be displayed during a specific time period (typically one message per time period).

Nearly all the transportation agencies responding to the survey partner with other agencies to develop and deliver safety messages. These partnerships are primarily with the state police and other state agencies but also include local or federal agencies and other state DOTs. Almost all these agencies maintain a catalog of safety messages that are used and reused throughout the year. These catalogs range from simple logs and spreadsheets (Colorado, Delaware, Maine, Ohio, South Dakota, Virginia and Wisconsin) to more complex ATMS tools (Maryland and Missouri).
Public Perception Survey

The public perception survey was completed by 406 respondents ranging in age from 18 years to 75+ years, representing more than five racial groups, and residing in the eight-county Twin Cities metropolitan area, Greater Minnesota or nearby states. Almost 60 percent of respondents use Minnesota roadways every weekday, while 23 percent use these roadways two or more times a week. Average use by the remaining respondents ranged from once a week to less than once a month.

Highlights of survey responses are provided below in two categories:

- Blizzard warning messages on DMS
- Creative safety messages on DMS

Blizzard Warning Messages on Dynamic Message Signs

Slightly more than half of survey respondents (220) reported seeing a blizzard warning message on DMS, while the remaining 186 respondents did not. Warning messages were most frequently viewed twice and were located in the Twin Cities metro area or along interstate highways. Most of these respondents were already aware of the blizzard warning before they began driving and had received weather information from news and weather websites, television and radio. These respondents were least likely to rely on social media, the 511 app or the MnDOT 511 travel information website. Viewing blizzard warning messages on DMS led more than half of these respondents to drive with extra caution.

Almost three-quarters of the respondents who were aware of the blizzard warning before they began driving rated blizzard warnings on DMS as helpful or very helpful. Slightly more than three-quarters of the respondents who were not aware of the blizzard warning before driving or couldn’t remember if they were aware also rated the messages as very helpful or helpful.

The respondents who were aware of the blizzard warning before they began driving were more likely to rate road weather messages on DMS as either somewhat more effective or more effective than weather alerts delivered through other media types such as radio, television, weather-related websites or social media. Almost two-thirds of the respondents who were not aware of the blizzard warning before they began driving rated DMS as either much more effective or more effective than weather alerts from social media.

The most useful time to get weather information is either while planning for a trip or immediately before leaving for a trip, according to all 406 respondents. Those who reported viewing blizzard warning messages on DMS were more likely to access information while planning for a trip while those who reported not viewing blizzard warning messages on DMS were more likely to access information immediately before leaving for a trip.

Seeing a warning message on DMS is the preferred method for disseminating information about adverse road conditions among respondents who reported viewing blizzard warning messages on DMS. Other dissemination methods preferred by this group include accessing information from news and weather websites, using a cellphone app other than 511 and accessing information from television or radio. Respondents who reported not viewing blizzard warning messages on DMS prefer news and weather websites, television or radio, a cellphone app other than 511 and the MnDOT 511 travel information website.

Creative Safety Messages on Dynamic Message Signs

More than three-quarters of respondents reported seeing the creative safety messages that are part of MnDOT’s Message Monday program. Only 86 respondents indicated that they never saw the messages.
Of the respondents who saw these messages, most saw them every week, typically when they were driving to work or school, running errands or shopping, or traveling recreationally. Eighty-six percent of these respondents rated the comprehension of creative safety messages as either very easy to understand or easy to understand.

The highest ratings (very effective or effective) were given to the following messages:

- Drive to lake: $100. Case of beer: $24. DWI: $10,000.
- Drinking and driving can kill a friendship.
- Work zone safety. Don’t speed through their office.

Most of the 86 respondents who reported never seeing a Message Monday message displayed on DMS rated these messages as somewhat effective or very effective tools to encourage safe driving.

In general, Message Monday messages on DMS were seen as more effective than similar messages delivered through other media. Almost 60 percent of respondents seeing a specific Message Monday message reported a change in both their immediate and long-term driving behavior.

While 83 percent of respondents recommended continuing the current practice of delivering weekly creative safety messages on DMS, several respondents recommended delivering these messages more frequently, from two to three times a week to daily. Safety message topics that received the highest ratings were using cellular devices, not drinking or using drugs while driving, slowing down in work zones and buckling seat belts.

**Next Steps**

The information gathered in this study is expected to inform a MnDOT implementation project that will develop the software needed to automate deployment of blizzard warnings to existing DMS. These warning messages will be developed using data provided by a variety of data sources and communicated to IRIS, the system MnDOT uses to control DMS messaging.
Appendix A: State Department of Transportation Survey Questions

The following survey was distributed to selected state DOTs expected to have experience with the use of DMS to display:

- Weather-related messages that advise travelers of blizzard warnings or other unexpected or isolated conditions.
- Nontraditional, creative safety-related DMS messaging.

Note: Responses to the question below determined how respondents completed the survey:

- Respondents who answered “no” to the question were offered an opportunity to provide additional comments before finishing the survey.
- Respondents who answered “yes” to the question were directed to the remaining questions.

Does your agency currently deploy weather-related messages on dynamic message signs?

Generating Weather-Related Messages on Dynamic Message Signs

1. Please describe the type of weather events that will trigger the deployment of road weather-related messages on your agency’s dynamic message signs (DMS) by selecting all that apply

   - Severe thunderstorm warning.
   - Tornado warning.
   - Flash flood warning.
   - Dense fog warning.
   - High wind warning.
   - Freezing rain.
   - Winter storm warning.
   - Blizzard warning.
   - Any snowfall amount will trigger a DMS message.
   - Other (please describe).

2. Select the option below that best describes your agency’s process to deliver road weather-related messages via DMS.

   - A mostly manual process.
   - A mostly automated process (Please respond to Question 2A below.)
   - A combination of manual and automated processes (Please respond to Question 2A below.)

2A. Please indicate the vendor(s) providing the software/hardware and data source.

3. Select the option below that best describes your agency’s process to deliver road weather-related messages via DMS.

   - Our agency uses standard message templates. (Please respond to Question 3A below.)
   - Our agency develops custom DMS messages for each weather-related event. (Please respond to Question 3B below.)
   - Our agency uses a combination of templates and custom messages to create weather-related DMS messages. (Please respond to Question 3C below.)
3A. Please briefly describe the message templates and provide examples, if available.

3B. Please briefly describe who is responsible for developing the custom messages and any guidance used, providing examples and referencing specific agency guidance, if available. Provide links below to agency guidance or email them to chris.kline@ctcandassociates.com.

3C. Please briefly describe how your agency combines the use of templates and custom messages, providing examples and referencing specific agency guidance, if available. Provide links below to agency guidance or email them to chris.kline@ctcandassociates.com.

4. Please describe how your agency determines the timing of a DMS message generated to address a forecasted blizzard or other type of significant storm event.

Assessing Road Weather Messaging Practices

1. Has your agency attempted to assess travelers’ opinions and/or behaviors associated with road weather-related DMS messaging? If yes, please describe the results of this assessment.

2. What practices has your agency found to be most successful when delivering road weather-related messages via DMS?

3. What has your agency found to be most challenging when delivering road weather-related messages via DMS?

4. How is your agency’s DMS road weather messaging program related to other agency information delivery options (website, phone app, in-vehicle navigation system and others)? Please describe any relationship in terms of the process for developing messages, common messages across platforms and the technology used.

5. Do you have documents related to your agency’s road weather messaging using DMS that you can share (other than those you have already provided)? Provide links below to these documents or email them to chris.kline@ctcandassociates.com.

Creative Safety Messaging

Some transportation agencies are using dynamic message signs to display nonurgent, creative safety-related messages designed to catch drivers’ attention and expand agency outreach to motorists.

Note: Responses to the question below determined how respondents completed the survey:

- Respondents who answered “no” to the question were offered an opportunity to provide additional comments before finishing the survey.
- Respondents who answered “yes” to the question were directed to the remaining questions.

Does your agency currently use dynamic message signs to post creative safety messages?
Generating Creative Safety Messages on Dynamic Message Signs

1. What is your agency’s scheduled cycle for posting creative safety messages on dynamic message signs (DMS)?
   - Daily.
   - Once a week.
   - Several times a week.
   - Once a month.
   - Twice a month.
   - Every holiday.
   - Weekends.
   - Other.

2. How frequently does your agency change the actual message displayed on the DMS (for example, one message per cycle, multiple messages per cycle, etc.)?

3. Does your agency post creative safety messages on an as-needed basis to ensure a deployed sign reflects continual messaging?

4. Does your agency impose a limitation on how many hours per day a creative safety message can be displayed? If yes, please describe this limitation.

5. Does your agency impose limitations on the time periods each day creative safety messages can be displayed? If yes, please describe this limitation.

6. Does your agency impose a limitation on the number of creative safety messages that can be displayed during a specific period of time (for example, per month or per year)? If yes, please describe this limitation.

7. Has your agency partnered with another state agency to develop and deliver these messages? If yes, please describe this partnership.

8. Does your agency maintain a catalog of creative safety messages that are used and reused throughout the year? If yes, please describe these messages and provide examples.

Assessing Creative Safety Messaging Practices

1. Has your agency attempted to assess travelers’ opinions and/or behaviors associated with creative safety DMS messaging? If yes, please describe the results of this assessment.

2. Do you have documents related to your agency’s creative safety messaging using DMS that you can share (other than those you have already provided)? Provide links below to these documents or email them to chris.kline@ctcandassociates.com.

Wrap-Up

Please use this space to provide any comments or additional information about your previous responses.
Appendix B: State Department of Transportation Contacts

Below is the contact information for the individuals responding to the survey for this report.

**Alabama**
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State Transportation Systems Management and Operations Administrator  
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Maine Department of Transportation  
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**Maryland**
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Division Chief, Traffic Management Center Operations  
Maryland State Highway Administration Maryland Department of Transportation  
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**Massachusetts**
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Assistant Administrator, Traffic and Safety Engineering, Highway Division  
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**Michigan**
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Vermont Agency of Transportation
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Wisconsin
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Control Room Engineer, Bureau of Traffic Operations
Wisconsin Department of Transportation
414-227-2150, Dan.Schultz@dot.wi.gov
Appendix C: Public Perception Survey Questions

The following survey was distributed to members of the general public who were asked about MnDOT’s use of dynamic message signs (DMS) to display two types of messages along Minnesota’s roadways:

- Blizzard warnings.
- Creative safety messages.

Blizzard Warnings on Dynamic Message Signs

1. How frequently do you travel on Minnesota’s roadways?
   - Every weekday.
   - Two or more times a week.
   - Once a week.
   - Two or more times a month.
   - Once a month.
   - Less than once a month

Note: Responses to the question below determined how respondents completed the survey:

- Respondents who answered “no” to the question were directed to complete Questions 9 and 10.
- Respondents who answered “yes” to the question were directed to the remaining questions.

2. (Required) Did you see a blizzard warning on a DMS as you traveled on Minnesota’s roadways during the last two winter seasons?
   - Yes
   - No

3. How many times did you see a blizzard warning message on a DMS?
   - Once
   - Twice
   - Three times
   - More than three times
   - I don’t remember

4. Where were you when you saw the blizzard warning on one or more DMS? Check all that apply.
   - Twin Cities metro area
   - Greater Minnesota (outside the Twin Cities metro area)
   - Interstate highway (examples are I-35, I-90, I-94, I-394, I-494 and I-694)
   - State highway (typically abbreviated as MN and followed by a number)
   - I don’t remember
Note: Responses to the question below determined how respondents completed the survey:

- Respondents who answered “no” or “I don’t remember” to the question were directed to complete Questions 6 through 10.
- Respondents who answered “yes” to the question were directed to complete Questions 5A through 10.

5. (Required) Were you aware of the blizzard warning before you began driving?

- Yes
- No
- I don’t remember

5A. How did you learn about the blizzard? Check all that apply.

- Calling 511 or using the 511 app
- Cellphone app other than 511
- MnDOT website (511 travel information)
- News and weather websites
- Television
- Radio
- Social media

6. How did seeing the DMS blizzard warning(s) alter your driving plans or the route you traveled? Check all that apply.

- I delayed the remainder of my trip by returning home
- I delayed the remainder of my trip by finding refuge at a local mall, hotel, rest area, etc.
- I took an alternate route I determined on my own
- I drove with extra caution
- I don’t recall making any changes in my driving plans or route

7. How would you rate the helpfulness of the blizzard warning(s) you saw on the DMS? Check only one.

- Not at all helpful
- Not helpful
- Somewhat not helpful
- Somewhat helpful
- Helpful
- Very helpful

8. How would you rate the effectiveness of road weather messages on DMS compared to weather alerts delivered through the other media types listed below (much less effective, less effective, somewhat less effective, somewhat more effective, more effective or much more effective)? Check only one for each media type.

- DMS compared to radio
- DMS compared to television
• DMS compared to weather-related websites
• DMS compared to social media

9. When do you feel is the most useful time to get weather information? Check only one.

• Planning for a trip
• Immediately prior to leaving
• At a stopping point
• While driving

10. What type of dissemination method do you prefer when seeking information about adverse road conditions? Rank the dissemination methods in the list below in order of preference, with 1 being your most preferred method and 7 being your least preferred method.

• Calling 511 or using the 511 app
• Cellphone app other than 511
• Seeing a message on DMS
• MnDOT website (511 travel information)
• News and weather websites
• Television or radio
• Social media

Creative Safety Messages on Dynamic Message Signs

Note: Responses to the question below determined how respondents completed the survey:

• Respondents who answered “never” to the question were directed to complete Question 2.
• All other respondents completed Questions 3 through 10.

1. (Required) Typically, how often do you see the Message Monday messages that appear on DMS while driving?

• Never
• Once every two or three months
• Once a month
• Two to three times a month
• Every week

2. Even though you’ve never seen them displayed on a DMS, how would you rate the following Message Monday messages as a tool to encourage safe driving techniques (not at all effective, not effective, somewhat not effective, somewhat effective, effective, very effective)? Check only one for each message.

• YOU HAD ME AT I DON’T TEXT AND DRIVE
• NOT WEARING YOUR SEAT BELT? WHAT’S HOLDING YOU BACK?
• LOVE TO RIDE? USE YOUR HEAD AND YOUR HELMET
• DRIVE TO LAKE $100 CASE OF BEER $24 DWI $10,000
• DRINKING & DRIVING CAN KILL A FRIENDSHIP
• CUTTING OFF TRUCKS CAN CUT LIFE SHORT
• ONLY CATS HAVE NINE LIVES BUCKLE UP
• WORK ZONE SAFETY DON’T SPEED THROUGH THEIR OFFICE

3. When do you typically see the Message Monday messages? Check all that apply.

• When I’m driving to work or school
• As a commercial vehicle driver driving my route
• During recreational travel
• When I’m running errands or shopping

4. Overall, how understandable are the Message Monday messages? Check only one.

• Not at all easy to understand
• Not easy to understand
• Somewhat not easy to understand
• Somewhat easy to understand
• Easy to understand
• Very easy to understand

4A. If you selected “not at all easy to understand” or “not easy to understand” from the choices above, please use the comment box below to explain why you find the Message Monday messages difficult to understand.

5. How would you rate the following Message Monday messages as a tool to encourage safe driving techniques, even if you’ve never seen the message displayed on a DMS (not at all effective, not effective, somewhat not effective, somewhat effective, effective, very effective)? Check only one for each message.

• YOU HAD ME AT I DON’T TEXT AND DRIVE
• NOT WEARING YOUR SEAT BELT? WHAT’S HOLDING YOU BACK?
• LOVE TO RIDE? USE YOUR HEAD AND YOUR HELMET
• DRIVE TO LAKE $100 CASE OF BEER $24 DWI $10,000
• DRINKING & DRIVING CAN KILL A FRIENDSHIP
• CUTTING OFF TRUCKS CAN CUT LIFE SHORT
• ONLY CATS HAVE NINE LIVES BUCKLE UP
• WORK ZONE SAFETY DON’T SPEED THROUGH THEIR OFFICE

6. How would you rate the effectiveness of Message Monday messages compared to similar messages delivered through the other media types listed below (much less effective, less effective, somewhat less effective, somewhat more effective, more effective, much more effective)? Check only one for each media type.

• Message Monday compared to radio
• Message Monday compared to television
• Message Monday compared to websites
• Message Monday compared to social media
7. Have you changed your immediate driving behavior after seeing a specific Message Monday message?
   
   - Yes
   - Somewhat
   - No
   - I don’t know

8. Has seeing the Message Monday messages over time altered your driving behavior in general?
   
   - Yes
   - Somewhat
   - No
   - I don’t know

9. Should creative safety messages continue to be delivered on DMS as they currently are (once per week on Mondays)?
   
   - Yes
   - No
   - Possibly, with changes (please describe below)

10. How important is it to provide Message Monday safety messaging information to drivers on the following topics (not at all important, not important, somewhat not important, somewhat important, important, very important)? Check only one for each topic.
    
    - Buckling your seat belt
    - Driving the speed limit
    - Using cellular devices
    - Slowing down in construction areas
    - Not drinking or using drugs while driving
    - Watching for motorcycles
    - Driving too close to another vehicle

About Yourself

1. (Required question) Are you?
   
   - Female
   - Male
   - Transgender
   - Nonbinary
   - Prefer not to answer

2. (Required question) How old are you?
   
   - 18-24
   - 25-34
   - 35-44
   - 45-54
   - 55-64
3. (Required question) What is your racial origin?
   - White
   - Black, African American or African
   - Asian
   - Native American or Alaskan Native
   - Hispanic
   - Two or more races
   - Of another race
   - Prefer not to answer

4. (Required question) Where do you live?
   - Greater Minnesota (outside the Twin Cities metro area)
   - Twin Cities 8-county metro area
   - I live in a neighboring state
   - I live elsewhere (please describe)

5. Please use this space to provide any comments or additional information about your previous responses.
## Appendix D: Profile of Public Perception Survey Respondents

### Table D-1. Profile of Public Perception Survey Participants: Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Female</th>
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<th>Transgender</th>
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### Table D-2. Profile of Public Perception Survey Participants: Racial Origin

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### Table D-3. Profile of Public Perception Survey Participants: Region

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<tr>
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