FHWA Road Weather Management

Maintenance Decision Support System

Deployment Guide

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7. Author(s) William D. Dye, Dye Management Group, Inc. Arkopal Goswami, Dye Management Group, Inc. Ed Boselly, Weather Solutions Group John Lasley, SAIC		8. Performing Organization Report No.
9. Performing Organization Name and Address Dye Management Group, Inc. 500 108th Ave NE, Suite 1700 Bellevue, WA 98004 Weather Solutions Group P.O. Box 7690 Olympia, WA 98507 SAIC 1710 SAIC Drive McLean, VA 22102		10. Work Unit No. (TRAIS)
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16. Abstract
This is a guide for transportation professionals on why and how to deploy winter Maintenance Decision Support Systems (MDSS). Adverse winter weather can cause traffic delays and crashes. Treating the effects of winter weather can also have impacts on the environment. Addressing the complexities of winter maintenance and operations requires transportation personnel to work with a myriad of issues including: conflicting weather forecasts, hard to obtain road condition reports, and challenging commuting patterns. An MDSS can help maintenance personnel manage this information and make more informed decisions. An MDSS integrates weather and pavement forecasts specifically targeted to road segments with maintenance rules of practice to provide personnel with optimized road treatment strategies. This technology was developed under the direction of the Federal Highway Administration (FHWA) with contract support from a consortium of national research laboratories. A stakeholder group consisting of personnel from transportation agencies, academia, and the private sector assisted with development.

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OVERVIEW

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An MDSS can help maintenance personnel manage this information and make more informed decisions. An MDSS integrates weather and pavement forecasts specifically targeted to road segments with maintenance rules of practice to provide personnel with optimized road treatment strategies.

This technology was developed under the direction of the Federal Highway Administration (FHWA) with contract support from a consortium of national research laboratories. A stakeholder group consisting of personnel from transportation agencies, academia, and the private sector assisted with development.

WHY USE MDSS?

MDSS can benefit state and local departments of transportation (DOTs) in many ways. Some benefits include:

- Reducing costs for labor, materials, and equipment
- Improving public safety
- Improving mobility
- Realizing a higher level of service on roads
- Maintaining consistency of service across districts or states
- Providing training for both new and experienced DOT personnel
- Enhancing collaboration between DOT maintenance areas, and
- Providing a way to review maintenance actions during past storms

DEPLOYING MDSS

There are four phases for deploying MDSS: Planning and justification; acquisition; implementation; and use and evaluation. Each of the phases has its own tasks to be completed. The specific tasks and resources required will vary depending on the software approach selected.

LESSONS LEARNED

Past implementations of MDSS have revealed the importance of:

- Initial and ongoing training
- Dealing with institutional barriers
- Management commitment
- Learning the system biases and tendencies
- Maintaining a network of environmental sensor stations along routes of interest, and
- Maintaining metadata[1] and current rules of practice of the agency and those available within the MDSS

GETTING HELP

There are many resources to guide an agency in deploying MDSS. These include: knowledgeable individuals (in government, industry, and academia), MDSS users, training, reports, articles, information on MDSS software offerings, technology transfer, and samples and templates of requests for proposals. Many of these resources are available on-line and are updated on a continuing basis. Links are included in this guide.

WHY USE MDSS?

Winter maintenance is complex. In order to provide safe and clear roadways, maintenance managers must be able to handle multiple tasks and process a great deal of information effectively and wisely. But conflicting weather forecasts, unreliable road condition reports, and the variable effectiveness of roadway treatments make winter road maintenance particularly difficult.

A Maintenance Decision Support System (MDSS) can help maintenance personnel manage this information, thereby improving roadway levels of service and safety, reducing impacts on the environment, and being more efficient in the use of labor, equipment, and chemicals.

MDSS can benefit state and local departments of transportation (DOTs) in many ways. Some benefits include:

- Reducing costs of labor, materials, and equipment
- Improving public safety
- Improving mobility
- Realizing a higher level of service on roads
- Maintaining consistency of service across districts or states
- Reducing impacts on the environment
- Providing training for both new and experienced DOT personnel
- Providing a "one-stop" location for weather and pavement treatment information
- Enhancing collaboration between DOT maintenance areas
- Providing a way to review maintenance actions during past storms
- Better staging of equipment during pre-storm preparations
- Ability to better allocate shift personnel
- Making more informed decisions about the effectiveness of chemicals before, during and in the post-storm environment

An MDSS can*:

- Provide route-specific weather and road condition forecasts
- Offer optimized recommendations for application times and chemical types and amounts
- Generate "what if?" scenarios to experiment with changes to the recommended treatment strategy
- Train new maintenance supervisors using the customized rules of practice and historical playback capabilities

***Note: Not all MDSS contain these capabilities.**

MDSS BACKGROUND

The Federal Highway Administration (FHWA) defines MDSS as "a decision support tool that integrates relevant road weather forecasts, coded maintenance rules of practice, and maintenance resource data to provide winter maintenance managers with recommended road treatment strategies."[2] A decision support system uses data and models to evaluate different options, helping to guide a person in decisions about a given problem (in this case, winter maintenance operations).

MDSS improves upon existing forecasting and expert systems by providing optimized treatment recommendations. Advanced forecast systems provide specific weather and road condition forecasts, but do not provide snow and ice treatment recommendations. Likewise, expert systems, which rely on logic designed to mimic decisions of experts in the field, are constrained by the conditions that are input into the system at the outset. MDSS is a decision support system – helping maintenance professionals with recommendations that make roads clearer and safer under many scenarios.

HOW MDSS DEVELOPED

In 1999, the FHWA Road Weather Management Program initiated The Surface Transportation Weather Decision Support Requirements Project. This project combined the capabilities of six national laboratories, State DOTs, the private sector, and academia into a collaborative stakeholder group. Under the group's guidance, the laboratories integrated state-of-the-art weather forecasting capabilities with computerized winter maintenance rules of practice, resulting in the federal MDSS functional prototype. This prototype underwent several developmental cycles and several seasons of field demonstrations and evaluations.

In 2002, a Pooled Fund Study was initiated to develop, implement, and deploy an operational version of MDSS. The study focused upon refinement, validation, and wide-scale deployment of sustainable decision support technologies. By 2004, MDSS technologies were mature enough for interested private sector companies to begin to incorporate MDSS features into their product lines and to begin to provide services to DOTs. Today, there are several companies that provide various levels of MDSS capabilities within their product lines. Information about MDSS is available at the National Center for Atmospheric Research's web site.[3] Vendor contact information is available from the FHWA web site.[4]

WHAT MDSS DOES

MDSS is a tool designed to support snow and ice control operations along specific road segments. MDSS is based on leading diagnostic and predictive weather research capabilities, road condition formulas, and rules of practice for anti-icing and deicing. MDSS generates information and recommendations based on predicted:

- Pavement temperature
- Pavement condition (e.g., pavement friction and snow accumulation)
- Weather impacts
  - Air temperature
  - Wind and gusts
  - Relative humidity and dewpoint
  - Precipitation (type, intensity, and amount)
- Pavement/bridge frost potential
- Blowing snow potential
- Treatment recommendations
  - Recommended treatment plan (such as plow only, chemical use, and prewetting)
  - Recommended chemical application amount
  - Timing of initial and subsequent treatments
  - Indication of the need to pre-treat or post-treat the roads

MDSS can be used for strategic planning 12-48 hours in advance of a storm, so personnel, material, and equipment resources are ready.

MDSS also enables personnel to make tactical decisions and manage their resources just prior to and during a storm (0-12 hours). For example, if a storm has passed a district and is approaching another district, the maintenance managers can move resources accordingly. Previously, weather and road condition information have not been well-organized and integrated, making it difficult for maintenance crews to decide which actions to take.

With the development of MDSS, maintenance personnel have a 'one stop shop' that provides weather and pavement forecasts, and treatment recommendations within a single application.

MDSS technologies can provide two-way communication links between the maintenance supervisors and trucks using mobile data communication and automated vehicle location technology. This includes equipping snowplows with global positioning system devices that are capable of obtaining and reporting weather conditions and equipment status as the trucks move along their routes. The goal is to obtain, in near real-time, the location of each truck, the plow blade position, the chemical type and application rate, along with air and road temperatures and pavement conditions.

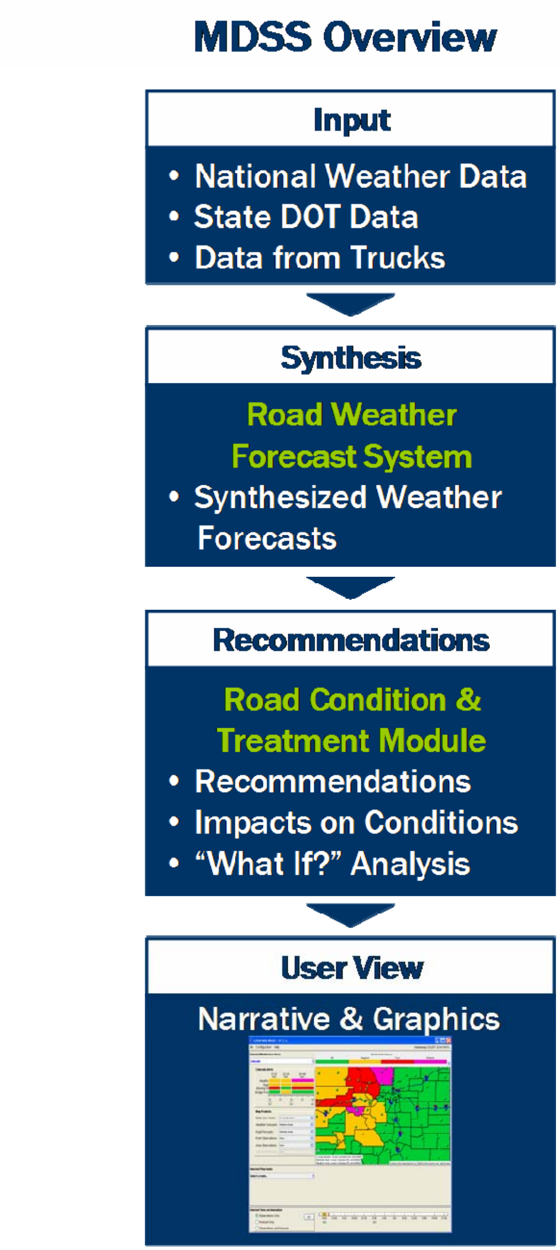
Weather forecast models generally do a good job providing forecast information for large-scale events, such as frontal systems and winter storms. However, for short-lived or small-scale events the models may have difficulty in providing accurate forecasts. In such cases, MDSS users must use radar data, weather observations, experience, and other tools to monitor conditions and use the MDSS output effectively.

Commercial road weather service providers (commercial providers) offer MDSS that may include all or part of the functionality mentioned above. These systems provide a range of integrated weather and road condition forecasts that enable trucks to communicate with the central MDSS.

Commercial providers offer various approaches to MDSS. One approach is a web-hosted solution where software is operated at the commercial provider's site with agency access provided by the Internet. Another approach is a hosted client/server where part of the application operates on agency computers, but other parts run on a central server, typically web-hosted, at a commercial provider's site. A third alternative is for the agency to have the application completely installed and operated at its sites.

Agencies may also choose to develop their own applications.

(Photo courtesy of the Washington State Department of Transportation)



The overall flow of the functional prototype MDSS is shown in the exhibit on the left. Commercial products based upon the prototype have a similar structure; products not based upon the prototype may differ in structure but have similar functions.

Data input for the MDSS prototype includes meteorological and road observations and output from weather prediction models. This includes surface meteorological observations from National Weather Service and Federal Aviation Administration airport sites. These systems are updated at least once per hour. Input also includes both atmospheric and pavement data from DOT environmental sensor stations. Many of these stations have sensors to measure atmospheric, pavement, and water level conditions along roads. In some cases, data can be transmitted from maintenance vehicles regarding their locations and treatment activities and input to the MDSS.

All of the input data are then forwarded to the Road Weather Forecast System. This system has formulas that synthesize the information to create a forecast that contains all of the elements that are needed to begin treatment recommendation generation. Elements include: forecasted air temperatures, precipitation types and their probabilities, and wind speeds.

The Road Condition and Treatment Module takes the forecasted weather elements and uses a computer model to predict road conditions (e.g., snow depth and pavement temperature). This model also generates recommended treatments and gauges the effectiveness of those treatments.

Once maintenance professionals settle on a treatment plan, MDSS presents recommendations in a user view in graphic, map, and narrative form. From here, users can view specific roads and weather parameters. The MDSS recommendations can be customized based on agency-defined policies and by capturing the knowledge of experienced staff. For example, agency policy may restrict the application of certain chemicals on specific routes due to environmental concerns. Such restrictions can be reflected in treatment plans. If an agency is using mobile data communications/automated vehicle location, treatment recommendations can be sent directly to an operator in a truck in some vendor systems.

In some implementations of MDSS, the system can generate "what if?" scenarios. This capability allows a maintenance manager to modify the timing, chemical type, or application rate on any of the routes to see how the changes might affect the treatments or forecasted road conditions.

The exhibits that follow are prints of screens from the FHWA functional prototype. These provide an idea of how the systems look and what information they provide. It should be noted that any given commercial MDSS product will have a different presentation or may allow the agency to configure its own screens. Some of the screens available from commercial providers are based on extensive analysis of how computer users interact with systems (i.e., human factors).

MAIN MDSS DISPLAY SCREEN

(This screen is from the FHWA functional prototype. Any given commercial system will have a different appearance.)

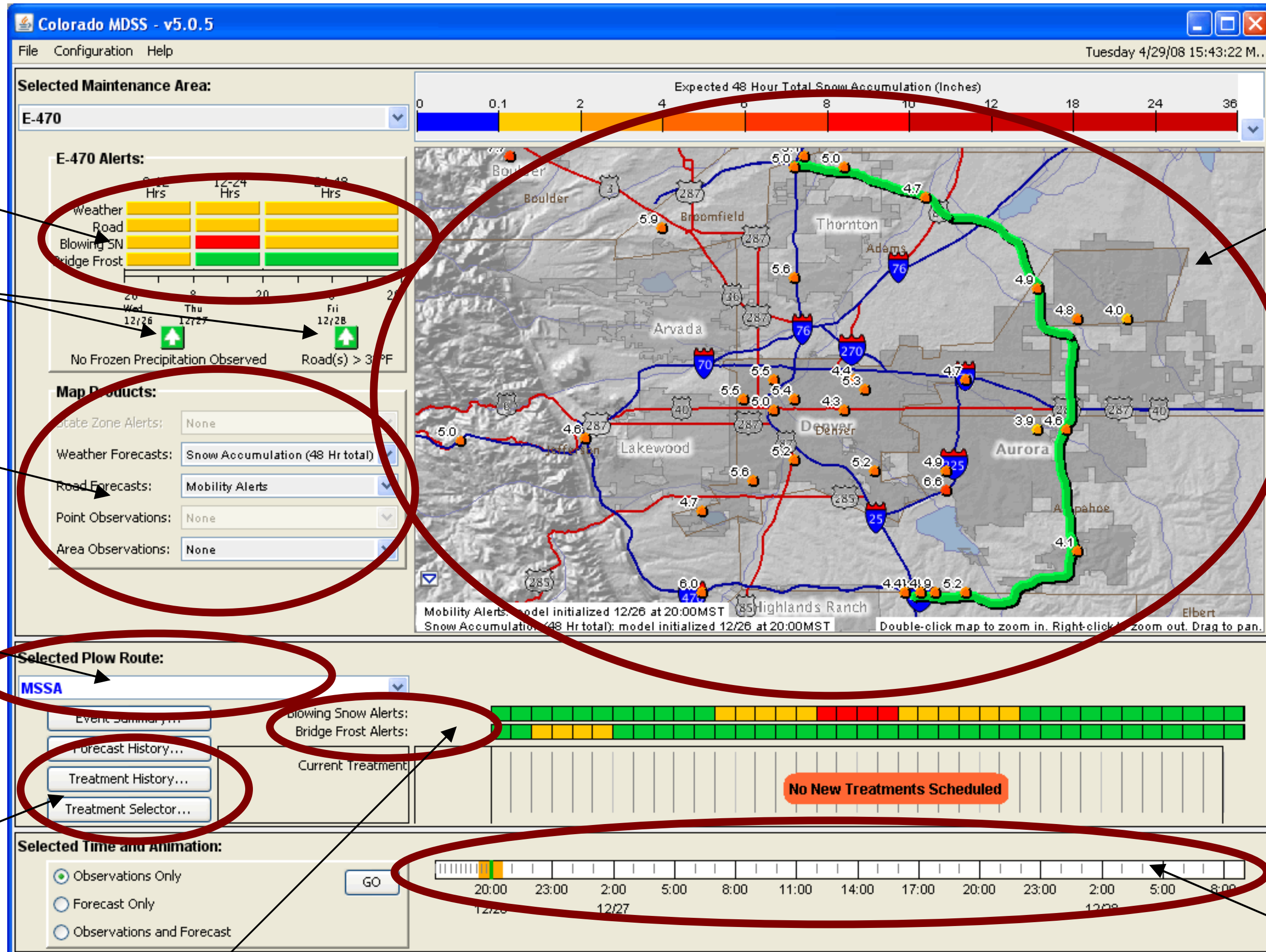
Road & Weather Alerts

Frozen precipitation & road temperatures below 32F Alerts

Observations & Forecast Parameters

Route Selection

Access to Event Summary, Treatment History, & Selection



High Resolution Topographic Map & ESS Observations

Forecast Time & Animation Control

Blowing Snow & Bridge Frost Alert Bars

WHAT IF SCENARIO

(This screen is from the FHWA functional prototype. Any given commercial system will have a different appearance.)

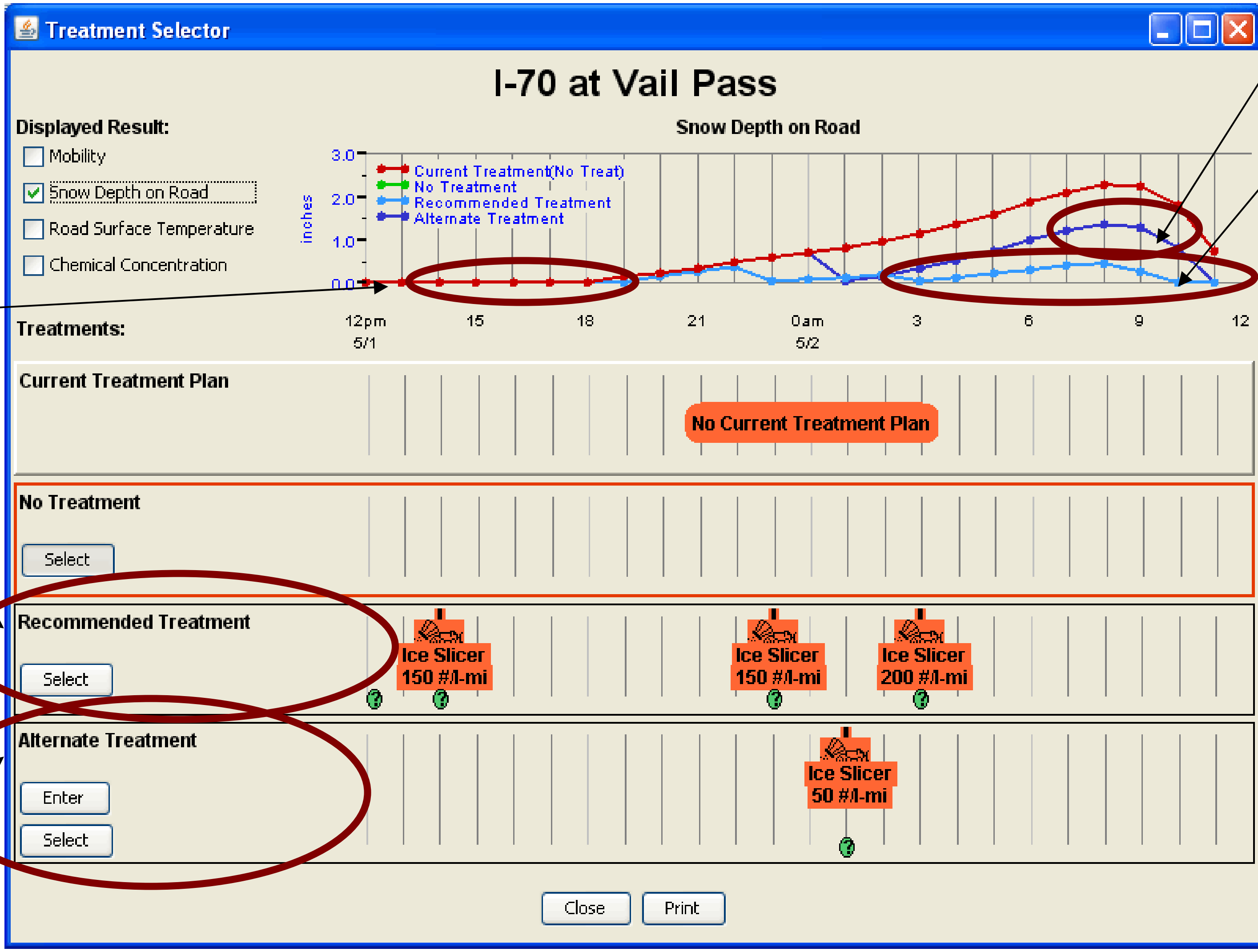
Using An Alternative Treatment Plan (dark blue)

Using Recommended (Optimized) Treatment Plan (light blue)

Base Case—No Treatment (red)

Recommended Treatment

Alternative Treatment



I -70 at Vail Pass: light snow (~ 2.5") is forecast for Vail Pass. The red line shows the forecast accumulation on the road if no action is taken. The optimized solution (dark blue trace) is associated with the "Recommended Treatment" shown below. An "Alternate Treatment" consisting of one plow pass and minimal chemical is associated with the dark blue trace. The "what if" scenario allows operators to change application types, times and amounts and see the computed results along the route.

DEPLOYING MDSS

This section provides guidance on the steps for deploying MDSS. It is based upon experience implementing intelligent transportation systems and other information technology. There are different approaches for implementing technologies, including commercial methodologies and those used by other agencies.

This guide identifies four basic phases for MDSS Deployment, as illustrated in the exhibit below. Each phase involves multiple tasks described in the narrative that follows. The deployment tasks will vary depending on the approach used; web-hosted, hosted client/server, agency installed, or agency developed. These differences are identified throughout. This section focuses on implementation of commercial applications anticipating that most agencies will pursue this direction.

MDSS Deployment Phases and Tasks

Planning & Justification	Acquisition	Implementation	Use & Evaluation
Project Organization	Process Analysis	Acquire & Install Hardware	Continue Process Change
Feasibility Study	Requirements Definition	Install & Test Software	Evaluate Benefits
Implementation Plan	Select Commercial Provider	Design Configuration, Extensions, & Interfaces	Conduct Ongoing Training
Organizational Change Management		Configure Software	
		Develop Extensions & Interfaces	
		Conduct Testing	
		Conduct Training	
		Conduct Pilot	
		Implement	
		Manage Project	
		Post-Implementation Review	

PLANNING & JUSTIFICATION

PROJECT ORGANIZATION

Project organization involves identifying the project team and structure for the MDSS project. The key team member is the project manager. This person should have strong project management expertise; good understanding of maintenance activities, including snow and ice control; and sound business judgment. The project manager is in charge of the day-to-day deployment effort, including directing all team members and ensuring the project is completed on budget, on schedule, within scope, and with high quality. The project manager will oversee the work of any commercial providers and ensure that the ultimate users of the system are involved.

Another important individual is the project sponsor. This should be an influential administrator within the agency who will have the authority to marshal resources, resolve issues, and advocate for the project to the senior management team and external bodies.

The project should establish a steering committee comprised of a cross-section of individuals who will use or oversee use of the MDSS. This should include those from headquarters and the field, supported by information technology professionals. The steering committee will provide policy guidance, identify issues to resolve, and communicate about the deployment throughout the agency.

MDSS deployments of commercial software will involve a commercial provider and individuals who will implement the system either from the commercial provider or from a consulting firm. The individuals who will help tailor the system for the agency are called systems integrators. At times, the commercial provider will also be the systems integrator. The agency may decide to enter into an agreement with other states (often called a pooled fund study). In that case, the specific organizational approach will be determined by the associated partnering agreement.

FEASIBILITY STUDY

Those in an agency interested in acquiring an MDSS must first obtain approval of management and potentially other decision-makers such as the legislature, city council, or information technology organization. In some cases, estimating costs and providing a general indication of benefits is sufficient to get the necessary approval. In other cases, decision-makers may request extensive analysis and justification. For the latter, a feasibility study or business case is often used. In many state and local governments, there are established processes that feasibility studies must follow. Agencies should check on the requirements of their particular agency.

Feasibility studies typically involve identifying user and agency needs and alternatives, and their associated benefits, costs, and risks.

Needs

A needs analysis is completed during the feasibility study to identify what information the system is to provide and what functions it will perform. These needs are similar to the requirements definition identified later in this guide, but are generally less detailed. Representative users of the system should be involved in a process to identify these needs and their priorities.

Alternatives

There are a variety of ways to determine alternatives for MDSS deployment. Alternatives can be dictated by such things as:

- Whether to use an MDSS which is web-hosted, hosted client/server or implemented at agency sites
- Whether to implement commercial software or develop customized software
- The extent of technology used (for example, MDSS with or without automated vehicle location technology)
- The extent of geographic implementation (for example, only part of the system or statewide)
- Whether to phase implementation
- Whether to partner and pool resources with other state or local transportation agencies
- The level of integration with other systems such as: maintenance management systems, inventory control, and traffic systems

Each alternative will have different degrees of benefits, costs, and risks.

For example, if an agency evaluates implementing commercial software compared to developing customized software, it might find that a commercial software implementation has somewhat fewer benefits because it is not uniquely tailored to the agency. However, the commercial software cost and risk may be lower than customized development. MDSS with automated vehicle location capabilities could deliver more benefits but would cost more and could be higher risk. MDSS initially can be deployed on only a few routes and later expanded to other routes and maintenance facilities. This also would have increased cost and risk. Detailed information regarding these new routes such as their physical characteristics, availability of weather forecasts, and pavement condition information would have to be collected in order for them to be accurately displayed.

By examining each alternative on the basis of benefit, cost, and risk, the agency and its authorizing decision-makers can decide whether to go forward with MDSS deployment and, if so, how.

Benefits

Benefits are the reasons to pursue any new technology. However, identifying and quantifying benefits is often considered the most difficult aspect of performing a feasibility study. To justify MDSS, benefits should exceed costs. This step requires that specific functions and features be translated into specific benefits to the agency.

MDSS benefits are likely to include: reducing costs of labor, materials, and equipment; increasing public safety; increasing mobility; improving maintenance levels of service; and enhancing productivity.

Benefits should be quantified wherever possible. Quantified benefits are also called tangible benefits. Where benefits are not quantified, they are considered intangible benefits. Identifying quantified benefits requires good performance measurement and cost information. It also requires professional expertise that agencies may not have. One way to estimate benefits is to base them upon the experience of other agencies.

Where benefits cannot be reasonably quantified, intangible benefits should be used. Here, the agency identifies the type of benefit based upon case study information from elsewhere as well as by using professional judgment. Often such information is sufficiently compelling to convince decision-makers to authorize the MDSS effort.

(Photo courtesy of the Oregon Department of Transportation)

Estimating Costs

The cost analysis should identify all costs over the life-cycle of the MDSS system.

The agency should calculate two types of costs:

1) Planning through implementation costs
2) Annual operating costs

The exhibit on the following page lists typical costs and provides a template for identifying costs over the life of the system.

The cost of an MDSS deployment can vary depending upon the configuration of the deployment. A significant operating cost can be that of the weather forecast provider.

Assessing Risks

All projects have risks that may affect project completion and estimated costs. Some of these risks are addressed by preparing detailed cost estimates and applying uncertainty factors while estimating costs. However, other risk factors must also be considered. These risks are more qualitative in nature, such as management support or user involvement. These factors should be evaluated to determine if the project is a high or reasonable risk project.

Preparing the Financial Summary

In this step, benefits, costs, and risks associated with the project are summarized and compared. These are brought together with benefits over the system lifecycle to provide a total benefit-cost-risk picture.

Cost Calculation Template

Cost	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
A. Planning through implementation costs										
1. MDSS license fees or web-hosting fees										
2. Contract software integrator										
3. Agency information services staff										
4. Agency user staff										
5. Other agency support staff										
6. Hardware										
7. Telecommunications										
8. Travel expenses										
9. Training										
10. Overhead										
B. Annual operating costs										
1.MDSS maintenance fee										
2. Web hosting fee										
3. Weather forecast provider										
4. Other agency support staff										
5. Hardware capital recovery										
6. Telecommunications										
7. Travel										
8. Training										
9. Overhead										
C. Total										

IMPLEMENTATION PLAN

The implementation plan identifies the tasks, timeframes, resource requirements, and work products necessary to implement the MDSS. The plan will be done on a preliminary basis during the Planning and Justification phase, because a commercial provider and system integrator has not yet been selected. Once that occurs, the vendors will prepare an updated plan by which the project will be managed.

ORGANIZATIONAL CHANGE MANAGEMENT

This phase spans the life of the project and involves the planning, design, and development of an organization change management and communications program.

Change management helps to minimize the depth and length of disruption brought on as a result of major change, such as the implementation of an MDSS. People are rarely comfortable with change — even change that appears positive. Much, if not most, of this discomfort is due to uncertainty. Employees and managers should assume equal responsibility for helping to minimize discomfort through knowledge and skill development, clarity of leadership, and open communications.

A department-wide MDSS implementation project is not just a systems implementation; it is a large process change effort. A successful MDSS implementation requires analysis of business processes and procedures, organization objectives, services, roles, and responsibilities.

Like any new system, users must be trained on how to use the MDSS. In addition, implementation will require users to take an active role in configuring the MDSS to process their information and meet their needs.

A typical change management program should include:

- Strong project sponsorship by a senior administrator
- User involvement in system design and configuration
- An organizational readiness assessment, which determines what users need
- A communications program, including newsletter inserts, web site information, and presentations
- A change agent program, involving individuals throughout the agency

One approach for facilitating organizational change management is to phase the implementation. For example, the MDSS might be used initially as a strategic tool for advance forecasting and predicting event duration/severity by snow operations managers. This can result in budget savings. Once these managers have confidence in the system, they can help sell it to line winter maintenance personnel who will use it for tactical purposes such as to develop treatment recommendations.

ACQUISITION

PROCESS ANALYSIS

Benefits from the MDSS will only be realized if maintenance personnel change their processes to capitalize on the route-specific forecasts and treatment recommendations presented by the system. There should be an initial process analysis to think through how MDSS capabilities will change specific snow and ice decision-making processes and provide the greatest benefits. There should be workshops with future MDSS users and an MDSS expert to understand current processes and map out future ones. The new processes will form part of the basis for the requirements in the next task.

REQUIREMENTS DEFINITION

One of the most important steps in the deployment process is defining requirements for the MDSS. Requirements are the basis for communicating to vendors what the agency wants in a system. They also become part of the criteria for evaluating a system. There are two basic types of requirements: functional and technical. Functional requirements identify what functions the system is to perform. An example of a functional requirement would be: "Develop a recommendation for anti-icing treatment based upon weather and pavement conditions." Technical requirements specify the hardware, operating system, and communications environment that the agency desires. An example of a technical requirement would be: "The system shall operate on the Windows computing platform." A special type of requirement is one that addresses performance such as what computer response time or communication time is expected from the MDSS.

The requirements definition process should involve a cross-section of MDSS users from headquarters and the field. The process should include workshops and interviews to identify requirements and set priorities.

Agencies considering procuring MDSS should acquire the National Center for Atmospheric Research-developed "MDSS Functional Specification Template and Procurement Guidance" document, which provides materials agencies can use when compiling a procurement package. A procurement package includes:

- Candidate functional requirements for MDSS products and services
- Information that DOT personnel can use to evaluate prospective MDSS services
- Questions that could be asked when interviewing prospective vendors

The functional specification template is available on the National Center for Atmospheric Research web site.[5]

There are several communication methods that can be deployed to support MDSS. Each method varies in speed, availability, and cost. These methods are compared in the exhibit on the following page.

Other considerations relate to the agency's software approach. For example, if a DOT were implementing a web-hosted service, then the required bandwidth would be dependent on the requirements of the provider. Some systems use very small bandwidth as only minimal graphics are sent from the central server to the end users. The opposite may be true of other commercial systems if they are heavily dependent on sending graphics or large files.

If a DOT were to deploy a version of MDSS internally, it would need sufficient bandwidth to input observations and large model files. In addition, it would need to communicate with remote users to refresh displays and return data requests.

COMMUNICATION METHODS

DIAL UP	
Availability:	Extensive; available in most remote locations
Speed:	Slow
Cost:	Low
DSL	
Availability:	Moderate, based on telephone network; may not be available in remote locations
Speed:	Variable, depends on distance from provider; can be slow as dial up or fast as cable
Cost:	Moderate
BROADBAND CABLE	
Availability:	Moderate, available from cable television & other providers; may not be available in remote locations
Speed:	High
Cost:	Moderate
SATELLITE	
Availability:	Extensive; available anywhere
Speed:	Moderate; lower than cable or DSL
Cost:	High
CELLULAR	
Availability:	Moderate, available from most cellular phone providers; can be used for mobile data collection; may not be available in remote locations
Speed:	Variable; slower than DSL, cable and possibly dial up
Cost:	High

The cost to an agency for communications will depend upon its current communications infrastructure, and the particular software deployed. If an agency can use existing communications infrastructure, it can minimize costs. In implementing MDSS software, the agency also must account for agency security requirements. This includes firewall security and permissions for different levels of access by different system users.

SELECT COMMERCIAL PROVIDER

This includes the development of a request for proposal (RFP) to select the commercial provider, review of the commercial providers' proposals, review of product offerings through demonstrations or other means, selection of an MDSS and the system integrator, and negotiation of the contract. The system integrator may be the commercial provider or a different company such as a consulting firm. The system integrator will help install and configure the software to meet the requirements, develop interfaces to and from existing systems, define conversion requirements and processes, provide training, and support the implementation. The system integrator also may participate in post-implementation activities.

When acquiring software, agencies must sign license agreements with commercial providers. These license agreements protect the proprietary nature of the MDSS and limit the ability of the agency to use the associated intellectual property. The price for the MDSS will be determined by the provisions of the license, which is often based upon the number of system users, the number of forecast points and the complexity of the forecast routes.

Commercial providers upgrade systems over time to implement additional features and capitalize on new technology. To obtain these upgrades, agencies will typically need to pay an annual maintenance cost. Implementing upgrades will require many of the same deployment steps identified in this section.

Once a system is selected, an agency will conduct negotiations and ultimately agree to a contract with the vendor consistent with its organization's contracting process.

IMPLEMENTATION

ACQUIRE & INSTALL HARDWARE

If the MDSS is web-hosted the hardware requirements focus on providing adequate communications access for the users and providing work stations, including laptop computers and in-vehicle or handheld devices to communicate with the hosted application. If the MDSS is hosted client/server, or installed entirely at the agency, the agency will need to provide hardware and communications systems upon which to operate the software.

INSTALL & TEST SOFTWARE

Software to be operated at agency sites will need to be installed and tested to ensure it is operating properly.

DESIGN CONFIGURATION, EXTENSIONS, & INTERFACES

During this task, the commercial provider, the system integrator, and the users work together to relate the state's requirements to the capabilities of the software in order to determine how the software will be configured to meet the users' requirements. Also included in this task is the design of interfaces to the existing systems and possible modifications to those existing systems if they are needed to support the new MDSS. Any extensions to the core software would also be designed at this point.

CONFIGURE SOFTWARE

Depending on the system, configuration can include a number of tasks but usually involves setting up validation and descriptive tables; identifying how calculations will work, including limits, and other variables; creating user-defined fields; modifying reporting structures; updating screens; and creating user roles and related security. MDSS configuration likely will include such things as: information about pavement characteristics for the pavement temperature model, chemical types, and plow route information, as well as rules of practice for each maintenance area. Configuration requires a considerable amount of thought and time by agency personnel.

(Photo courtesy of the Portland National Weather Service Office)

If additional capabilities are needed to meet mandatory requirements, they would be defined during this task to be developed as extensions to the core software, rather than as modifications.

DEVELOP EXTENSIONS & INTERFACES

Any extensions to the core MDSS software are developed in this task. As stated earlier, modifications to the code of the core system should be avoided. These extensions represent additional functionality that would integrate with the core system. These modules would be developed by the commercial provider or systems integrator.

One of the key interfaces is likely to be between the MDSS and the agency's maintenance management system. Maintenance management systems typically keep track of labor, materials, and equipment usage, and this information should be reconciled between the two systems. Likewise, some maintenance management systems perform analysis of the level of service provided for winter maintenance, and the MDSS information can contribute to this analysis.

CONDUCT TESTING

Testing is done to confirm that the MDSS configuration works correctly, to validate that the interfaces correctly transfer incoming and outgoing data, and to ensure reports and screens work correctly. This is done on parts of the system at first, and then on the system as a whole. The final stage of testing is a user acceptance test where the users perform extensive testing on the system to make sure all parts meet the requirements, that the system is configured, that the interfaces and any extensions were developed as specified in the design, and that all hardware and communications components work as required.

User Training Outline:

I. MDSS Purpose
   A. The definition and purpose of MDSS
   B. Why the agency is implementing MDSS
II. System Basics
   A. Getting started
   B. Navigating the system
III. MDSS Use
   A. Agency policy
   B. Use in decision making/step by step
   C. When not to use it
   D. The role of professional judgment
   E. Planning for the winter
IV. Getting Help
   A. System troubleshooting
   B. Help in interpreting data
   C. System documentation
V. Other Issues
   A. Cooperation with other districts and states
   B. Evaluating MDSS benefits

CONDUCT TRAINING

User training is a key factor in the success of the project. A training program is developed and presented for the participants of the pilot, updated to reflect the findings of the pilot, and presented to the remaining users shortly before implementation. The training program should include role-based modules that address the business processes first and how the system supports those processes second. Role-based training focuses on the processes to be performed rather than just the capabilities of the software. The exhibit at the right is a sample outline for user training.

Training can either be provided by the commercial provider, system integrator or in-house personnel.

Technical staff will also need to be trained for the hosted client/server and the agency installed deployments so that staff can help support the agency-side applications.

CONDUCT PILOT

A pilot should be conducted at one of the field sites. The employees of that site and the central staff receive the initial MDSS training described above and conduct the pilot. During the pilot, the implementation team will be integrally involved to answer questions and resolve errors. At the end of the pilot, an assessment will be done by the team and the participants to determine which, if any, outstanding issues need to be resolved before going live statewide. Additional time is set aside for resolving issues and making adjustments prior to beginning the statewide rollout. Further pilot testing may be required to ensure that the system changes work properly and for the agency to be confident that the system is ready.

IMPLEMENT

Implementation involves deploying both the hardware and software for production operation. It also includes conversion of data if necessary. During implementation, follow-up is also needed to confirm that the system is operating as expected, and to identify and correct any problems. The implementation should be rolled out to locations incrementally if possible.

MANAGE PROJECT

Other key tasks performed throughout the implementation include project management, change management, and risk management.

POST-IMPLEMENTATION SUPPORT

This task provides follow-up training to users, addresses any problems or issues users may be experiencing and evaluates how the MDSS is performing.

(Photo courtesy of the Oregon Department of Transportation)

USE & EVALUATION

CONTINUE PROCESS CHANGE

Once the MDSS is up and running, there is a need to continue to refine adverse weather decision processes based on how maintenance personnel are using the system. Often, it takes several years for some personnel to become comfortable with a new system. Managers should continue to monitor use of the MDSS and share lessons learned throughout the agency. The agency may also want to establish an MDSS users group with members from across the agency who can share ideas on how to use the system for their maximum benefit.

EVALUATE BENEFITS

If the agency wants to ensure that benefits from the MDSS are realized, it should set up a process to evaluate those benefits over time. Using the benefits in the feasibility study as a baseline, knowledgeable personnel can help the agency establish an evaluation framework to collect information about tangible and intangible benefits realized. The agency also can collect lessons learned from different parts of the organization and communicate these agency-wide.

CONDUCT ONGOING TRAINING

Training must be provided on at least an annual basis to ensure that maintenance personnel know how to use and capitalize upon the MDSS. This is because personnel change through promotions or vacancies. Even individuals who are previously trained can benefit from refresher courses, training on new capabilities, or even ongoing coaching in use of the system.

(Photo courtesy of the Montana Department of Transportation)

The following topics cover a number of lessons learned from MDSS implementations and other technology projects, and provide useful guidance. In addition, resources such as the Intelligent Transportation Systems Peer-to-Peer program provide access to those with direct experience deploying MDSS.[6]

INITIAL AND ONGOING TRAINING

In order to achieve the full benefits of an MDSS, the users need to understand fully how it works, how to interpret the information it offers, and how best to apply it in support of decision making. This type of training needs to occur before the tool is introduced. Once an MDSS is adopted, the MDSS vendor can offer active support to the maintenance crew that is using the tool to explain its capabilities, answer questions that arise, and suggest effective ways to take best advantage of its capabilities.

DEALING WITH INSTITUTIONAL BARRIERS

Human factors should be acknowledged and addressed when adopting an MDSS. These include job security, distrust of new approaches, comfort in doing things the same, pride in personal ownership of route management, and a need for proof that an MDSS can offer a better tool to support operations. Maintenance recommendations that are not substantially similar to the way maintenance personnel approach the same situation are often perceived as inaccurate, when in reality they may just represent a different approach.[7] The organizational change management approaches in this guide are designed to address these concerns.

There also may be information technology institutional barriers such as agency policies associated with the archival of data for use in training and for use in post-storm review of decision making processes.

MANAGEMENT COMMITMENT

Jurisdiction-wide MDSS projects can be expensive, long-term efforts that require the cooperation of many individuals inside and outside an agency. To obtain this cooperation, these projects must have commitment from key management and this support must be evident throughout the agency. Management must marshal the required resources for the project; strongly articulate its benefits to agency personnel; and work to resolve conflicts that threaten project success. The executive sponsor recommended in this guide should perform this role.

STRONG PROJECT MANAGER

A strong project manager is an essential ingredient to MDSS success. This individual must have technical knowledge and leadership abilities. Equally important, the project manager must exercise sound business judgment concerning such issues as project scope and technology. Once a project manager is selected, he or she must receive top management support and be held accountable for project results.

LEARNING SYSTEM BIASES AND TENDENCIES

MDSS users need to be aware that weather and pavement condition forecasts can contain errors and biases due to both the resolutions of the forecasts and variations in terrain, bad sensor sites, and even bad sensors. If a forecast seems suspect, the best avenue is to contact the forecast provider.

MAINTAINING METADATA AND CURRENT RULES OF PRACTICE

Metadata and rules of practice within the system should be kept current and accurate. Metadata is data about the meteorological or pavement observations and the environmental sensor station properties. This can include station location, elevation, solar orientation, and site qualities such as trees, pavement, structure, (as built characteristics), nearby water sources, and wind sensing qualities. The metadata provide a level of quality for the data. Rules of practice are the agency's methods of operation such as the types of pavement treatments used in particular conditions.

THOROUGH, REALISTIC WORK PLAN

Definitions of what is to be done by whom and when, with constant monitoring of the process and follow-through, are essential. The MDSS project work plan is the key element for estimating project budgets and schedules, and for monitoring project status. The work plan must provide the ability to manage all functions critical to project success. It must include realistic estimates of budgets, schedules, and accomplishments based upon experience and provide for phased deliverables in workable steps. Management should closely monitor budget, schedule, and accomplishment status in order to take corrective action as necessary to keep the project on track.

WELL PERFORMING HARDWARE AND COMMUNICATIONS

The performance of computers, the communications network, and the connection to an internet service provider can affect the perception of an MDSS. If any one of these components is slow, users may attribute it to the MDSS. It is important that the system infrastructure provide good performance to ensure that the overall system performs well and is perceived positively.

SCOPE MANAGEMENT

One of the most persistent problems in project management is controlling scope. Changes to the scope can threaten project success. Techniques such as change control can be instituted to manage scope. Change control implies setting boundaries for system functions and only adding functions outside those boundaries through a formal, documented action. Projects must have change control procedures and priority systems to define system scope and to manage the project within that scope.

There are many resources to guide an agency in deploying MDSS. These include: knowledgeable individuals to contact, training, articles, information on MDSS software offerings, and sample requests for proposals. Many of these resources are available online and are updated on a continual basis; links are included in this guide. MDSS offerings and associated information continue to evolve so care must be taken in using information to ensure that it is current.

PLANNING AND JUSTIFICATION

Flyers and brochures have been developed to provide users with an overview of MDSS and its capabilities. Contact information for experts who can guide future users in planning and justifying the system for their agency is available at:

http://www.transportation.org/sites/aashtotig/docs/mdss_v2.pdf

All MDSS prototype software has been made available at no cost. This allows interested parties to test and evaluate the package. Steps for obtaining the latest MDSS prototype source code can be obtained at:

http://www.ral.ucar.edu/projects/rdwx_mdss/products/steps.php

ACQUISITION AND IMPLEMENTATION

The National Center for Atmospheric Research has created a document that provides a template for creating an MDSS RFP. This document is available at:

http://www.ral.ucar.edu/projects/rdwx_mdss/documents/MDSS_FRD_Procurement_Template_22July06.doc

The Aurora Program (DOT Pooled Fund) has a web page that contains RFPs that are associated with previous MDSS acquisitions. These RFPs can be accessed at:

http://www.aurora-program.org/matrix.cfm

"Deployment of Maintenance Decision Support Systems for Winter Operations" provides the overview of the functionalities of an MDSS:

http://onlinepubs.trb.org/onlinepubs/circulars/ec098.pdf

USE AND EVALUATION

The National Center for Atmospheric Research maintains a web site that summarizes steps on how to use the MDSS prototype at:

www.rap.ucar.edu/projects/rdwx_mdss/prototype.php

The most recent MDSS prototype technical documentation can be obtained from:

http://www.rap.ucar.edu/projects/rdwx_mdss/documents/

FOR ADDITIONAL INFORMATION

Further information on MDSS and the federal prototype can be found on the Federal Highway Administration web site at:

http://ops.fhwa.dot.gov/weather/mitigating_impacts/programs.htm#p3

ENDNOTES

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[1] Metadata is information about data, such as characteristics of a given pavement.

[2] http://www.ops.fhwa.dot.gov/weather/seminars/mdss_roadshow/index.htm

[3] http://www.ral.ucar.edu/projects/rdwx_mdss/documents/

[4] http://ops.fhwa.dot.gov/weather/wmv/rwis.cfm

[5] http://www.ral.ucar.edu/projects/rdwx_mdss/documents/

[6] http://www.its.dot.gov/peer/index.htm

[7] Development of a Maintenance Decision Support System – Interim Report (Draft Phase IV), prepared by Meridian Environmental Technology, Inc., Grand Forks, ND, January 2008