1. Weather-Related Decision Support Tools Used by Surface Transportation

Instructor Notes: This module is the third part of a lesson that discusses Tools for Monitoring Road Weather. This presentation is about weather-related Decision Support Tools used by transportation agencies, why they are an important tool for traffic operations and maintenance departments, and how they can help improve operational efficiency for transportation operators. This presentation should take approximately 15 minutes.

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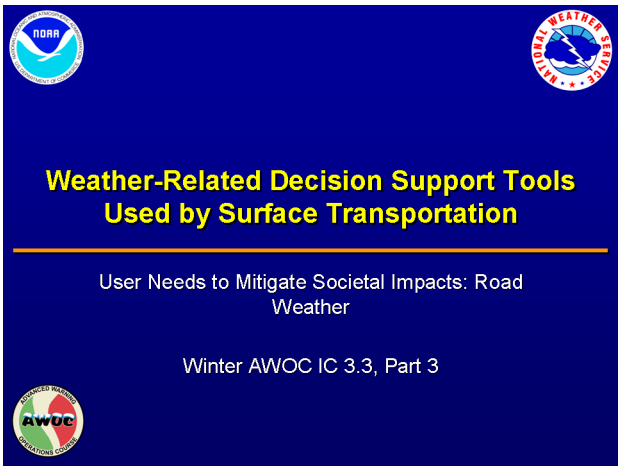

2. Learning Objectives

Instructor Notes: There are two learning objectives for this lesson: 1. Explain, in general terms, what a weather-related decision support tool is and how this software benefits maintenance and traffic operations. 2. Describe, in general terms, the meteorological inputs, basic processing steps (where appropriate), and possible outputs of the weather-related decision support tools discussed.

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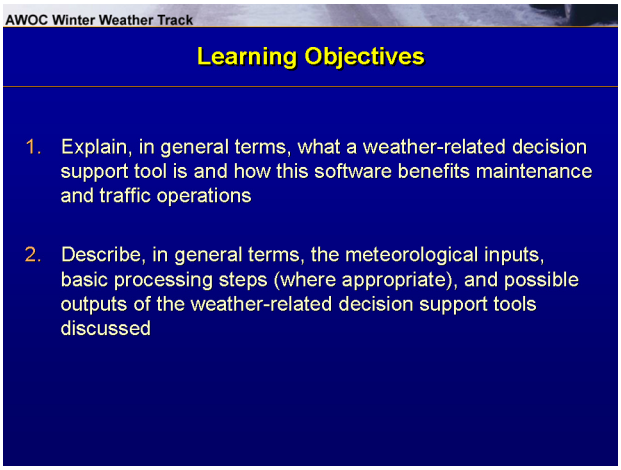

3. A Very Brief History on This Topic

Instructor Notes: Over the past couple of decades, weather forecasts and observations have become both numerous and readily available. [CLICK] While weather information is extensive, it can be difficult for non-meteorologists to use it effectively. [CLICK] In the late 1990s, this situation led to a lack of linkage between the weather information maintenance managers had at their disposal and their decision-making process for deciding on road treatments during winter weather. [CLICK] One way to create the needed linkage was to develop a decision support tool that integrates weather forecasts and observations into the implementation of winter weather maintenance strategies. [CLICK] Here's a simple example of what a decision support tool can do. Road managers in South Carolina use a decision support tool that ingests RWIS data to detect conditions indicative of fog along the Cooper River Bridge (I-526 north of Charleston). This decision support tool alerts managers and recommends DMS warnings, speed limit reductions, truck restrictions or bridge closure based upon visibility distance. Transportation managers can then decide which actions to take (Pisano et al., 2005).

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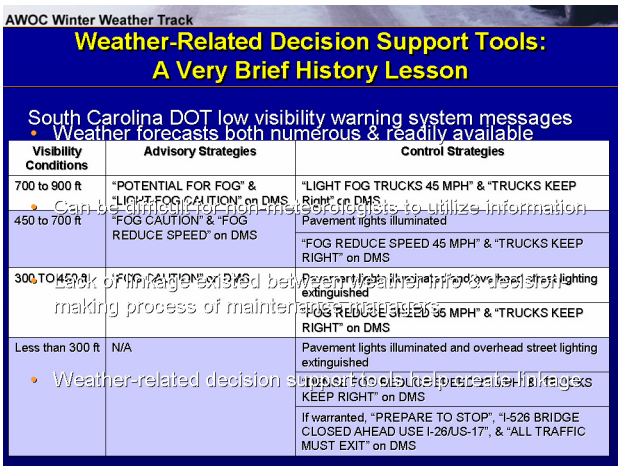

Visibility Conditions	Advisory Strategies	Control Strategies
700 to 900 ft	"POTENTIAL FOR FOG" & "LIGHT FOG CAUTION" on DMS	"LIGHT FOG TRUCKS 45 MPH" & "TRUCKS KEEP Right" on DMS
450 to 700 ft	"FOG CAUTION" & "FOG REDUCE SPEED" on DMS	Pavement lights illuminated
		"FOG REDUCE SPEED 45 MPH" & "TRUCKS KEEP RIGHT" on DMS
300 TO 450 ft	"FOG CAUTION" on DMS	Pavement lights illuminated and overhead street lighting extinguished
		"FOG REDUCE SPEED 35 MPH" & "TRUCKS KEEP RIGHT" on DMS
Less than 300 ft	N/A	Pavement lights illuminated and overhead street lighting extinguished
		"FOG REDUCE SPEED 25 MPH" & "TRUCKS KEEP RIGHT" on DMS
		If warranted, "PREPARE TO STOP", "I-526 BRIDGE CLOSED AHEAD USE I-26/US-17", & "ALL TRAFFIC MUST EXIT" on DMS

4. The Maintenance Decision Support System

Instructor Notes: The FHWA/RWMP worked with a consortium of national laboratories (including the U.S. Army's Cold Regions Research and Engineering Laboratory, CRREL; the Massachusetts Institute of Technology/Lincoln Laboratory, MIT/LL; the Forecast System Laboratory, FSL; the National Severe Storms Laboratory, NSSL; and the National Center for Atmospheric Research, NCAR) to develop a decision support tool that provided weather forecasts tailored to the road surface. This tool, the Maintenance Decision Support System (or MDSS), combines weather and road condition forecasts with customized rules of practice to provide maintenance managers treatment recommendations for the road segments in their area during winter weather events (Pisano et al., 2004). [CLICK] MDSS requirements and capabilities were determined by talking with numerous DOT managers. [CLICK] The application is locally customizable so maintenance managers can tailor the MDSS treatment recommendations to fit with local resources and

accepted rules of practice. [CLICK] Ideally, maintenance supervisors using MDSS treatment recommendations would provide a high level of service with their available personnel and equipment while minimizing the amount of chemicals used to treat roads.

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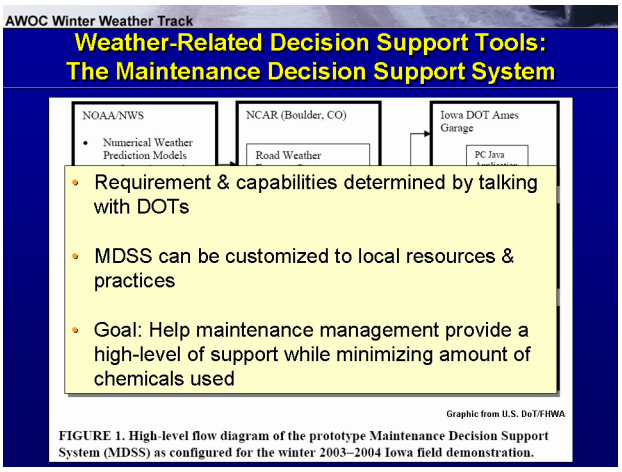

5. Development of the MDSS Prototype

Instructor Notes: Over several years, the FHWA/RWMP worked with the various national labs to develop and test a prototype MDSS. Each of the labs used technology developed from previous projects to quickly develop their individual components of the system. As a result, the system was developed faster than would have otherwise been possible. The original prototype underwent two seasons of field evaluations and is now available for use. The graphic shown here is one example that resulted from the prototype process: a visualization program for Colorado DOT that helps them monitor road conditions for the higher elevation passes in and around Vail, CO (FHWA, 2008). [CLICK] As you could see from the graphic, the ultimate goal of the prototype project was to develop a system that the private sector could incorporate into their regular products and services. [CLICK] In 2004, MDSS technologies were mature enough to implement certain features. [CLICK] By 2007, 21 state transportation agencies were using (or developing) some form of MDSS tools in conjunction with America's Weather Industry(FHWA, 2008). Besides the implementation of MDSS technologies by the private sector, several state DOTs have pooled their resources to develop their own MDSS that will build upon the original prototype system. We'll say more about that later in the presentation.

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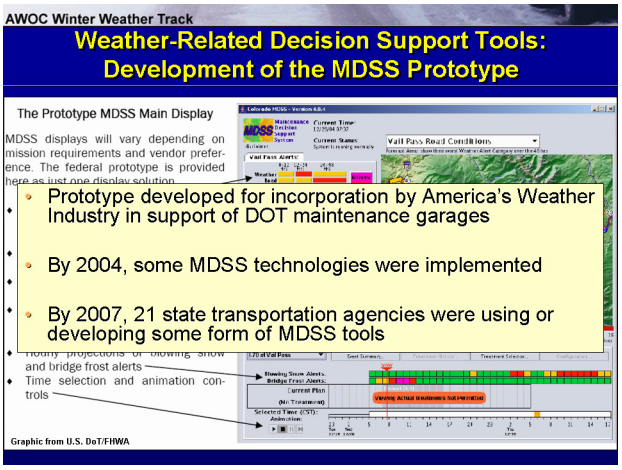

6. How Does the MDSS Work?

Instructor Notes: In general, road maintenance supervisors don't want to be meteorologists. They just want reliable weather forecasts and observations that will help them do their job. The MDSS does this for them through the following steps. [CLICK] The MDSS can accept several numerical weather prediction model grids, METARs, and RWIS data as meteorological inputs. [CLICK] Algorithms in the RWFS combine the data and generate a consensus forecast. The RWFS uses this consensus forecast to generate road temperature and condition forecasts. [CLICK] The RWFS output is used as input into the Road Condition and Treatment Module (RCTM). The RCTM utilizes algorithms that take the RWFS forecast parameters and outputs variables such as snow accumulation, frost probability (road and bridges), and chemical concentration and dilution rates. [CLICK] The output from the RCTM then goes into the rules of practice algorithm for anti- and deicing operations. These algorithms, which are customized by maintenance supervisors for their local use, then generate route-specific treatment recommendations. [CLICK] The proposed road treatment strategies include: [CLICK] - A treatment plan (including the possibility of plowing only, chemical application, abrasives, or any combination of the three), [CLICK] - The recommended chemical application amount and timing, plus recommendations for any subsequent treatments, and [CLICK] - An indication of whether pre- or post-treatment of roads is necessary.

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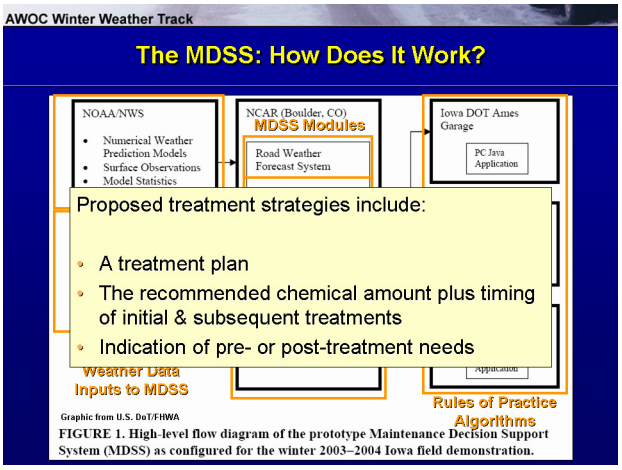

7. How Maintenance Garages Use the MDSS

Instructor Notes: Besides the various algorithms and meteorological inputs, [CLICK] the MDSS prototype included a graphical user interface that was evaluated and approved by DOT maintenance practitioners. The examples shown here are from the prototype MDSS that was evaluated by the Iowa DOT (Pisano et al., 2004). In the graphic on the left, users can display real-time ESS data on multiple scales, compare current and previous weather model forecasts, as well as view an event summary. In the graphic on the right, they can display the impacts from a variety of treatment scenarios based on the most recent forecast. [CLICK] Besides displaying the information generated by the MDSS, the prototype software also allows users to generate "what if" scenarios. In this way, they can create an ensemble of possibilities (similar to NWP ensembles) and determine which course of treatment is the best approach to mitigate the impacts of adverse weather. [CLICK] This part of the MDSS can also be used as a training tool for new maintenance managers [CLICK] or to perform post-mortem evaluations after an event to see if different treatment strategies could have been more effective.

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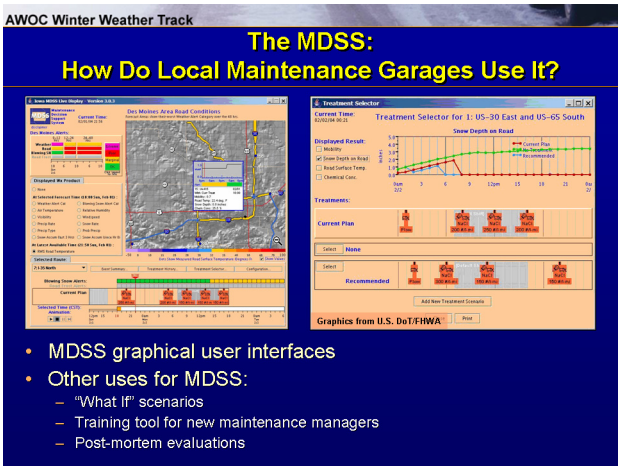

8. The Weather Response System

Instructor Notes: The MDSS is not the only weather-related decision support tool in development. [CLICK] The FHWA/RWMP is in the process of developing a prototype decision support tool for TMCs and TOCs. This tool, the Weather Response System, was originally developed through a partnership with the Missouri DOT (MoDOT). The WRS could be used by traffic, maintenance, construction, and customer service personnel operationally to support cold and warm season operations (e.g., pavement striping, work zones, emergency repairs, mowing, and brush cutting; FHWA, 2006). The original version was tested and evaluated, with subsequent development on going. [CLICK] The WRS prototype uses forecast and observation data from the NWS (i.e., NDFD and text products) and other sources to support traffic management, maintenance, and operations activities. This software brings together road condition and weather information with the technology for addressing maintenance, traffic, incident, and emergency management. [CLICK] The WRS prototype assists transportation personnel by providing relevant information for their internal uses, as well as for dissemination via DMS, HAR, the Internet, 511 and other public and private media outlets. This software should also help improve the integration of weather information into the decision-making process of personnel where it is still uncommon.

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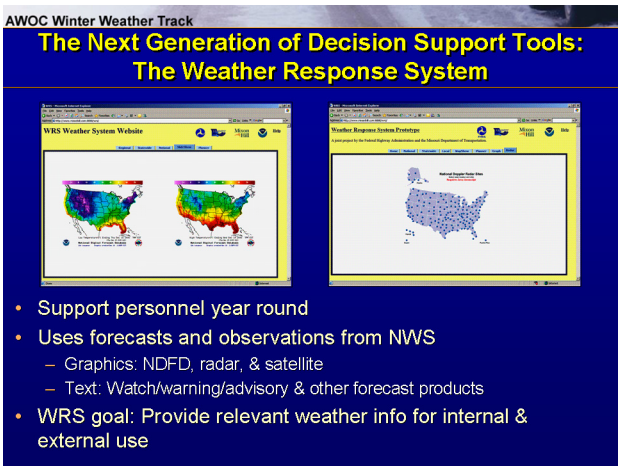

9. Feature Requests during WRS Testing

Instructor Notes: During the WRS evaluation by MoDOT, several features were requested by their staff (FHWA, 2006). [CLICK] These requests for the WRS may provide insight into how transportation personnel in your area may want to use weather data. These requests included: [CLICK] - Longer range forecasts for a “heads up” of potential problems down the road; [CLICK] - E-mail or pager alerts when certain key thresholds are met (e.g., watches/warnings issued, winter precipitation forecast); [CLICK] – The ability to display storms throughout their geographic area of responsibility; and [CLICK] - Access to all data of interest, including POPs, precipitation type, when precipitation is forecast to start, the duration of precipitation, QPF, precipitation rates, proba-

bility of hail, lightning data, humidity information, and graphical hydrology products overlaid on street maps. It's important to remember that any changes to NWS products and services to support requests like the ones shown here must follow standard NWS policies and procedures (i.e., NWS Policy Directive 1-10).

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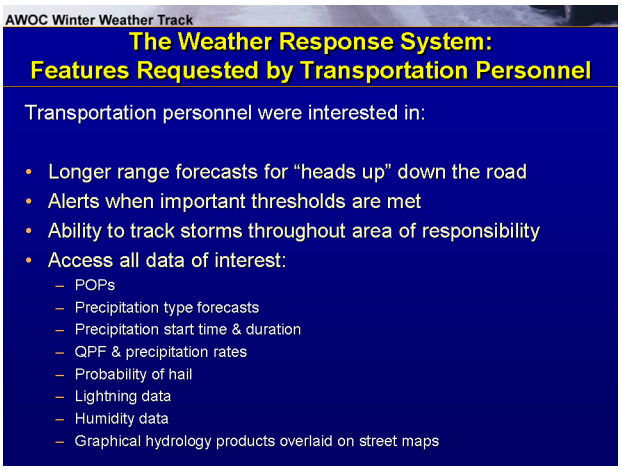

10. The Pool-Funded MDSS & the MODSS

Instructor Notes: A separate MDSS initiative has grown out of the original MDSS prototype project. [CLICK] A group of states (led by South Dakota) have pooled their funds to develop an operational MDSS for their state agencies with support of a private contractor (Pisano et al., 2006). This new, pool-funded MDSS (or PF MDSS) will have new functionality, including the ability: [CLICK] – To monitor actual road surface conditions and treatment applications; [CLICK] – To utilize physical models instead of just rules of practice to determine treatment options; [CLICK] – To assess past and present weather conditions and the current state of the roadway; and [CLICK] – To identify a range of feasible maintenance treatments, including "standard" and "optimal" options. For the new functionality in the PF MDSS to be effective, new technology would be required. One such tool is equipping snowplows with GPS automated vehicle location (AVL) devices that can report real-time weather conditions, equipment status, and chemical application rate to a central server that could be accessed by the PF MDSS software. [CLICK] In addition to the PF MDSS, a new version of the MDSS prototype is in development and called the Maintenance and Operations Decision Support System (FHWA, 2008). MODSS will have all the functionality of MDSS, plus it will include support for summer maintenance (e.g., mowing, line painting) and construction projects that are weather sensitive.

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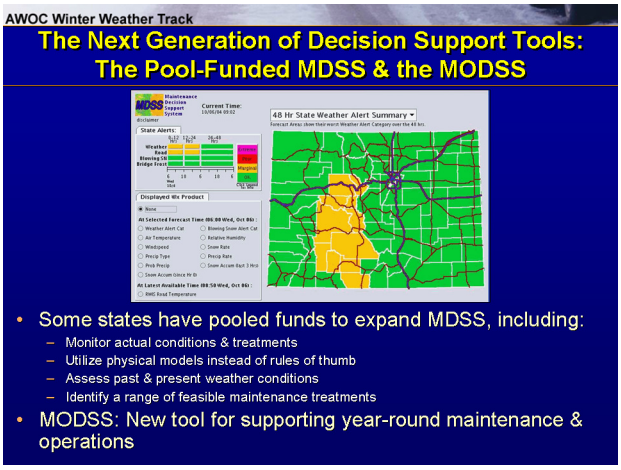

11. Weather Integration

Instructor Notes: The development of decision support tools indicate a trend in the transportation management and operations community. [CLICK] Offices that realize the significant role weather has on their day-to-day operations are working to better integrate weather information into their personnel's workflow. These organizations, see decision support tools as a way to be more in response to adverse weather (FHWA, 2006). [CLICK] Road maintenance operations have made a significant shift from being reactive to being proactive during winter weather events. Many TMCs and TOCs are trying to follow suit. These centers are taking steps to more fully integrate weather information into their day-to-day operations. The goal of this integration is to help managers and staff more fully incorporate available weather information into critical decision-making. [CLICK] What weather integration actually means varies from office to office, and region to region. [CLICK] In some places, it means having local, regional, and national weather on a display (similar to the SA displays in many WFOs) during operational hours. In other offices, they make attempts to incorporate weather forecasts and observations into the software applications they use on a daily basis. This process could be as simple as having the NWS web page open in a browser for easy access as a SOP, generating alerts based on weather watches and warnings, or using software that allows for weather information to be overlaid with traffic conditions. Some DOTs have even gone so far as to have meteorologists on staff to assist the rest of their personnel with their weather information needs.

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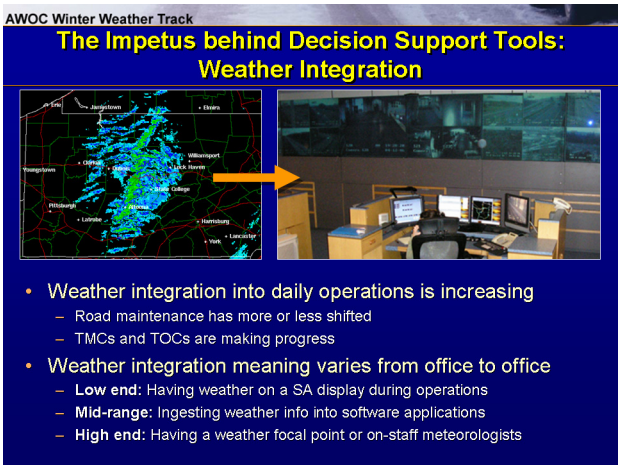

12. Where NWS Products & Services Fit in

Instructor Notes: The NWS provides a range of products and services to many users. [CLICK] Some surface transportation departments decide that this information is sufficient to meet their operational needs. Most transportation agencies, however, rely on private weather service providers for at least some road-specific weather information in addition to NWS forecasts and warnings. NWS forecasters should work with local surface transportation partners to ensure they understand what products and services the NWS can provide and what additional level of service is available from the private sector. [CLICK] While there are benefits in increasing the weather information available to transportation operators, some problems will likely arise. After all, these are not trained meteorologists. They are not going to understand everything the are looking at. [CLICK] For instance, they may see virga or anomalous propagation echoes and think that precipitation is occurring. They may look at RWIS data during a winter weather event and think no precipitation is falling at a remote location because the rain gauge sensor is frozen. As more and more transportation organizations add weather data to their operations, NWS staff may find themselves having to educate their partners on interpreting weather data.

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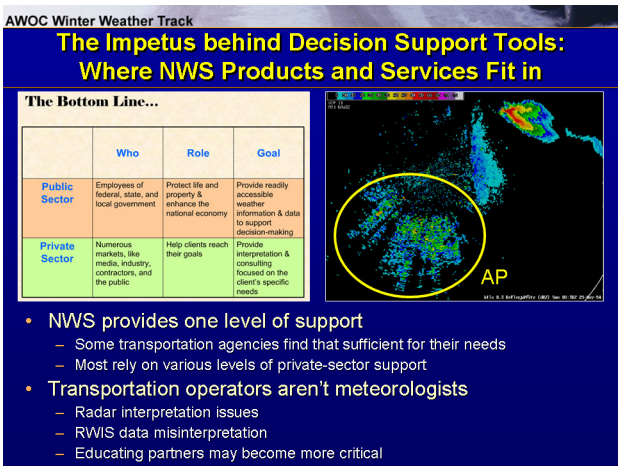
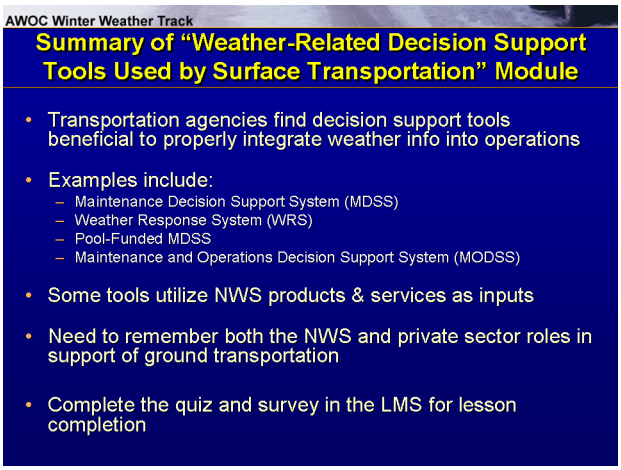


13. Summary

Instructor Notes: In summary, this module provided a brief background on weather-related decision support tools and how transportation agencies find these tools useful to better integrate weather information into their day-to-day operations. [CLICK] An example of such a tool, the Maintenance Decision Support System, was presented to illustrate the kinds of meteorological inputs it uses, how it processes that data, and ultimately ends up with a treatment recommendation for maintenance department staff. Other examples of decision support tools (such as the Pool-funded MDSS, the Weather Response System, and the Maintenance and Operations Decision Support System) were also mentioned. [CLICK] Some of these different tools use information from the NWS as inputs. In some cases, these inputs are raw meteorological data (e.g., MDSS) while in other cases these inputs are the products that NWS WFOs issue for the general public on-line (e.g., WRS). [CLICK] For either set of tools, it's important to remember the roles that both the NWS and private sector meteorologists play in meeting the needs of state and local surface transportation agencies. [CLICK] You have now completed the content for Winter AWOC IC 3.3. To receive credit in the NWS Learning Center, you need to take the quiz and fill out the survey evaluation in the LMS. I recommend that you complete both of these steps as soon as possible and prior to starting the next lesson in this course.

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