

# NORTH/WEST PASSAGE



June 2017

Forecasting and Alerting Travelers about Critical Road Conditions

Project 11.2

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## 1. INTRODUCTION

Transportation agencies use data from Road Weather Information Systems (RWIS), Maintenance Decision Support Systems (MDSS), National Weather Service (NWS) or private meteorological services to understand current and forecasted road and weather conditions so they can make operational decisions about staffing, equipment, materials, etc. during weather events. Providing travelers with information about *current* road conditions is also a critical strategy that agencies use to manage operations and traffic during weather events. The convergence of these road weather management activities has led to agencies exploring the use of *forecasted* road conditions to alert travelers of critical conditions that may impact their trips.

Through the Federal Highway Administration (FHWA) Road Weather Management Program (RWMP), results of select work in this area were documented in 2015 as emerging Weather Responsive Traffic Management (WRTM) strategies. [South Dakota DOT \(SDDOT\) Regional Traveler Information System for Weather Responsive Traffic Management](#)<sup>1</sup> describes how SDDOT developed a system to enhance and increase the frequency of road condition reports, while improving and expanding road weather information provided to travelers. The project introduced a new layer to the SDDOT traveler information web site that provides potential road condition threats forecasted over the next 24 hours. In 2016, the RWMP released another report documenting transportation agency interactions and working relationships with the weather enterprise through the Pathfinder project. [Collaboration Across the Road Weather Enterprise: The Pathfinder Project](#)<sup>2</sup> describes practices with disseminating consistent messages about weather and its impact on the roads for the states of California, Nevada, Utah and Wyoming in relation to the I-80 corridor. The project explored how transportation agencies and weather organizations could develop consistent forecast messages that prompt travelers to change departure times, choose alternate routes, select different modes of transportation, or cancel trips in response to adverse weather conditions.

The North/West Passage pooled fund program focuses on cross-border intelligent transportation systems (ITS) coordination along the I-90 and I-94 corridors through the states of Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, and Minnesota, as illustrated in Figure 1.



Figure 1: North/West Passage Members

***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

<sup>1</sup> South Dakota DOT (SDDOT) Regional Traveler Information System for Weather Responsive Traffic Management, [https://ntl.bts.gov/lib/56000/56900/56952/FHWA-JPO-16-269\\_V1.pdf](https://ntl.bts.gov/lib/56000/56900/56952/FHWA-JPO-16-269_V1.pdf), FHWA-JPO-16-269, November 2015.

<sup>2</sup> Collaboration Across the Road Weather Enterprise: The Pathfinder Project, <https://ops.fhwa.dot.gov/publications/fhwahop16086/fhwahop16086.pdf>, FHWA-HOP-16-086, December 2016.

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. Interviews were conducted in February and March 2017 with the following individuals:

- Tony Ernest - Idaho Transportation Department (ITD)
- Cory Johnson - Minnesota DOT (MnDOT)
- Brandi Hamilton - Montana DOT (MDT)
- Brandon Beise, Joe Snustad, Mike Kisse - North Dakota DOT (NDDOT)
- Dave Huft - South Dakota DOT (SDDOT)
- Ron Vessey – Washington DOT (WSDOT)
- Gabe Gutierrez - Wyoming DOT (WYDOT)

## 2. OVERVIEW OF ROAD CONDITION REPORTING PRACTICES

For this report, discussions and information gathering focused on how the states are reporting road conditions from three perspectives: current, automated and forecasted.

- **Current:** Condition of roads at present point in time
- **Automated:** Any degree of automation used to support current road conditions
- **Forecasted:** Predicted condition of roads at a future point in time

To better understand what the states may be considering for *forecasted* road conditions, information was gathered about the states’ practices with reporting *current* road conditions. Presuming that *automation* would be a significant factor in forecasting road conditions, the states were also asked about the use of automation to generate road condition reports. This section summarizes the practices of North/West Passage states for generating current road condition reports and using automation to generate reports.

### 2.1 Current Road Condition Reports

As the agencies responsible for maintaining interstate and state roadways, the DOTs provide reports to alert travelers about current road conditions to assist in planning trips. Reports are based on a combination of weather, maintenance and traffic variables – all of which combine to create a unique impact on the condition of the road as illustrated in Figure 2. This section describes the methods used by the North/West Passage states to report on current road conditions.

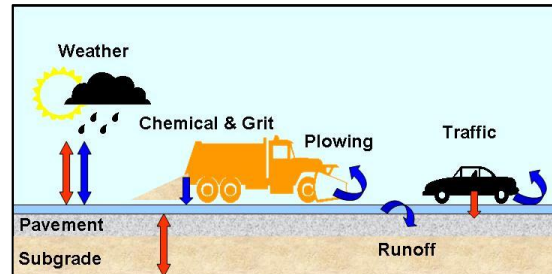


Figure 2: Weather, Maintenance and Traffic Variables in Road Conditions (SDDOT)

#### Report Entry

Observations of road conditions among the North/West Passages are typically the responsibility of maintenance staff. There are slightly different approaches for entering the road condition reports into each state’s traveler information system for dissemination to the public.

- In Minnesota, Montana, Idaho and Washington plow drivers primarily radio road conditions to a supervisor who enters the report. Supervisors may also observe conditions while patrolling or viewing cameras to generate reports. Reports are then posted to traveler information services.
- In Wyoming, plow drivers radio back conditions to the Transportation Management Center (TMC) staff where reports are entered. However, plow drivers can also use a tablet in their vehicle to enter road conditions. The report is then automatically posted to traveler information services and TMC staff is also notified of the report.
- In North Dakota plow drivers enter conditions using a tablet with cellular connection inside the truck. The tablets are typically shared among four plow drivers. The condition reports are automatically posted to traveler information services.
- In addition to reporting road conditions by radio, plow drivers in South Dakota, also use Mobile Data Collectors (MDC) in their vehicle to enter road conditions. Reports are then disseminated via traveler information services.

### **Report Frequency**

The frequency of how often road condition reports are updated varies by state. In Montana reports are posted once in the morning, once in the afternoon, and as conditions change. South Dakota reports are entered three times a day and as conditions change. In North Dakota, there are scheduled times set to enter reports at 5:00 am, 6:00 am, 7:00 am, 8:00 am, 12:00 pm, 3:00 pm, 6:00 pm, 8:00 pm, and 10:00 pm, as well as when conditions change. In Minnesota, reports are entered at minimum every three hours and in Washington reports are every four hours. Idaho and Wyoming update daily or as conditions change.

### **Reporting Sources Outside of the DOT**

Minnesota, Wyoming and Idaho all have citizen reporting programs that provide additional road reports to supplement information provided by DOT maintenance staff. North Dakota is also considering a citizen reporting program. In addition, some areas of Washington utilize third-party data for road reporting.

### **Disseminating Reports**

Reports of current road conditions are consistently disseminated via the states' traveler information services including phone, web, app, social media, and email/text alerts. Reports are also disseminated in some states via dynamic message signs and highway advisory radio, as well as news releases.

## **2.2 Automated Reporting for Road Conditions**

None of the North/West Passage states have fully automated the reporting of current road conditions. Most reporting is still based on a staff observations and manual entry into a system. However, a few of the states automatically post RWIS data on their traveler information website as another source of road information. For example, in South Dakota, RWIS data is reported with a camera image on their traveler information website as shown in Figure 3. It is not expected that the RWIS data will be translated by the states into road conditions, as the information provided by RWIS is for a specific point and a dense network of RWIS deployments would be needed.



Figure 3: Example - South Dakota Camera Image and RWIS Data

However, MnDOT is currently conducting an evaluation to compare MDSS data to road condition reports generated by maintenance staff. The purpose of the evaluation is to determine if the MDSS data could be translated to reports of current road conditions, replacing the manual process of maintenance staff observing and radioing in road reports. MDSS uses RWIS data, as well as other data from other weather sources, mobile sensors, etc. to provide recommended maintenance actions based on current and forecasted conditions. Five miles on either side of the sensors are used to translate point data into segment data. MDSS is modified each year and the data continues to improve as historical information is gathered. If the evaluation results show that the MDSS data is comparable to road condition reports, generated by maintenance staff, MnDOT intends to display the automated reports from MDSS on their traveler information service as a replacement for manual reporting. The evaluation is scheduled to be complete by June 2017.

Wyoming uses Variable Speed Limits (VSL) for high winds on select corridors. The speed limits posted on the VSL are recommended based on an algorithm and automated calculations of data, however a manual entry is needed to change the VSL. Wyoming is considering automating this process since the recommended VSL speed is accepted every time.

### 3. APPROACHES TO FORECASTING AND ALERTING

Although DOTs routinely forecast road conditions for planning and executing maintenance operations, the forecasts have not traditionally been disseminated to alert travelers. That direction is changing as Weather Responsive Traffic Management (WRTM) strategies are developed, evaluated and encouraged by the FHWA RWMP. Two prominent strategies – Pathfinder and Integrated Mobile Observations (IMO) – are featured in the current round of [Every Day Counts 4: Road Weather Management – Weather Savvy Roads](#) innovation category. Pathfinder and IMO are intended to help agencies manage road systems and inform travelers ahead of, and during, adverse road weather conditions. Pathfinder encourages collaboration between DOTs and weather organizations to translate weather forecasts into consistent

transportation impacts for travelers. Similarly, IMO focuses on agencies collecting weather and road condition data from government fleet vehicles, such as snow plows.

The National Weather Service (NWS) also recognizes the value of providing weather forecasts in ways that allow travelers to make informed decisions about their trips. The NWS Western Region Headquarters has developed a [Transportation Decision Support](http://www.wr.noaa.gov/wrh/travel/) prototype website to display weather forecasts at the roadway level for the Western Region as shown in Figure 4. It provides weather forecasts for select road segments of US and state highways and Interstates. The roadway segments are color-coded based on 6-hour time intervals. For example, green indicates no significant weather hazard is expected to impact travel during the forecasted time. Website visitors can enter a starting location, including the departure day and time, and an ending location. Turn by turn directions are then provided along with forecasted weather for the selected route and travel time. The weather forecasts are derived from the National Digital Forecast Database (NDFD) generated by the NWS. The website explains that a road segment is first applied a 2.5km buffer, and is then overlaid on top of the NDFD gridded forecasts. The road segment forecast is then created by finding the “worst forecasted weather” in that buffer. In this way, the forecast is not always applicable to the entire road segment, but instead will display the most inclement weather a traveler is likely to experience on that roadway.

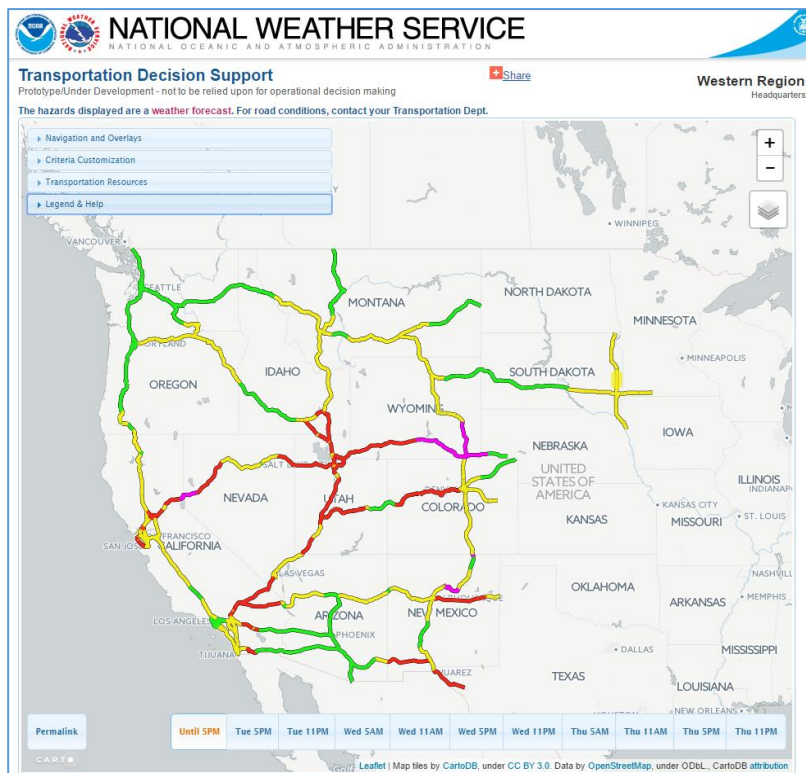


Figure 4: NWS: Transportation Decision Support Website  
 (<http://www.wr.noaa.gov/wrh/travel/>)

As of May 2017, the website was labeled as a prototype under development. However, the NWS has recommended that the site be expanded nationally. The NWS also acknowledges the distinction between the weather forecasts for roadways that they provide, and the road condition reports that are provided by DOTs. The website states, “This forecast is for planning purposes only and you should call 511 or access the

511 page from your state transportation department for current road conditions.” Links are then provided to each state’s traveler information website.

The remainder of this section describes approaches used, or being considered, by the North/West Passage states for providing forecasted road conditions. The approaches range in complexity from the use of historic operational experience in North Dakota, to the use of MDSS outputs for threat forecasts in South Dakota.

### 3.1 North Dakota

NDDOT does not operate 24/7 and it is common for roads to blow shut during a weather event overnight. This led to their interest in predicting where this would likely occur and providing warnings to travelers. Illustrated in Figure 5, NDDOT staff identified trouble spots throughout the state where it is common for the snow to drift over the road at night based on certain weather conditions.

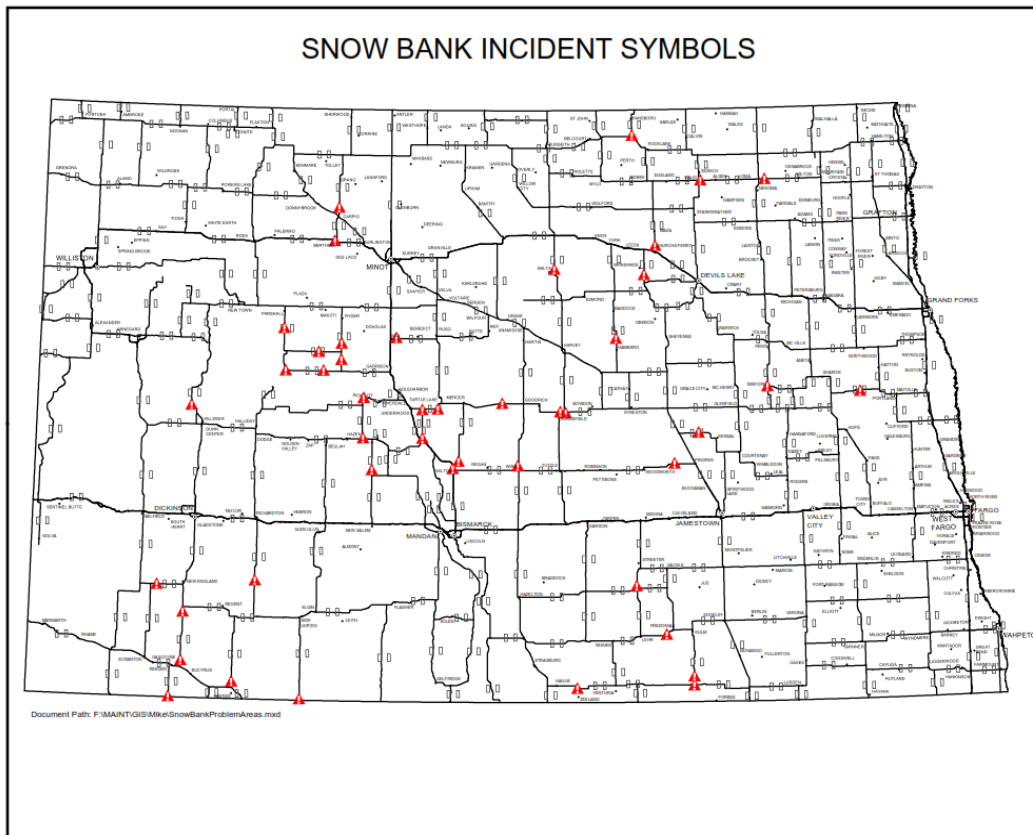


Figure 5: NDDOT Snow Bank Spots

These spots are typically on low volume and low level of service roads. The plows are generally only on these roads a couple times a day and are not able to keep up with the drifts on every high backslope or tree row. Figure 6 shows the impact of drifting snow in these locations. During off hours, district administration can post an icon on the NDDOT traveler information map of warnings that extend longer than two hours. Typically, the icon would be displayed in the evening and then removed in the morning after the plows have maintained the drifted area. Not only has the information been useful to the public, but it has been also useful to the highway patrol when they are in the field.





*Figure 6: Photos of Snow Drifts across North Dakota Roads*

### 3.2 Idaho

ITD is developing six-hour weather – not road condition – forecasts for their traveler information website and app. The weather forecasts are intended to provide travelers with additional, targeted information to assist in their travel planning. The new function is based on the NWS Transportation Decision Support website described above. However, since the NWS Transportation Decision Support website is a prototype, ITD felt strongly about developing a similar yet separate function within their traveler information system in the event that the prototype is no longer available. ITD completed a concept of operations for the function in early 2017 and it is expected to be operational next winter season. The data will be updated hourly and the reports will note the supplemental source for the weather information.

### 3.3 Wyoming

Like ITD, WYDOT does not forecast and alert travelers of road conditions. However, they do post weather forecasts on DMS, as illustrated in Figure 7, to change driving behavior prior to a weather event. In addition, high wind forecasts are disseminated to truckers 48 hours in advance through a commercial vehicle portal that companies can subscribe to for road specific condition reporting.



Figure 7: WYDOT DMS of Forecasted Weather  
 Source: [“Collaboration Across the Road Weather Enterprise: The Pathfinder Project”](#)

### 3.4 South Dakota

Similar to other North/West Passage states, SDDOT does not operate 24/7, yet they were interested in developing threat forecasts to provide travelers with 24-hour road conditions. The FHWA RWMP partnered with SDDOT to develop and implement 24-hour threat forecasts. The forecasts were developed using MDSS analysis of current road conditions to predict road conditions for the next 24 hours. MDSS uses weather and pavement modeling to generate predicted weather and road conditions for pre-defined road segments. Although the forecasts do not incorporate maintenance activities, SDDOT noted that “...the benefit of the forecasts is not their precision but rather as a signal of noteworthy conditions that may affect travelers.” Threat forecasts are then disseminated by the traveler information website, mobile app and phone services. Figure 8 illustrates how South Dakota’s current road conditions are shown on the website, and Figure 9 shows how threat forecasts are shown on an alternate page of the website. The [evaluation](#) for this project surveyed travelers who indicated that, after viewing the threat forecasts, they either changed the timing or routing of their trips, or felt more prepared for them.

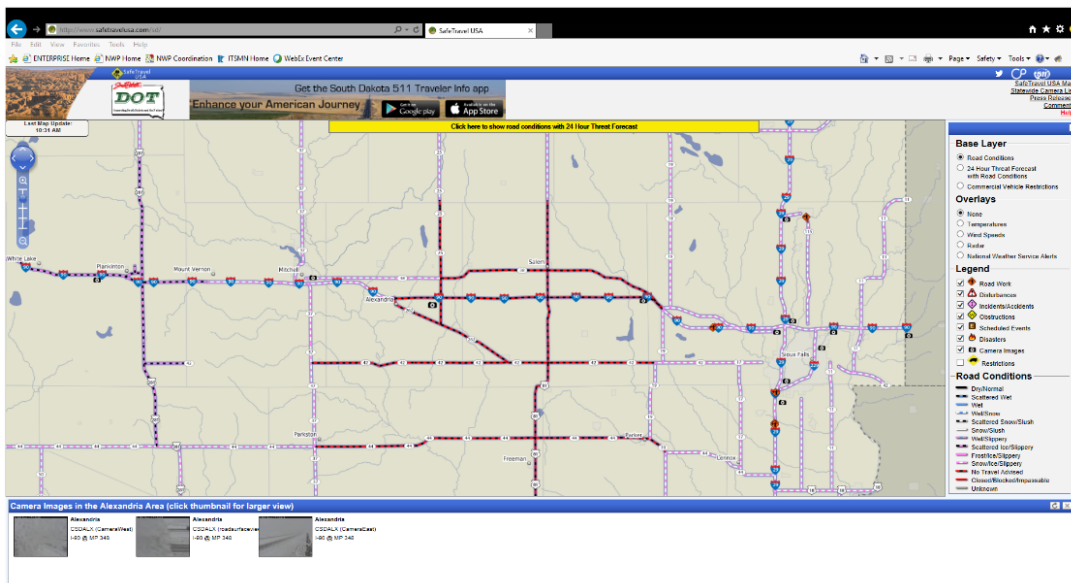


Figure 8: SDDOT Traveler Information Website – 11/18/16, 10:30 am Current Road Conditions

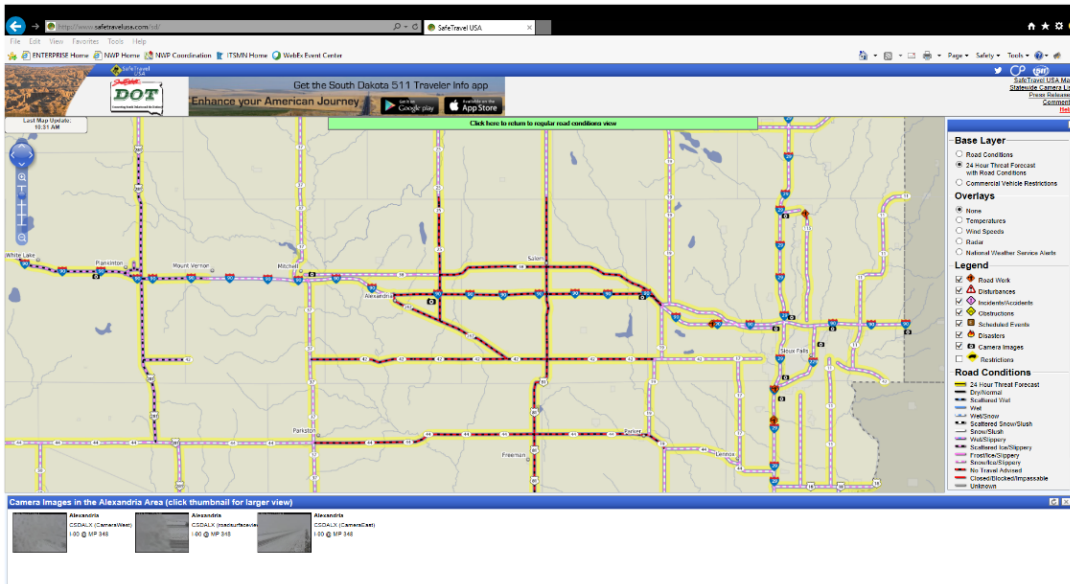


Figure 9: SDDOT Traveler Information Website - 11/18/16, 10:30 am, 24 Hour Threat Forecast

#### 4. CHALLENGES WITH ROAD CONDITION REPORTING

There are a number of challenges with reporting current and forecasted road conditions, as well as any automation associated with such reporting. For example, during a weather event, there are many tasks that maintenance and traffic operations staff are responsible for, and creating *current* road condition reports can be a task that is sometimes forgotten. There are still other challenges with consistency when reports are based on the subjective observations of individual staff. Two plow drivers could potentially drive the same road segment and describe the segment two different ways.

During the interviews for this project, it was often noted that *automated* road condition reports require accuracy to be as good, if not better than, the manual reports for the public to continue using and trusting the reports. *Forecasted* road condition reports are viewed as challenging because weather events could shift, making road condition reports inaccurate. WYDOT has issues with high winds and the geometry of their roads which may make it difficult to accurately forecast road conditions.

Table 1 summarizes some of the challenges identified by the North/West Passage states with providing current, automated, and forecasted road condition reports.

Table 1: Challenges with Current, Automated and Forecasted Road Condition Reporting

Challenges	Current	Automated	Forecasted
Consistency	●		
Frequency	●		
Accuracy	●	●	●
Reliability	●	●	●

Consistency is a common challenge for agencies as they primarily rely on staff or traveler observations for reports of current road conditions. Observations are subjective and can naturally be interpreted in several

different ways that can result in inconsistent reports. The frequency of reports is more challenging for routes that are assigned lower maintenance priority and for agencies that do not plow 24/7. When agencies are dependent upon staff observations and staff may not travel a road for several hours, the lower frequency of reporting can lead to questionable and less accurate reports. Although accuracy can be impacted by the situations described under both frequency and consistency, it can also be affected by simple errors in reporting and rapidly changing weather conditions. Reliability is a concern for any kind of information provided when staff or systems that provide information may not always be available.

Although there are challenges with the different types of road condition reporting, it appears that automated or forecasted reporting could potentially have fewer challenges. This likely because of the more manual processes associated with reporting current road conditions.

## 5. FUTURE POTENTIAL FOR FORECASTING

Because agencies already create and use forecasted road conditions for operational purposes during weather events, the primary issue debated in this project is whether or not agencies should make forecasted road conditions available to travelers.

Throughout the interviews, some of the North/West Passage states expressed concern that the challenges associated with reporting current road conditions would be compounded if they began reporting forecasted road conditions for travelers. Some of the states also noted specific concerns about travelers expecting a higher level of accuracy and timeliness related to forecasted road conditions from the DOT than weather forecasts reported by media or the National Weather Service. However, there was also curiosity among the states to learn more about how they could potentially approach forecasted road conditions and how they could introduce automation into the reporting of current road conditions. The experience in South Dakota, in particular, is an excellent case study for other states to further explore.

SDDOT specifically evaluated travelers' impressions of the forecasted road conditions that were provided. They surveyed travelers as they visited the SDDOT traveler information website to gauge their level of awareness and viewing, impressions about ease of finding and understanding, usefulness of the format, and how travel plans were affected. Awareness and views of the information were higher among those visiting the website in contrast to those using the Smartphone app and 511 phone services. The majority of respondents agreed or strongly agreed that the information was easy to find and understand across all three traveler information services – web, app and phone. Respondents were asked to rate usefulness of the information format in relation to presentation, nature and timeframe of the forecasted threats. Over 80 percent of the survey respondents rated all of the information formats as quite or very useful on the website, app and phone. Most notably, when asked whether the forecasted information affected their travel plans, over 50 percent of the survey respondents indicated that they changed their travel timing or routing based on the forecasted information. Findings from the South Dakota experience clearly illustrate travelers' interests in receiving forecasted road conditions.

There is also growing potential for data analytics to play a role in future road condition reporting – for both current and forecasted conditions. ITD noted that IBM and the Idaho National Laboratory are exploring ways to combine and analyze weather information with road surface conditions using IBM's Watson Image and Video Analytics tool. The Watson Visual Recognition can monitor unstructured data from video feeds and image snapshots to identify scenes and patterns in video data. Apps can combine

this data with machine data to gain a greater understanding of past events and emerging situations. Data analytics like this may soon provide viable options for automating the reporting of both current and forecasted road conditions for transportation agencies.

The FHWA RWMP is also encouraging agencies to continue exploring opportunities to provide forecasted road conditions for travelers. The Pathfinder and IMO applications under the [Every Day Counts 4: Road Weather Management – Weather Savvy Roads](#) innovation category provide resources to help agencies manage road systems and inform travelers ahead of, and during, adverse road weather conditions.

## 6. SUMMARY

This report summarized road condition reporting practices in the North/West Passage states, the challenges agencies face with reporting, the approaches being used to forecast road conditions and alert travelers, and the future potential for forecasting road conditions for traveler information. The following bullets highlight key findings from the information that was gathered.

- Most of the North/West Passage states' maintenance staff radio road conditions to a supervisor or TMC where reports are entered and then displayed via traveler information services.
- In some states, tablets and other mobile devices are used by maintenance staff to enter road conditions from vehicles or truck station offices.
- None of the North/West Passage states have fully automated reporting of road conditions. However, MnDOT is conducting an evaluation to compare MDSS data and manually entered reports for current road conditions. If the data compares favorably, MnDOT intends to next year automate current road condition reports using MDSS data.
- Only some of the North/West Passage states are forecasting road conditions. There is variation in the complexity and sophistication of the forecasting and alerts that are used.
  - North Dakota is identifying roadways prone to drifting overnight and placing icons on their traveler information map if an event is forecasted to last longer than two hours.
  - Idaho is developing weather forecasts for road segments based of the NWS Transportation Decision Support Tool. The weather forecasts will be provided through traveler information services.
  - South Dakota is utilizing MDSS data to identify 24 hour “threats” when road conditions might deteriorate to an unsafe condition. They are alerting travelers on their traveler information website.
- There are a number of challenges with current, automated, and forecasted road condition reporting, however automating or forecasting road condition information may have fewer challenges than the manual processes used for reporting current road conditions.

There will be further opportunity to discuss current, automated and forecasted road condition reporting during the 2017 Road Weather Management Stakeholder Meeting on June 20-22 in Minneapolis, Minnesota.