Deploying the Maintenance Decision Support System (MDSS) in Iowa

CTRE Project 02-129

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Final Report • November 2003

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16. Abstract

Adverse weather conditions dramatically affect the nation's surface transportation system. The development of a prototype winter Maintenance Decision Support System (MDSS) is part of the Federal Highway Administration's effort to produce a prototype tool for decision support to winter road maintenance managers to help make the highways safer for the traveling public. The MDSS is based on leading diagnostic and prognostic weather research capabilities and road condition algorithms, which are being developed at national research centers.

In 2003, the Iowa Department of Transportation was chosen as a field test bed for the continuing development of this important research program. The Center for Transportation Research and Education assisted the Iowa Department of Transportation by collecting and analyzing surface condition data. The Federal Highway Administration also selected five national research centers to participate in the development of the prototype MDSS.

It is anticipated that components of the prototype MDSS system developed by this project will ultimately be deployed by road operating agencies, including state departments of transportation, and generally supplied by private vendors.

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DEPLOYING THE MAINTENANCE DECISION SUPPORT SYSTEM (MDSS) IN IOWA

CTRE Project 02-129

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ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

Adverse weather conditions dramatically affect the nation's surface transportation system. Each year, 6,600 people die, 470,000 people are injured, and 544 million hours of time are lost on the nation's highways because of adverse weather conditions, according to the Federal Highway Administration (FHWA). The development of a prototype winter Maintenance Decision Support System (MDSS) is part of the FHWA's effort to produce a prototype tool for decision support to winter road maintenance managers to help make the highways safer for the traveling public. The MDSS is based on leading diagnostic and prognostic weather research capabilities and road condition algorithms, which are being developed at national research centers.

In 2003, the Iowa Department of Transportation (Iowa DOT) was chosen as a field test bed for the continuing development of this important research program. The Center for Transportation Research and Education assisted the Iowa DOT by collecting and analyzing surface condition data. The FHWA also selected five national research centers to participate in the development of the prototype MDSS. They were selected because of the applicability of their expertise to the MDSS task. The participating national labs include the Cold Regions Research and Engineering Laboratory (CRREL), National Center for Atmospheric Research (NCAR), Massachusetts Institute of Technology - Lincoln Laboratory (MIT/LL), National Severe Storms Laboratory (NSSL), and the Forecast Systems Laboratory (FSL).

It is anticipated that components of the prototype MDSS system developed by this project will ultimately be deployed by road operating agencies, including state departments of transportation, and generally supplied by private vendors.

INTRODUCTION

The development of a prototype winter Maintenance Decision Support System (MDSS) is part of the Federal Highway Administration (FHWA) Road Weather Management Program. The objective of the MDSS effort is to produce a prototype tool for decision support to winter road maintenance managers. The MDSS is based on leading diagnostic and prognostic weather research capabilities and road condition algorithms, which are being developed at national research centers. It is anticipated that components of the prototype MDSS system developed by this project will ultimately be deployed by state departments of transportation (DOTs), and generally supplied by private vendors.

There are five national research centers that are participating in the development of the MDSS Functional Prototype (FP). The participating national labs include

- Army Cold Regions Research and Engineering Laboratory (CRREL)
- National Center for Atmospheric Research (NCAR)
- Massachusetts Institute of Technology - Lincoln Laboratory (MIT/LL)
- NOAA National Severe Storms Laboratory (NSSL)
- NOAA Forecast Systems Laboratory (FSL)

The MDSS field demonstration evaluated the MDSS by operating the systems in a real-time winter environment. This allowed the users to work the system and verify the data. The following evaluations were performed in FY2003:

1. Weather prediction component
2. Treatment recommendations
3. Impact of supplemental mesoscale models
4. Potential benefit of operational system
5. Identify and evaluate current system limitations

The Iowa DOT provided a field test bed for the MDSS prototype in the winter of 2003.

Field Demonstration Period

The MDSS field demonstration began on February 3, 2003, and continued through April 7, 2003, to capture all major snow events. The system operated 24 hours per day, 7 days per week during this period. Three DOT maintenance garages participated in the demonstration:

- Ames Garage
- Des Moines - North
- Des Moines - West

Selected Winter Maintenance Routes for Field Demonstration

Iowa DOT representatives selected several winter road maintenance routes that were used in the MDSS field demonstration. A total of 15 routes, covering 400 miles, were configured in the MDSS. The selected routes are described in Table 1 and a corresponding map of the routes is provided in Figure 1. Separate treatment plans were generated by the MDSS prototype for each of the routes shown in Figure 1.

Table 1. Iowa maintenance routes for the MDSS field demonstration

Garage	Segment Number	Route	Start Mile Post	End Mile Post	ADT Range	Service Level*
Ames	1A	US 65	98.38	112.09	1,500–2,000	C
Ames	1B	US 30	164.93	172.30	5,000–6,000	B
Ames	2	US 65	112.09	132.59	1,000–2,000	C
Ames	3	I-35	111.60	128.46	20,000–23,000	A
Ames	4	I-35	96.60	111.60	23,000–26,000	A
Ames	5	US 30	142.88	172.30	6,000–27,000	B
Ames	6	IA 210	13.79	34.43	1,000–3,000	D
Des Moines North	7	I-35	93.20	96.60	26,000–53,000	A
Des Moines North	8	I-35	86.94	93.20	53,000–59,000	A
Des Moines North	9	I-80	137.82	142.10	50,000–61,000	A
Des Moines North	10	I-35/I-80	131.50	137.82	59,000–63,000	A
Des Moines West	11	I-35/I-80	123.53	131.50	32,000–72,000	A
Des Moines West	12	I-35	67.89	72.70	22,000–33,000	A
Des Moines West	13	I-235	0.00	8.80	42,000–125,000	A
Des Moines North	14	I-235	8.80	14.26	46,000–125,000	A
Des Moines North	15	IA 415	0.00	21.93	1,000–21,000	B-D

* Service Level
A = interstates
B = 5,000+ vehicles per day
C = 2,500 – 5,000 vehicles per day,
D = less than 2,500 vehicles per day

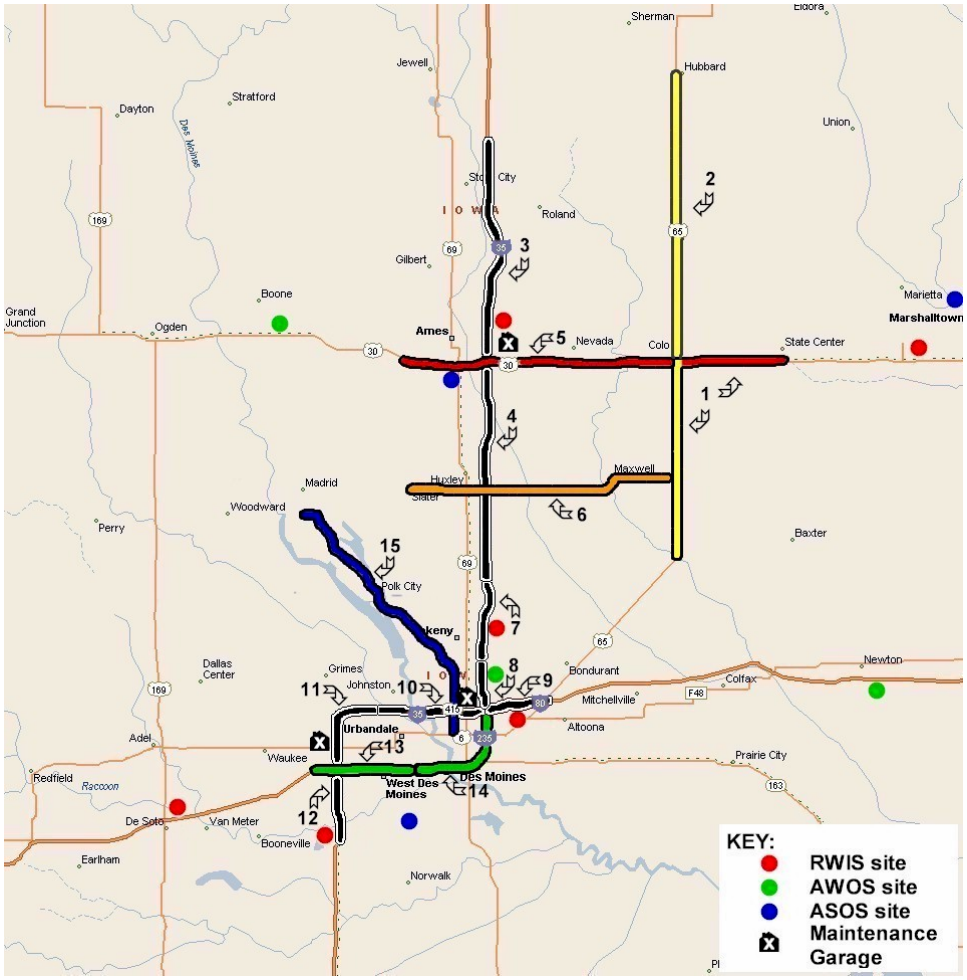


Figure 1. Map of routes to be supported by the MDSS prototype during the winter of 2003 Iowa field demonstration

The MDSS Iowa Weather Display

The MDSS Iowa weather display was configured to provide weather alerts when the weather conditions deteriorated according to the criteria in the MDSS technical description. Based on the Iowa weather forecast zones, the alerts appear on the MDSS Iowa weather display, as illustrated in Figure 2. These forecast zones are consistent with the weather forecast zones used by Meridian Environmental Technology, which was the operational road weather forecast provider for Iowa during the winter of 2002–2003.

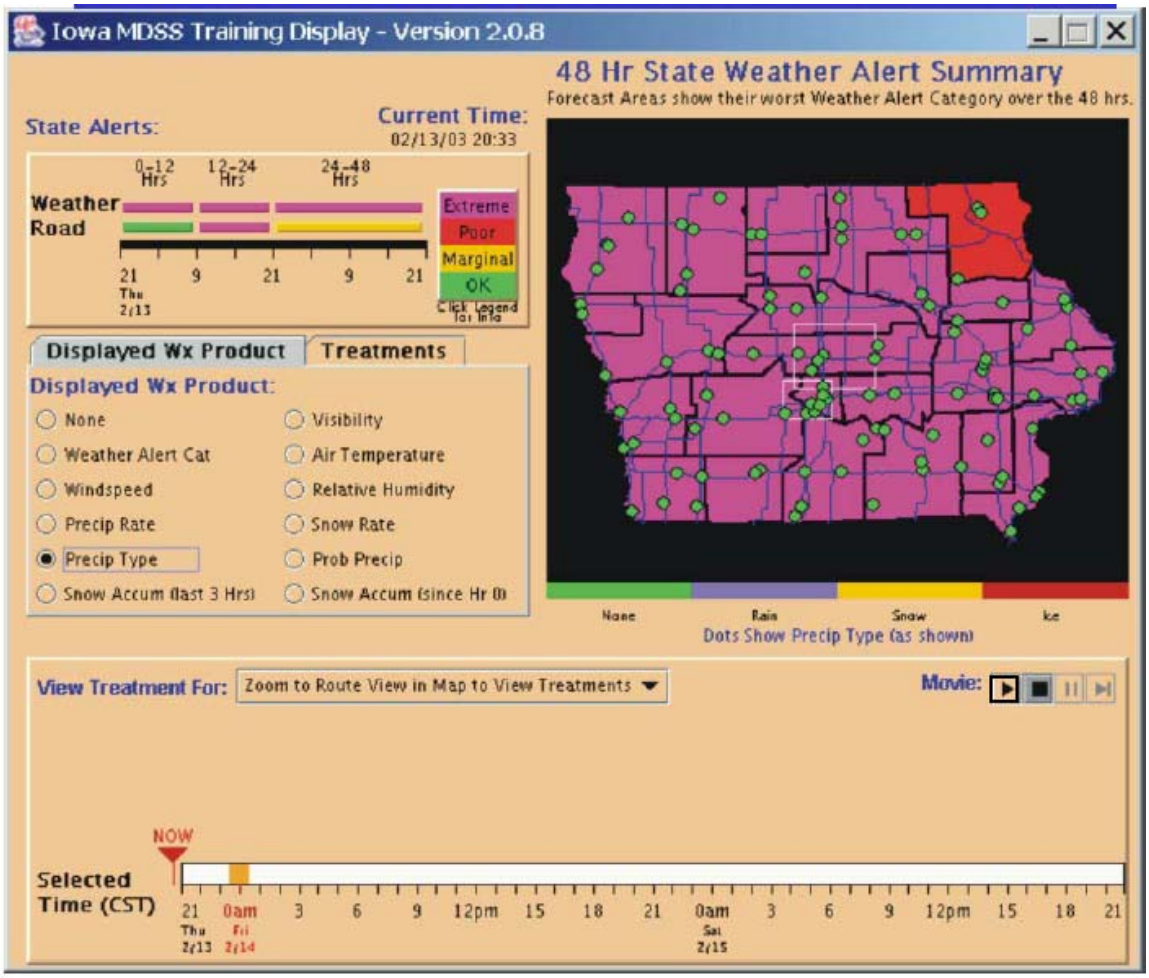


Figure 2. MDSS Iowa weather display page

MDSS System Configuration for Iowa

The MDSS core components (e.g., Road Weather Forecast System, Road Condition and Treatment Module, and data server) are operated centrally at NCAR in Boulder, Colorado. A server at NCAR communicates via the Internet with local PCs running the display application at the Iowa DOT maintenance garages. Supplemental weather forecast models run at FSL in Boulder and the data are forwarded to NCAR for inclusion in the Road Weather Forecast System (RWFS). Iowa DOT Road Weather Information Systems (RWIS) data were also provided to NCAR via FSL as part of the MADIS project.

The MDSS displays are located in the three maintenance garages. Each garage had the MDSS display running at the supervisor's desk and an additional display application at the shift supervisor's desk. Data were obtained over the Internet (client-server approach). A simplified illustration of the system configuration is provided in Figure 3.

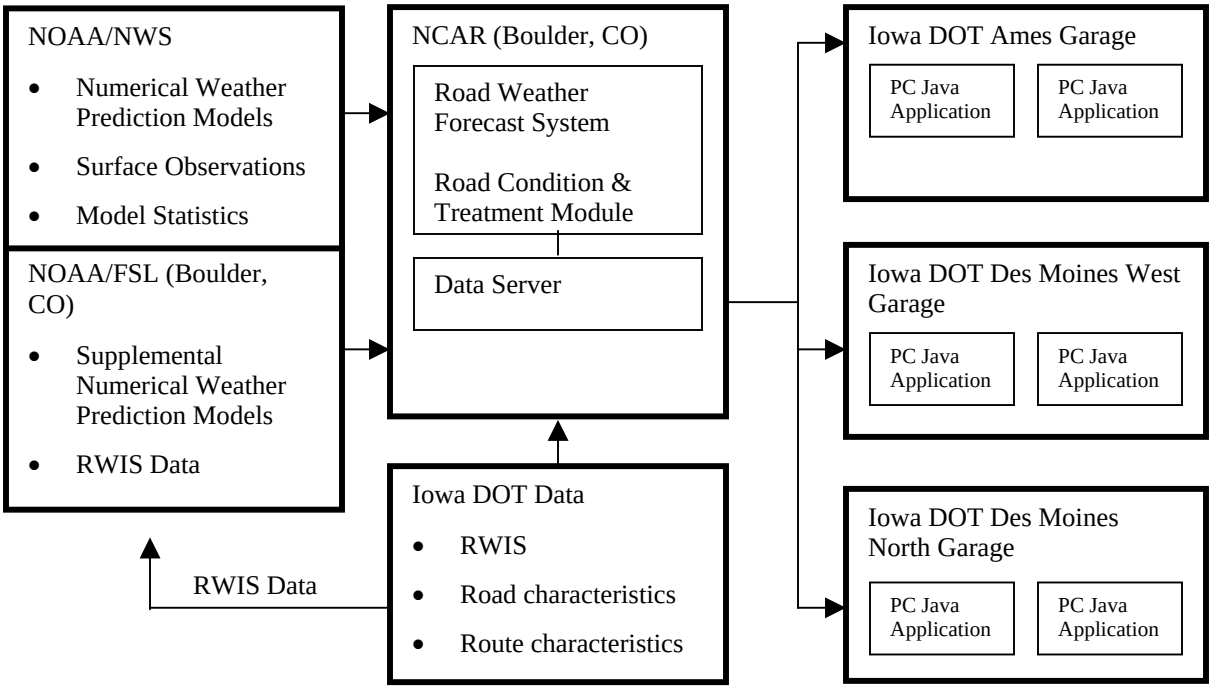


Figure 3. Depiction of the MDSS prototype configuration for the Iowa field demonstration. All network MDSS connections to the sites will be via the Internet (figure courtesy of NCAR)

Training

Following the installation of the MDSS software at the participating garages, three training sessions on the MDSS prototype were conducted. A preliminary training session was held on January 17, 2003, followed by a hands-on training session on January 21 and 22, 2003.

The objectives of the training program were to provide the users of the system information about the MDSS, explain the system's capabilities and limitations, and provide the users with hands-on experience with the system. The training session also provided an opportunity to discuss the data collection process during the demonstration period. The training sessions were held at the Ames, Des Moines North, and West Des Moines garages.

FIELD TEST PERIOD

The national labs were responsible for preparing a technical performance assessment by performing data analyses that sought to answer questions related to the technical performance of the MDSS system. Iowa DOT worked with the labs to identify critical ground truth data sets.

From the period of February 3–April 7, 2003 the MDSS was field tested. There were a total of eight weather events that tested the system, varying in intensity:

Light Snow Events	5
Heavy Snow Events	3
Mix: Snow/Rain/Ice	1
Total Weather incidents	**8**

Data Sources

Iowa DOT also provided field weather and operational data from the garages to verify the model. Data were obtained from several sources. Where available, data were obtained and archived in real time. If real time data were not available, archived data were used. The following data were collected for verification:

1. Iowa RWIS (weather and road condition data)
2. NWS METAR (aviation observations)
3. Local observer surface data (where available)
4. Weather satellite
5. Weather radar
6. NWS storm summaries
7. Iowa DOT observations (where available)
8. Iowa DOT Maintenance Concept Vehicle data
    a. Air temperature
    b. Pavement temperature
    c. Material distribution setting
    d. Freezing point detection
    e. Treatment type
    f. Treatment rate
    g. Plow position
    h. Position data

Iowa DOT Highway Maintenance Concept Vehicle Data

The team also provided data from the Highway Maintenance Concept Vehicle to the MDSS team. The HMCV incorporates numbers sensor inputs that can be used in the analysis. The HMCV is equipped with a friction meter, a FRENSOR freezing point detection system, and an automated vehicle location system (AVL) to provide position data. Other improvements include an RDS dump body, dual side-mounted 120 gallon pre-wetting tanks, a 900-gallon stainless steel anti-icing tank, and high-intensity discharge plow lights.

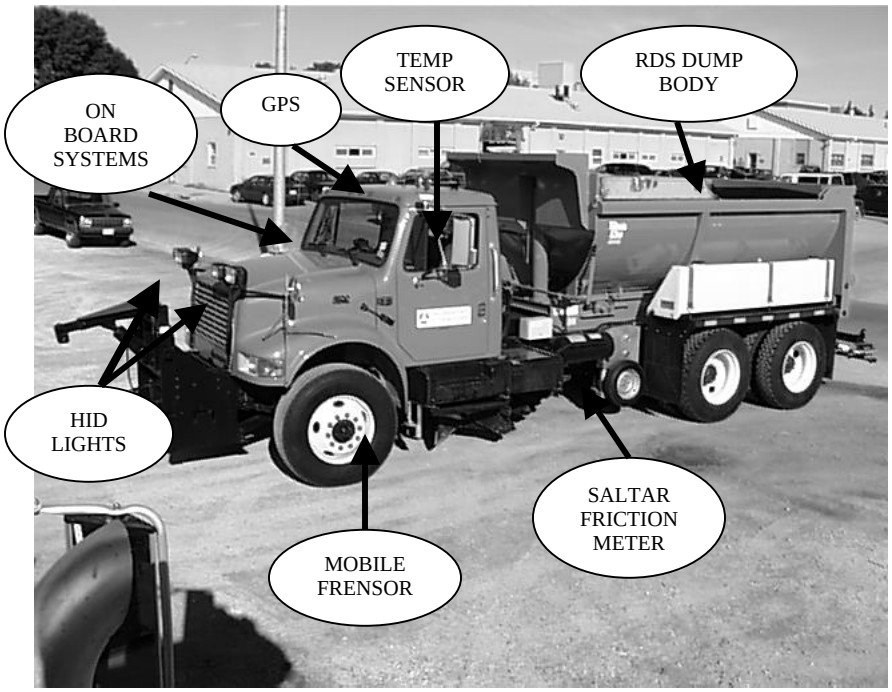


Figure 4. Iowa DOT Highway Maintenance Concept Vehicle

The data generated by the HMCV is stored on the AMS 200 Data Management Console. The data were then downloaded to a PC following a storm and analyzed. The HMCV data were then forwarded to NCAR for their use in developing the MDSS prototype. A sample of the HMCV data report is submitted in Appendix B.

Data Collection Forms

In order to fully estimate the road conditions and determine the actual treatments performed during each event, it was necessary for Iowa DOT personnel to fill out data forms following each shift that required winter road treatments. Numerous iterations of the format and content of these forms were determined through discussions between Iowa DOT, the Labs and the FHWA.

The winter maintenance data collection forms captured the following information:

- Date
- Shift time
- Route ID
- Equipment type
- Treatment performed
    - Treatment start and stop times
    - Chemicals used (NaCl, $CaCl_2$, etc.)
    - Chemical amount (tonnage)
    - Plowing performed

- Estimated road condition per route
    - Wet, dry, icy, snow packed, blowing snow, snow depth, slush, rain, freezing rain, frost, etc.
    - Road temperature (where available from equipment)
- Any other pertinent observations such as chemical dispersion rate, condition of road before and after treatment, precipitation start and stop times.

It was the Center for Transportation Research and Education's responsibility to ensure that the data collection forms were completed and available to the garages when questions arose. CTRE staff members rode along with snowplow drivers on several occasions to determine how the drivers were handling the data collection process along with their other duties.

Following the storm, the data collection forms were collected and then reviewed for accuracy and completeness. If errors or omissions were found, the garages were contacted to obtain additional information. Following the review, the data were transferred to a spreadsheet and then forwarded to NCAR to be incorporated into the MDSS.

CONCLUSIONS AND RECOMMENDATIONS

Following the field demonstration, a MDSS stakeholders' meeting was held in Des Moines on June 17–18, 2003, to discuss the outcome of the project. Interested parties from across the United States, as well as from other countries, including Great Britain and Canada, were on hand to provide input to the MDSS project.

The following recommendations were put forth following this past winters' field demonstration:

- The MDSS weather predictions need improvement. The MDSS failed to pick up light snow events. While these events do not produce a lot of precipitation, operationally, the garages still need to deploy personnel and equipment to clear the roadways. The garages also reported that the start time for events were not as accurate as they would have liked. To effectively deploy the pre-treatments, it is critical for the field supervisors to know the start time of precipitation events.

- During the field tests, system users in the garages also requested refinements in the display portion of the MDSS interface. The display on the screen uses dots to indicate weather conditions. The users of the systems asked that the weather data be shown, along with wind direction and velocity, so they might more easily obtain the weather conditions.

- An important aspect of the field test was collecting weather data from the garages and equipment operators. To collect the data, we used paper data collection forms that the equipment operators and supervisors completed. This proved to be a cumbersome and time-consuming process. The field staff strongly recommends that further data collection be automated to allow the equipment operators to focus on the task at hand. Data, such as plow position, location, spreader rates, and pavement temperature can be collected with

the existing GPS and Iowa DOT AVL units. Other data, such as weather and traffic conditions will still have to be collected manually.

A further recommendation is to tie the MDSS into the chemical inventory system to track chemical usage and assist in keeping the chemical inventory at optimal levels.

During the winter of 2003–2004, the Iowa DOT will again work with the MDSS team to field test the MDSS. The Ames and Des Moines garages will again be used to test the interface and collect road and surface condition data for the model and to field test the treatment recommendations. The MDSS shows promise in assisting winter maintenance managers in fighting winter storms. If fully deployed, the MDSS could assist winter maintenance managers statewide with prompt, accurate, tactical information to alleviate the effects of winter weather on the roadways. By providing as many probabilistic weather forecasts and treatment recommendations as possible to the field-level supervisors, better-informed decisions on clearing the roadways in the most cost effective manner can be made.

ADDITIONAL RESOURCES

Ketcham, S., D. Minsk, R. Blackburn, and E. Fleege. *Manual of Practice for an Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel.* US Army Cold Regions Research and Engineering Laboratory, June 1996. http://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm/.

The Maintenance Decision Support System (MDSS) Project. http://www.rap.ucar.edu/projects/rdwx_mdss/index.html.

A Tutorial on the Maintenance Decision Support System Field Demonstration Software, February 4, 2003 http://www.rap.ucar.edu/projects/rdwx_mdss/iowa.html.

APPENDIX A

Garage Data Collection Forms

MDSS Supplemental Daily Log: AMES GARAGE

Driver Name:	Truck ID:	
Shift Start Date:	Shift Start Time:	(24 Hr.)
Shift End Date:	Shift End Time:	(24 Hr.)
Comments:		

Segment ID	Route	Start MP	End MP
1A	U.S. 65	98.38	112.09
1B	U.S. 30	164.93	172.30
2	U.S 65	112.09	132.59
3	I-35	111.60	128.46
4	I-35	96.60	111.60
5	U.S. 30	142.88	164.93
6	IA 210	13.79	34.43

Directions: Use 1 Column per Run. Use a New Column if one of the following applies:

1). you are starting a new segment

2). you make a significant change on the same segment (such as a change of application rate)

3). you begin a second treatment on the same segment

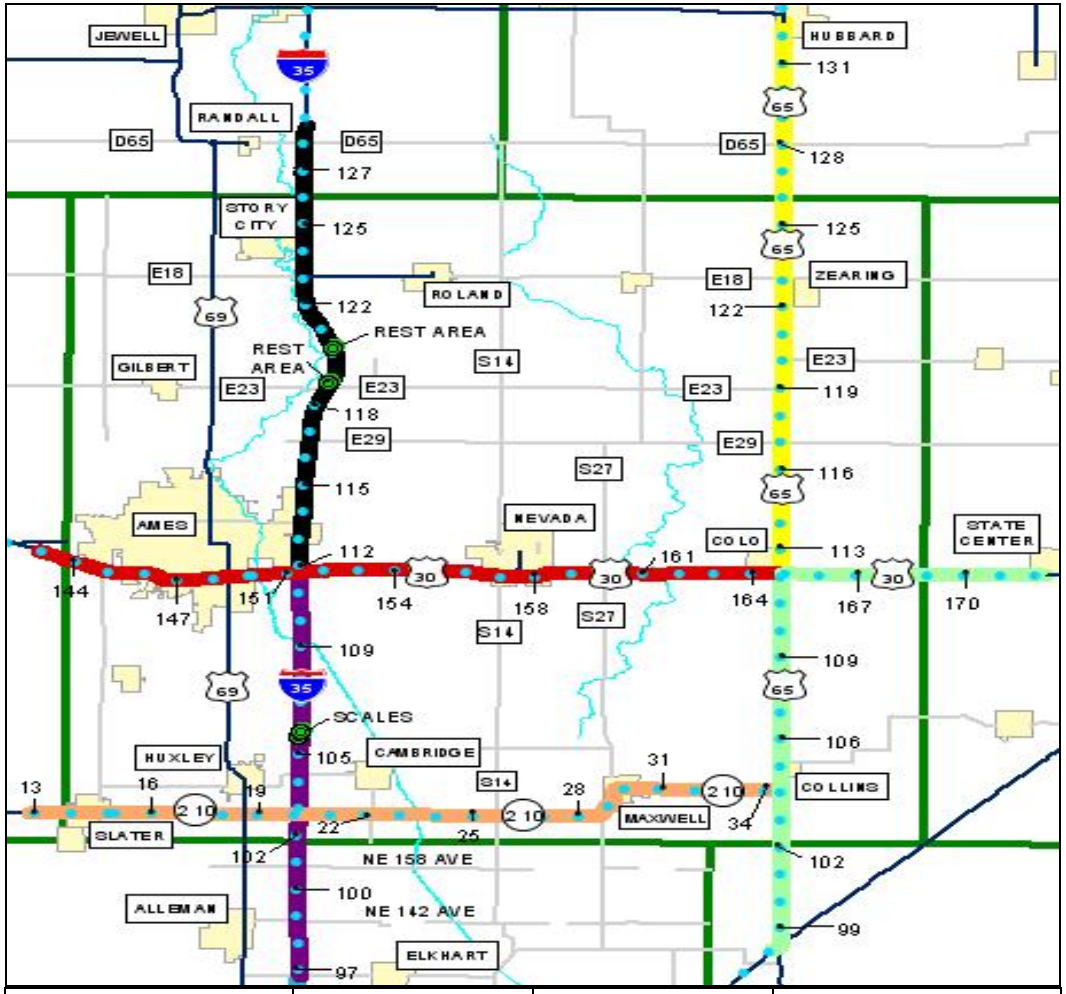
Mark up the map on the reverse side with any additional details that makes the report of your treatment more complete.

	Run 1	Run 2	Run 3`	Run 4
Segment ID Covered (circle one)	**1A 1B 2 3 4 5 6**	**1A 1B 2 3 4 5 6**	**1A 1B 2 3 4 5 6**	**1A 1B 2 3 4 5 6**
Treatment Start Time (24 Hr.)				
Treatment End Time (24 Hr.)				
Did You Plow?	YES NO	YES NO	YES NO	YES NO
Lane Materials Applied On	Driving Passing	Driving Passing	Driving Passing	Driving Passing
Pre-Storm Chemical Application **Note amount**	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile
During Storm Chemicals applied? **(Circle type)** **Note amount**	NONE Salt Calcium Iceban Iceslicer brine _____gal or lb/lane-mile	NONE Salt Calcium Iceban Iceslicer brine _____gal or lb/lane-mile	NONE Salt Calcium Iceban Iceslicer brine _____gal or lb/lane-mile	NONE Salt Calcium Iceban Iceslicer brine _____gal or lb/lane-mile
Abrasives applied? (amount)	_____lb/lane-mile	_____lb/lane-mile	_____lb/lane-mile	_____lb/lane-mile
Road condition before treatment **(Circle all that apply)**	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow
Road condition after treatment? **(Circle all that apply)**	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown
Estimate Traffic Volume (circle one)	low normal high	low normal high	low normal high	low normal high
Traffic speed (circle one) **(approx. mph)**	Stopped slow normal (<5) (6 – 45) (45 +)	Stopped slow normal (<5) (6 – 45) (45 +)	Stopped slow normal (<5) (6 – 45) (45 +)	Stopped slow normal (<5) (6 – 45) (45 +)
Treatment Specific Comments				

Mark up this map with any information that adds detail to the treatment information from the front of this form (examples: show the treatment route, highlight areas of drifts, and indicate accident locations). Use the boxes provided to organize the details. Draw a line from the box to the highlighted region.

Run 1 Details

Run 2 Details



Segment ID	Color	Segment ID	Color
1A / US 65 S	Green	1B / US 30	Green
2 / US 65 N	Yellow	3 / I-35 N	Black
4 / I-35 S	Purple	5 / US 30	Red
6 / IA 210	Orange		

Run 3 Details

Run 4 Details

MDSS Supplemental Daily Log: DES MOINES NORTH GARAGE

Driver Name:	Truck ID:
Shift Start Date:	Shift Start Time: (AM/PM)
Shift End Date:	Shift End Time: (AM/PM)
Comments:	

Segment ID	Route	Start MP	End MP
1	I-35	93.20	96.60
2	I-35	86.94	93.20
3	I-80	137.82	142.10
4	I-35/I-80	131.50	137.82
5	I-235	8.80	14.26
6	IA 415	0.00	21.93

Directions: Use 1 Column per Treatment. Use a New Column if one of the following applies:

1). you are starting a new segment

2). you make a significant change on the same segment (such as a change of application rate)

3). you begin a second treatment on the same segment

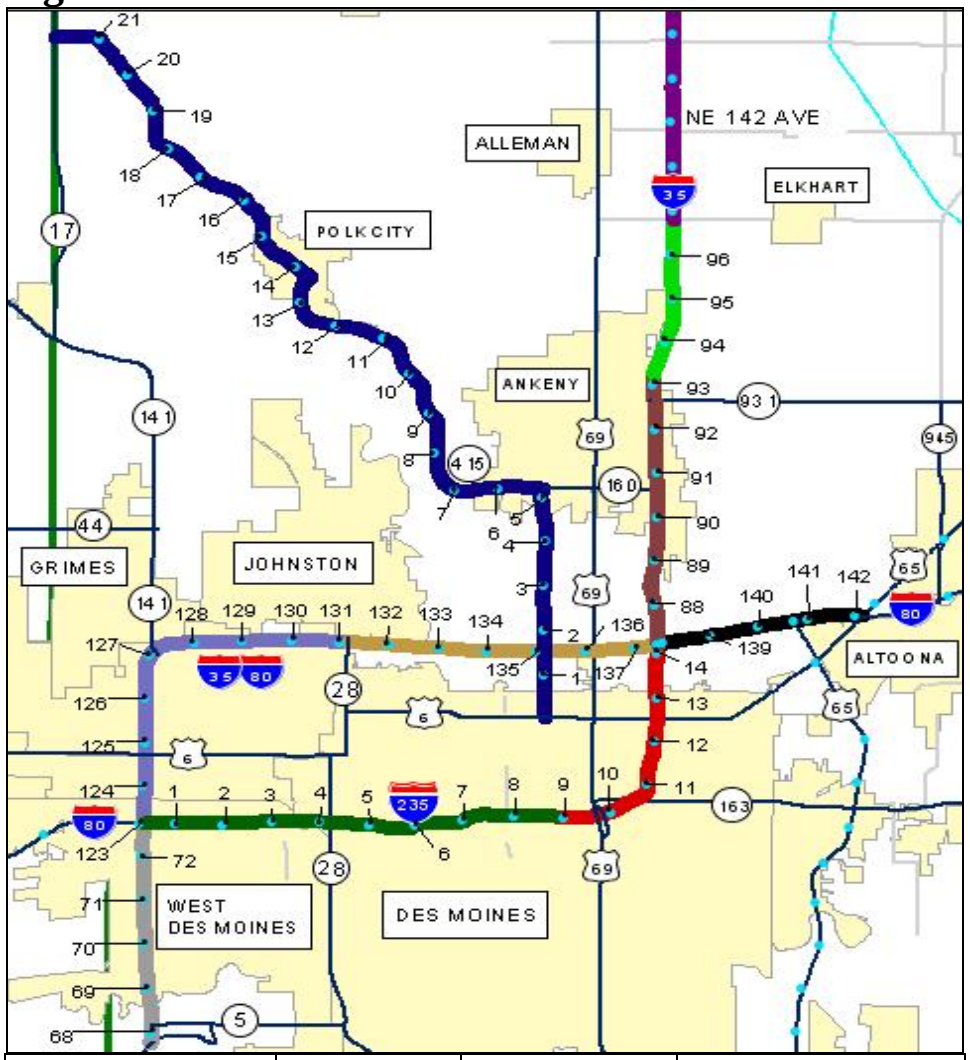
Mark up the map on the reverse side with any additional details that makes the report of your treatment more complete.

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Segment ID Covered (circle one)	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Treatment Start Time	AM/PM	AM/PM	AM/PM	AM/PM
Treatment End Time	AM/PM	AM/PM	AM/PM	AM/PM
Did You Plow?	YES NO	YES NO	YES NO	YES NO
Lane Materials Applied On	Driving Center Passing	Driving Center Passing	Driving Center Passing	Driving Center Passing
Pre-Storm Chemical Application Note amount	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile
During Storm Chemicals applied? (Circle type) **Note amount**	NONE Salt Brine _____gal or lb/lane-mile	NONE Salt Brine _____gal or lb/lane-mile	NONE Salt Brine _____gal or lb/lane-mile	NONE Salt Brine _____gal or lb/lane-mile
Abrasives applied? (amount)	_____lb/lane-mile	_____lb/lane-mile	_____lb/lane-mile	_____lb/lane-mile
Road condition before treatment (Circle all that apply)	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow
Road condition after treatment (Circle all that apply)	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown
Estimate Traffic Volume (circle one)	low normal high	low normal high	low normal high	low normal high
Traffic speed (circle one)	stopped slow normal	stopped slow normal	stopped slow normal	stopped slow normal
Treatment Specific Comments				

Mark up this map with any information that adds detail to the treatment information from the front of this form (examples: show the treatment route, highlight areas of drifts, and indicate accident locations). Use the boxes provided to organize the details. Draw a line from the box to the highlighted region.

Treatment 1 Details

Treatment 2 Details



Segment ID	Color	Segment ID	Color
1	Green	2	Brown
3	Black	4	Gold
5	Red	6	Blue

Treatment 3 Details

Treatment 4 Details

MDSS Supplemental Daily Log: DES MOINES WEST GARAGE

Driver Name:	Truck ID:	
Shift Start Date:	Shift Start Time:	(AM/PM)
Shift End Date:	Shift End Time:	(AM/PM)
Comments:		

Segment ID	Route	Start MP	End MP
1	I-35/I-80	123.53	131.50
2	I-35	67.89	72.70
3	I-235	0.00	8.80

Directions: Use 1 Column per Treatment. Use a New Column if one of the following applies:

1). you are starting a new segment

2). you make a significant change on the same segment (such as a change of application rate)

3). you begin a second treatment on the same segment

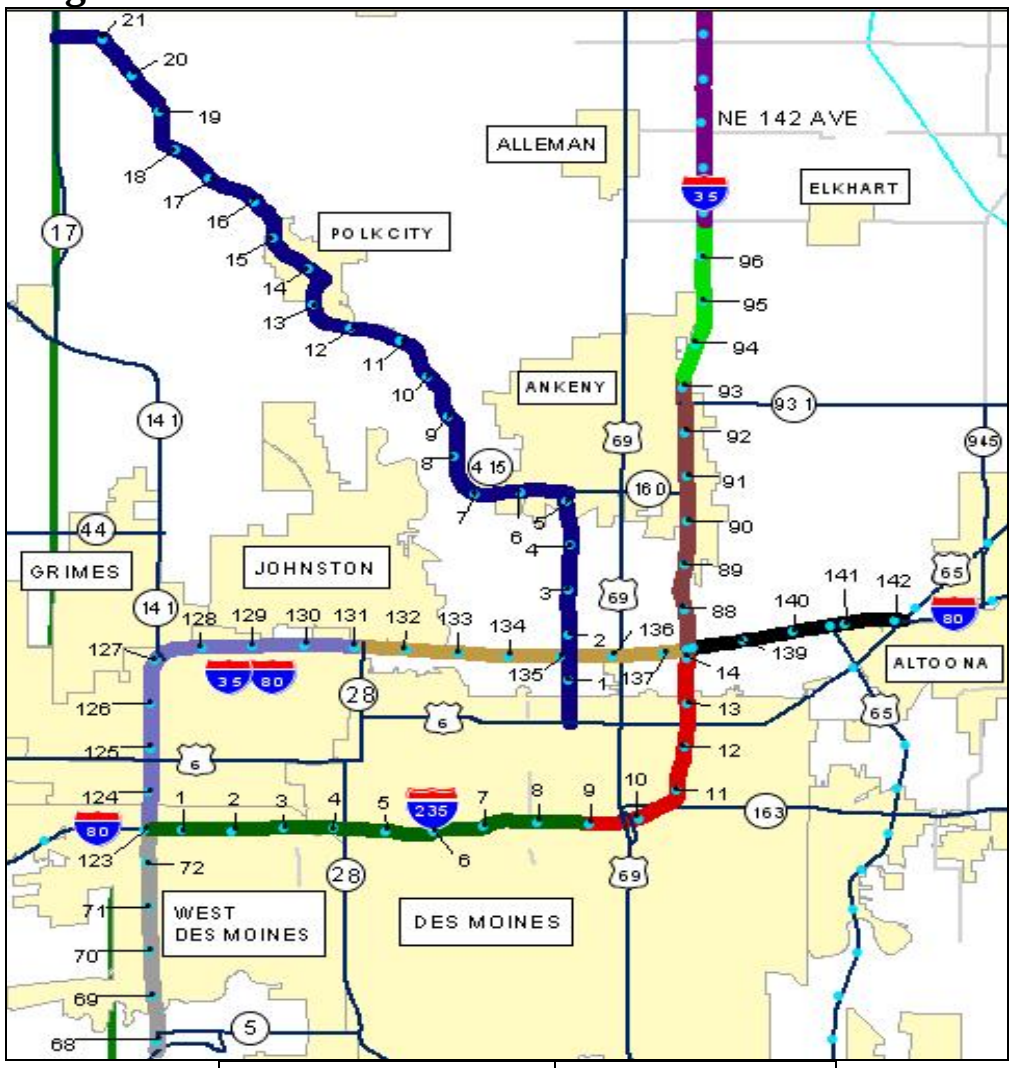
Mark up the map on the reverse side with any additional details that makes the report of your treatment more complete.

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Segment ID Covered (circle one)	1 2 3	1 2 3	1 2 3	1 2 3
Treatment Start Time	AM/PM	AM/PM	AM/PM	AM/PM
Treatment End Time	AM/PM	AM/PM	AM/PM	AM/PM
Did You Plow?	YES NO	YES NO	YES NO	YES NO
Lane Materials Applied On	Driving Center Passing	Driving Cennter Passing	Driving Center Passing	Driving Center Passing
Pre-Storm Chemical Application **Note amount**	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile	YES NO Brine _____gal/lane-mile
During Storm Chemicals applied? **(Circle type)** **Note amount**	NONE Salt Brine _____gal or lb/lane-mile	NONE Salt Brine _____gal or lb/lane-mile	NONE Salt Brine _____gal or lb/lane-mile	NONE Salt Brine _____gal or lb/lane-mile
Abrasives applied? (amount)	_____lb/lane-mile	_____lb/lane-mile	_____lb/lane-mile	_____lb/lane-mile
Road condition before treatment **(Circle all that apply)**	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow	dry wet slushy icy snow-packed road frost drifting snow
Road condition after treatment **(Circle all that apply)**	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown	dry wet slushy icy snow-packed drifted snow unknown
Estimate Traffic Volume (circle one)	low normal high	low normal high	low normal high	low normal high
Traffic speed (circle one)	stopped slow normal	stopped slow normal	stopped slow normal	stopped slow normal
Treatment Specific Comments				

Mark up this map with any information that adds detail to the treatment information from the front of this form (examples: show the treatment route, highlight areas of drifts, and indicate accident locations). Use the boxes provided to organize the details. Draw a line from the box to the highlighted region.

Treatment 1 Details

Treatment 2 Details



Segment ID	Color
1	Light Blue
2	Grey
3	Green

Treatment 3 Details

Treatment 4 Details

APPENDIX B

Highway Maintenance Concept Vehicle Data

Highway Maintenance Concept Vehicle Event Report for January 30, 2003

Add Record

Totals

Print

Add Equipment data

WINTER MAINTENANCE EVENT REPORT

STATE:

REPORT NO.

COUNTY:

WEEK ENDING (Fri @ Midnight):

DISTRICT:

CITY:

TRUCK ID	30144
CONSOLE NUMBER	DCS710C
EVENT TYPE (S I)	
STORM START(date and time)	
CREW OUT(date and time)	02:24:24 ,1/30/03
STORM END(date and time)	
CREW IN(date and time)	08:10:34 ,1/30/03
AVERAGE AIR TEMP	13
AVERAGE PAVEMENT TEMP	12.4
PAVEMENT BARE(date and time)	
TYPE OF PRECIPITATION	
AVERAGE SNOW AMOUNT	
TOTAL SALT USED(tons)	6.8
TOTAL PROD1 USED	0
TOTAL PROD2 USED	0
TOTAL SAND USED(cy)	3.1
PREWETTING AGENT USED	
TOTAL PREWET USED (gal)	3
ANTI-ICE AGENT USED	
TOTAL ANTI-ICE USED(gal)	539
TOTAL UNIT HOURS	5:46:10
DISTANCE PLOW USED(miles)	
DISTANCE LEFT WING USED(miles)	
DISTANCE RIGHT WING USED(miles)	
DISTANCE SCRAPER USED(miles)	
CREW SIZE	
TOTAL REGULAR HOURS	
TOTAL OVERTIME HOURS	
SCANCAST USED? (Y N)	
SCANCAST ACCURACY (G F P)	

HMCV Daily Work Sheet, as downloaded from the AMS 200, for February 17, 2003

Daily Work Sheet - Snow Removal, Ice Control & Equipment

Equipment	Equipment usage time	Equipment usage distance (miles)
Plow	0:00:00	0
Left Wing	0:00:00	0
Right Wing	0:00:00	0
Scraper	0:00:00	0

Date: 2/17/2003

Truck ID: 30144

Console ID: DCS710C

Operator ID:

No equipment data collected in this pass

Start Time	Stop Time	Hours Master On	Average Speed (mph)	Spreading Distance (mi)	Sand (tons)	Salt (tons)	Prod1 (tons)	Prod2 (tons)	Prewet (gal)	Anti ice (gal)
22:15:58	1:27:56	3:11:58	2.09	6.70	0.00	6.60	1.60	0.00	0.00	19182.00
TOTALS		**3:11:58**	**2.09**	**6.70**	**0.00**	**6.60**	**1.60**	**0.00**	**0.00**	**19182.00**

The worksheet shows time of day of the operation, average speed of the vehicle, distance of the operation and how much material was spread. On this date, the report indicates harsh conditions, due to the average speed and distance that the vehicle traveled and the amount of material that was deployed.