QUARTERLY PROGRESS REPORT

to the

CLEAR ROADS PANEL
STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

on

State Project ID #0092-06-23
Pooled Fund Project #TPF-5(092)
Contract #406028
Purchase Order #TRG3403142

DETERMINING EFFECTIVENESS OF DEICING MATERIALS AND PROCEDURES

for the period

January 1, 2008 to March 31, 2008

SUBMITTED BY

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April 11, 2008

Preface

This quarterly progress report summarizes the progress of the research team during the first calendar quarter of 2008 to accomplish the research objectives of Wisconsin State Project ID #0092-06-23, “Determining Effectiveness of Deicing Materials and Procedures”. The project team started to work on the study on August 1, 2006 the contract starting date. This report covers the project effort from January 1 through the end of the quarter on March 31, 2008.

Edward J. Fleege
Principal Investigator, and
Overall Project Manager

Section 1
Introduction

Research Problem Statement

Snow and ice control on the U.S. highway system consumes over $2 billion in direct costs each year. Indirect costs associated with corrosion and environmental impacts add at least $5 billion. State and local agencies are employing solid and liquid chemicals, abrasives, and mechanical methods - individually or in combination- in their snow and ice control operations. However, the process of selecting the ideal snow and ice control treatments that meet highway agency objectives can be difficult and costly. Research by the Strategic Highway Research Program (SHRP), the Federal Highway Administration (FHWA), the American Association of State Highway Officials (AASHTO), the National Cooperative Highway Research Program (NCHRP), and other organizations in the United States and other countries has tried to address many of the issues associated with snow and ice control treatments. However, both the expenditure level and the potential environmental impact of winter chemicals have also lead highway agencies to search for and implement more effective methods of winter maintenance; such as electronic ground-speed-oriented spreader controls, thermal mapping, pre-wetting, and anti-icing. These technologies have the potential of providing more effective and timely removal of snow and ice while requiring significantly less amount of chemicals.

Most of these alternative maintenance techniques require installation of advance information technologies such as road weather information systems (RWIS), automatic vehicle location (AVL) and fleet management systems and wireless communication to obtain real-time information on weather and road conditions. As a result these new solutions incur greater capital and operating costs than conventional operations. This difference in cost structure has lead to a wide spread interest and debate on the cost-effectiveness of these new methods and technologies.

Highway agencies are under increasing budget and environmental constraints to meet the expected level of service. Salt and fuel prices are increasing and agencies have fewer workers for operations. Chemicals that are being used on the roadways are affecting ground water, lakes and rivers. Highway agencies are now asking if the developed guidelines and/or their current practices are the “best value” for chemical application during snow and ice control operations. Field-testing procedures are needed to evaluate the effectiveness of the various winter chemical application rates.

The aim of this study is to develop testing guidelines for evaluation the performance of various winter road chemicals and to produce a portable test method that can be used by any interested highway agency in a variety of locations under a variety of winter conditions. The outcome of the study will provide state and local highway winter maintenance agencies with the ability to refine their current best practices to provide the traveling public with good service at an acceptable cost while protecting the environment.

Research Objective and Scope

The overall objective of the research is to develop field testing procedures and guidelines for determining the effectiveness of various winter chemicals at various application rates.

The scope of the research is divided into three parts. Part 1 will be the development of an evaluation plan. This evaluation plan will be designed to test the effectiveness of any winter chemical in any winter weather condition. The plan will specify the minimum equipment and data needed to conduct such evaluations.

Part 2 will be the small pilot test on proposed I-94 segment near Alexandria, MN during the 2007 – 2008 winter in an effort to validate the evaluation plan that was developed in Part 1. Two Mn/DOT snowplow trucks with ground-speed controllers will be available for this pilot test. Data collection forms will be developed and provided to record the necessary data from the snowplow truck operations.

Part 3 will be the final report that documents the findings and conclusions of this study. This report will include the testing guidelines and procedures that were developed along with the minimum equipment and data requirements, results of the pilot test, and recommendations for modifications to the testing procedures.

Research Approach

The research approach described below is designed to develop guidelines for testing the effectiveness of any winter chemical in any winter weather condition and to produce a portable test method that can be used by any interested highway agency in a variety of locations under a variety of winter conditions. In addition, a small pilot test will be conducted at the test section on the by-pass around Alexandria.

The research plan consists of three parts. A brief paragraph summarizing each part is presented below.

Part 1, Evaluation Plan

The evaluation plan will be developed following the gathering of related research and guidelines from around the country to understand the state of practice in testing the performance of winter chemicals and the use of sensor data in that evaluation. This information will be obtained by conducting an extensive literature search along with research on evaluating various sensors that are used for decision-making on maintenance operations. In addition to a review of the pertinent reports, domestic and international sources of information will be contacted.

Access will be obtained to the various archived databases. A through review will be made to acquire an understanding of the data being reported from the various systems, e.g. RWIS, MDSS, SAIL II, camera and Geonor T-200B series all weather precipitation gauge.

Using the gathered information and data, an evaluation plan will be developed that will identify the procedures to be used in evaluating the performance and optimum application rates of chemical treatments. In addition to the evaluation plan, a proposal will be developed detailing how the pilot test will be conducted.

Part 2, Pilot Test

The Pilot Test will be conducted to validate the Evaluation Plan developed in Part 1 of this project. The small pilot test will be conducted on I-94 between mile points 97 and 106 during the winter season of year 2007 –2008. During the pilot test, an attempt will be made to gather data across a representation sampling of winter events (freezing rain, snow, etc.). A minimum of 5 and a maximum of 10 events will be recorded and analyzed.

Within Part 2, there will be four activities involved in carrying out the pilot test. The first activity will be the development of forms that will be used to collect data and information. The second action will be to train the operators of the two snowplow trucks on the procedures to be used in completing the forms that are relative to their operations. The third action will be the data collection, assembling the data, and monitoring the integrity and accuracy of the data. The final activity will be analyzing the data from the pilot test.

Part 3, Reports

A Final Report will be issued in Part 3 to provide documentations of the findings and recommendations of this project. The Final Report will include an executive summary of the study plus provide the results of the literature search. This report will also include the testing guidelines and procedures that were developed including the minimum amount of equipment and data requirements needed to conduct a successful evaluation of the performance of various winter road chemicals. The documentation will include the results of the pilot test, and recommendations for modifications to the testing procedures that resulted from the findings of the pilot test. A draft of the Final Report will be submitted to Clear Roads TAC members approximately two months prior to the end of the project for their review and request for any modifications. A face-to-face meeting with the Clear Roads TAC members will take place one month prior to the end of the project to discuss the study findings and recommended revisions to the Final Report.

Section 2
Progress Schedule

The research on the project began on August 1, 2006. The project was to be conducted over a 12-month period of performance and be completed by July 31, 2007. On January 11, 2007 the completion date was extended to August 31, 2008. The revised planned schedule of activities by parts is presented in Figure 1. This schedule reflects the start date of August 1, 2006 and a revised completion date of August 31, 2008.

The revised planned progress schedule is presented in Figure 2. Figure 2A of the progress schedule illustrates the overall planned project schedule by part on a monthly basis. Figure 2B shows the planned schedule of expenditures over the project period. Figure 2C shows the planned schedule of percent completion over the project period. The progress schedule will be updated each month during the project period for internal review. The updated schedule will be presented in each quarterly report.

Determining Effectiveness of Deicing
Materials and Procedures

Planned Schedule of Activities

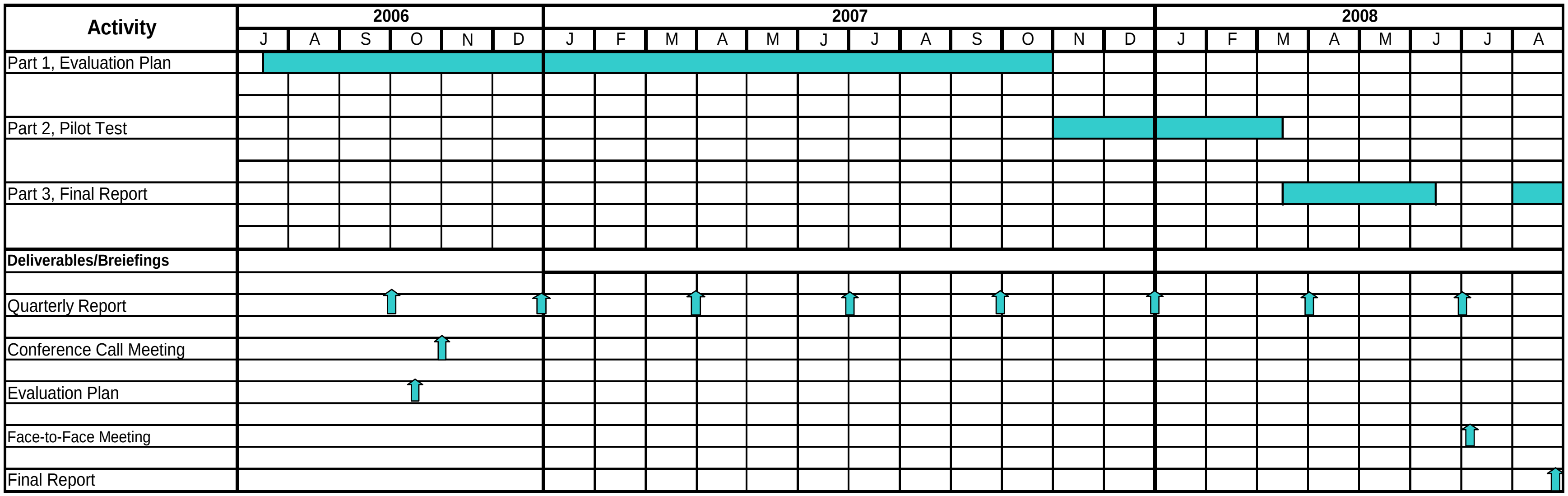


Figure 1 – Revised Planned Schedule of Activities

CLEAR ROADS RESEARCH PROGRAM
WISCONSIN DEPARTMENT OF TRANSPORTATION

PROGRESS SCHEDULE

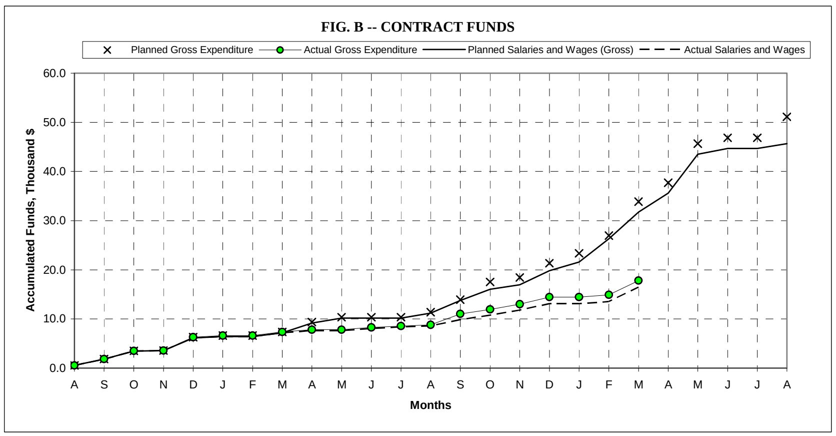
Project No. TPF - 5(092), Determining Effectivenes of Deicing Materials and Procedures — Year: 2008 — Quarter: First

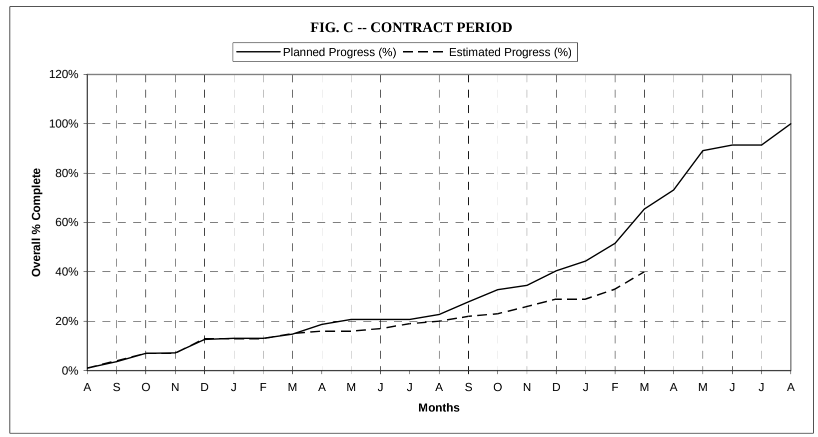
Research Agency: Edward J. Fleege

Principal Investigator: Edward J. Fleege

RESEARCH	2006					2007												2008								ESTIMATED %
ACTIVITY	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	COMPLETION
PART 1	3	12	22	23	41	42	42	47	60	67	67	67	73	90	100											99
PART 2															6	12	31	44	67	100						60
PART 3																				10	30	72	78	78	100	
OVERALL % COMPLETED	1%	4%	7%	7%	13%	13%	13%	15%	16%	16%	17%	19%	20%	22%	23%	26%	29%	29%	33%	40%						40

FIG. A -- OVERALL PROJECT SCHEDULE





Funds Expended	35%
Contract Amount	$51,126
Expended This Quarter	$3,375
Total Exp. to Date	$17,813
Balance	$33,313

Time Expended:	79.9%
Starting Date:	August 1, 2006
Completion Date:	August 31, 2008

Salaries and Wages Estimated This Quarter:	$11,938
Salaries and Wages Spent This Quarter:	$3,375
Accumulated Salaries and Wages To Date:	$13,088

Figure 2 – Project Progress Schedule

Section 3
Accomplishments During the Reporting Period

Overview of Current Quarterly Activities

The project team worked on Parts 1 and 2 of the project during the first quarter of 2008. This report covers the project effort through the end of the quarter on March 31, 2008. A majority of the work effort was spent this reporting quarter on Part 2, Pilot Test and a very limited amount of work was done on Part 1, Evaluation Plan. The results of these activities are described below.

Part 1, Evaluation Plan

The research team worked on four tasks of Part 1 during the three months of the fourth quarter of 2007. These activities were; Task 1 – Conduct Literature Search, Task 2 - Review Electronic Data, and Task 6 – Quarterly Report.

Task 1 – Conduct Literature Search

The results of the literature search revealed that highway agencies are searching for ways to measure performance of snow and ice control operations. Performance measures generally fall into three categories: inputs, which look at the resources dedicated to snow and ice control operations (such as the dollars spent, tons of winter chemicals used or staff time consumed); outputs, which look at the products produced (such as miles of pavement plowed or deiced); and outcomes, which look at the impacts on the goals of the agency (such as discernible reductions in road closure, and reductions in snow and ice related accidents). Another way of looking at outcomes is to measure the percentage of winter maintenance responses to winter storm events that met or exceeded the agency’s standards for snow and ice control operations.

One of the procedures that have been developed to assess the efficacy of a chemical treatment is based primarily on the experience from NCHRP 6-13 and FHWA TE#28 projects (1,2). The procedures include level of service (LOS) considerations; performance measures used to assess LOS; snow and ice control strategies and their application to support LOS choices; snow and ice control operational considerations; performance – based LOS; snow and ice control treatments; and data and equipment required for evaluation purposes.

A popular way to define LOS is in terms of results, at various points in time. Examples include maximum accumulation of snow on highways during a storm; absence of pack or bond during a storm; bare/wet pavement (x) hours after end-of-event; plowed and sanded (x) hours after end-of –event; friction number >(y), (x) hours after end-of-event; road plowed; and road passable.

Blackburn, Amsler and Bauer (1,3,4) defined Levels of Service (LOS) within snow and ice control as a set of operational guidelines and procedures that establish the timing, type, and frequency of treatments. The maintenance actions are directed toward achieving specific pavement conditions goals for various highway sections. They have reported that a variety of performance measures relative to LOS have been developed. These include (in order of popularity) pavement conditions (visual) at various points in time (some agencies use pictorial reference templates as an aid to condition observers); performance indices that relate to the amount of time pavement areas are snow/ice covered to total storm time (visual); reports cards (customer satisfaction surveys); pavement friction measurements at various points in time; and rating pavement slipperiness at various points in time based on vehicle handling characteristics. The visual approach appears to be gaining in popularity in the United States and abroad. Examples of visual characterization of roadway surfaces include the following:

- Centerline bare,
- Wheel path bare,
- Loose snow covered (percent area and depth),
- Packed snow covered (percent area and depth),
- Bare (percent area),
- Thin ice covered (percent area),
- Thick ice covered (percent area),
- Dry,
- Damp,
- Slush (percent area and depth),
- Frost, and
- Wet.

Using the descriptors above together with traffic flow and other visual information, a Pavement Snow and Ice Condition (PSIC) can be established for a point in time.

The Province of Alberta initiated research projects to identify and develop potential performance measures for snow and ice control operations. Cowe Falls, Jurgens and Chan (5,6) reported on the development of preliminary winter performance measures using a combination of speed data from weigh-in-motion (WIM) installations, winter driving road reports from the Alberta Motor Association (AMA) Road Reports and weather reports from Environment Canada. WIM speed data in conjunction with road reports showed promise as a performance measure based upon the analysis of one winter.

In a later report (7) these same three researchers conducted additional work with respect to the speed performance measures. Two factors were analyzed, namely the reduction in vehicular speed due to severe weather events, and the time for the traffic stream to recover after a severe event. They defined a severe weather event as being: snow accumulation greater than 3 inches or, visibility less than half mile, or the occurrence of freezing rain. Normal speed was defined as the mean speed minus one standard deviation.

Their finding suggested that speed reduction, roadway condition, and time to recover as a result of snow and ice events could be used for performance measurement. In addition, speed reductions are repeatable (coming from objectively derived data), are sensitive to snow and ice events, and are statistically different between sites. They also determined that winter storm events did not have major impact on traffic volumes and thus traffic counts could not be used to measure performance of winter maintenance activities.

In 1996, the Washington State Department of Transportation implemented a system of performance measures and service levels for highway maintenance activities known as the

Maintenance Accountability Process (MAP). At that time, the MAP did not include service levels for snow and ice control activities based field measurements. To gain similar benefits for snow and ice control activities, a pilot study (8,9) that included performance measures, service levels, and field measurement protocols was developed and implemented. Two performance measures were used: the amount of roadway traction provided at the time of a field measurement, and the time taken to regain bare pavement after the end of a snowfall event. Although the conclusions reached from the pilot study revealed the need for improvement and revision, the basic principles in this system were determined to be sound and suitable for future incorporation into the MAP.

Lee and Ran (10) from the University of Wisconsin at Madison initiated a study in 2003 to develop winter maintenance performance measures using speed data from automatic traffic recorders (ATRs) and winter storm report data from the Wisconsin Department of Transportation. Their approach was an attempt of a new method for measuring the performance of winter maintenance. The authors proposed to define a term as speed recovery duration to mean as the time between end of snow event and vehicle speed recovered to the normal speed.

However, this recovery duration did not show a direct relationship to weather factors in a snow event such as temperature, snow amount, and average amount of snow. Their findings did show that the maximum speed reduction in a snow event and the snow event duration could be used to illustrate the "vehicle speed reduction" in a snow event.

These same researcher two years later, conducted additional research work (11) by analyzing major contributing variables to "speed recovery duration," which is the time interval from when a winter weather event starts to when the roadway surface conditions is wet using a regression tree algorithm "GUIDE" (Generalized, Unbiased, Interaction Detection and Estimation). As a result of the study, a variable, "PassRatio," was developed. It was defined as the time interval between when a "winter weather event starts" and when the "roadway becomes passable" over the duration of the winter weather event.

Lee et.al. later conducted another study using vehicle speed data (12). Generally the storms that were studied in this research had duration around 10 to 11 hours and maintenance operation lasting 14 to 15 hours. In the study, the average speed was found by taking hourly speed data from six different dates: three dates from the three weeks preceding the storm date, and three dates from the three weeks following the storm data. They also intuitively selected as a beginning point of speed reduction, a value of 8 percent below the average traffic speed. This point is the time after the snow storm starts and at which traffic begins to slow down. Vehicle speeds started to drop less than an hour after the storm started, and the maximum speed reduction (MSR) was usually attained within 3-5 hours. Vehicle speeds recovered within one hour or less after the roadway pavement surface reached the bare/wet condition. This study confirms that vehicle speed appears to be a good measure of representing both driving conditions during weather events and snow and ice control operation performance. The study also found that traffic counts could not be used to measure winter maintenance performances.

References

1. Blackburn, R. R.; Bauer, K. M.; Amsler, D. E.; Boselly, S. E.; McElroy, A. D., "Snow and Ice Control: Guidelines for Materials and Methods" *NCHRP No. 526*, Transportation Research Board, Washington, D. C. (2004) http://gulliver.trb.org/publications/nchrp/nchrp_rpt_526.pdf
2. Ketchan, S A; Minsk, LD: Blackburn, RR; Fleege, EJ. "Manual of Practice For an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel" Cold Regions research and Engineering Laboratory; Federal Highway Administration, Mclean, VA (1996)
3. Blackburn, R. R.: Amsler, D. E.; Bauer, K. M. "Guidelines for Snow and Ice Control: Materials and Methods" 10th AASHTO/TRB Maintenance Management Conference, Duluth, Minnesota, (2003) p 165 http://gulliver.trb.org/publications/circulars/ec052.pdf
4. Blackurn, R.R.: Amsler, D. E.; Bauer, K. M., "Guidelines for Snow and Ice Control Materials and Methods" Sixth International Symposium on Snow Removal and Ice Control Technology, *Transportation Research E-Circular 063: Snow Removal and Ice Control Technology*, Spokane, Washington (2004) pp 31-49 http://gulliver.trb.org/publications/circulars/ec063.pdf
5. Cowe Falls, L.;Jurgens, R.; Chan, J., "Performance Measure for Snow and Ice Control in the Province of Alberta" Presented at the 85th Annual Meeting of the Transportation Research Board, Washington, D.C. (2006) CD-ROM
6. Jurgens, R.; Chan, J.; Cowe Falls, L., "Winter Performance Measures in Alberta, Canada" 11th AASHTO/TRB Maintenance Management Conference, Charleston, South Carolina, (2006) pp 91-102
7. Cowe Falls, L.;Jurgens, R.; Chan, J., "Effect of Winter Events on Highway Performance in the Province of Alberta" Presented at the 87th Annual Meeting of the Transportation Research Board, Washington, D.C. (2008) CD-ROM
8. Baroga, E V, "Washington State Department of Transportation's 2002-2003 Salt Pilot Project" Sixth International Symposium on Snow Removal and Ice Control Technology, Spokane, Washington, (2004), pp 282-295 http://gulliver.trb.org/publications/circulars/ec063.pdf
9. Baroga, E.V. "Performance Measures for Snow and Ice Control Activities", Ninth AASHTO/TRB Maintenance Management Conference, Juneau, Alaska, (2000) pp 75-80
10. Lee, C. and Ran, B., "A Pilot Study to Measure the Potential of Using Speed Recovery Duration as a Winter Maintenance Performance Measure" Presented at the 83rd Annual Meeting of the Transportation Research Board, Washington, D.C. (2004) CD-ROM
11. Lee, C.; Ran, B., "The Analysis of Winter Maintenance Logs using Regression Tree Algorithm." Preprint 85th Annual Meeting of the Transportation Research Board, Washington, D. C. (2006) CD-ROM
12. Lee, C., Loh, W., Qin, X., Sproul, M., "Development of New Performance Measure for Winter Maintenance using Vehicle Speed Data" Preprint 87th Annual Meeting of the Transportation Research Board, Washington, D.C. (2008) CD-ROM

Task 2 – Review Electronic Data

1. The two traffic detector sensors (Wavetronics) at the Alexandria ESS site have been brought on line and are reporting data. The information being reported, among others, is:

the average vehicle speed calculated as a vehicles travel though each traffic zone, number of vehicles that were detected passing through a traffic zone, and percentage of time that a traffic zone is occupied for each length of a single collection interval for the sensor in seconds. In the beginning, traffic data were being reported at intervals of every 15 minutes. During the winter season, Mn/DOT revised the reporting interval to every 3 minutes.

2. Data from the Geonor T-200B is still not available.
3. The Automated Vehicle Location (AVL) (IWAPI) system has been installed and reporting. However, the data are coming back every five minutes and due to the amount of activity in the area of Alexandra, it is not possible to determine when the trucks are operating on the East Bound roadway or the West Bound roadway.

Task 4 – MDSS Recommendations

The values of application rates being reported in the archived "Reported Action" by the operators for snow and ice control operations did not appear to be realistic, e.g. "prewet NaCl @11 lbs per lane mile." This issue was addressed by John Mewes of Meridian Environmental Techlnology, Inc. by the following response.

"Regarding the other questions, MDSS averages the material application rates it detects across each maintenance action. So, if the truck reports 200 lbs/ln-mi at one point and 0 lbs/ln-mi at another they might average out to 100 lbs/ln-mi. Since there are typically many such report points associated with a single maintenance action the cumulative application rate can end up anywhere in between the 0 and 200 lbs/ln-mi application rates. This said, I need to share that places where routes are tightly clustered and criss-crossing presently tend to give MDSS some trouble in interpreting what is going on maintenance-wise. This is especially true in the immediate vicinity of a garage as there tends to be a lot of plow traffic in the vicinity that makes interpretation difficult. Routes 6704, 6705, and 6701 (the latter being the I-94 stretch through town) are one example of this. If you looked at the I-94 routes either side of 6701 MDSS picked up on far fewer 'maintenance actions' but had significantly higher application rates associated with those actions. This is because the interpretation of the MDC/AVL data is much more straightforward on those routes owing to the fact that there isn't so much truck traffic across them. I don't know what possibilities there are for shifting your assessment to either of those routes, as the reliability of MDSS' interpretation of the MDC/AVL data will be better on those two routes."

As a result, the "Reported Action" listed in the archived MDSS database cannot be used in evaluation process. The operator's logs will be used to identify the application rates. Only the time stamp of activities will be of use in the evaluation process.

Mr. Dan Peterson, Supervisor of Alexandria Truck Station, (phone 320-763-5045) reported that snow and ice control operations coverage on I-94 test site is normally 20 hours/day, but for winter events such as freezing rain, the operations coverage will increase to 24 hours/day. The MDSS system assumes bare pavement conditions will be attained within 6 hours after precipitation ends; but Mn/DOT strides to obtain bare pavement conditions within 4 to 5 hours. In preparation for this winter's snow and ice control operations, the application rates of prewetted salt have been revised to 100 to 500 lbs/lane-mile; the application rates of the 50/50 mixture of sand and salt will be 100 to 800 lbs/lane-mile. The setting and reporting on the spreader/controller for application rates will be in lbs/lane-mile. However, in practice, the amount of discharge will be for two lanes and will be windrowed along center line.

Task 6 – Quarterly Report

This quarterly report constitutes the seventh of eight reports to be issued for this project.

Part 2, Pilot Test

The pilot test was set to have both a test section and control section. The test section consists of both the west bound and east bound divided lanes of I – 94 from Mile Point 97 to 106 (TP4 (TP4Y6701). Located within the test section is an ESS site that measures and collect data on the following parameters: wind speed and direction; air temperature: relative humidity: precipitation that only detects if it is precipitating; traffic speed and volume: and pavement temperature and condition on both the bridge and the approaches. The control section consists of both the west bound and east bound divided lanes of I – 94 from Mile Point 82 to 97 (TP4Y6806). The control section does not have an ESS site.

Task 2 – Data Gathering

Field data were received on two occasions: the first week of February and March 29. The following snow and ice control events were provided in February.

December 21, 2007 (Frost Event)
December 21-24, 2007 (Snow and Frost)
December 25, 2007 (Frost Event)
December 28, 2007 (Snow)
December 29, 2007 (Snow)
December 31, 2007 (Drifting Snow)
January 11-12, 2008 (Snow)
January 13, 2008 (Snow)
January 15, 2008 (Drifting Snow)

For the following events, the entire snow and ice control data in the second submittal were not forwarded to the research team. The data that was missing in the second submittal included: weather condition; event beginning time and date: event ending time and date; event duration; bare lane lost time and date; bare lane regain time and date; lost duration; recovery hours; and comments which normally includes the amount of snow for the event. The missing data have been requested from the Subarea Supervisor and should be available shortly. However, due to the late arrival and incomplete set of operator logs, the analysis could be could be conducted in this reporting quarter.

February 4, 2008
February 13-14, 2008 (Snow with only plowing)
February 17, 2008

March 8-9, 2008
March 13, 2008 (Frost)
March 17, 2008
March 21-22, 2008

Task 3 – Implement Electronic Gathering

Electronic data were downloaded from various archived data bases (MDSS, traffic, surface conditions, and atmospheric) for the following snow and ice control events.

December 21, 2007 (Frost)(no MDSS)
February 13-14, 2008
February 28, 2008 (Blowing Snow)
March 8-9, 2008
March 13, 2008 (Frost)
March 17, 2008
March 21-22, 2008

Task 4 – Analyze Data

The analysis of the collected event data has begun. Traffic speed data is only available at ESS site located near the bridge on the test section. The traffic speed data are being aggregated from 3 minute intervals to one hour intervals. Traffic speed data from the driving lanes of both the west bound and east bound I-94 are being used in the analysis. Only data from the driving lanes are being use because it is felt that traffic speeds would be more uniform and less erratic as compared to the passing lanes.

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In reviewing the traffic speed data, a number of questions have developed that must be answered before the analysis can be completed.

1. It appears that vehicle speeds tend to be somewhat lower during the early morning hours. If this is a condition that exist the majority of the time for dry pavement surface condition, the maximum amount of speed reductions caused by winter events for very early hours will be less than those experienced during daytime hours. This finding will require that the analysis show the reduction speeds instead of actual vehicle speeds. The researchers that were identified in the literature search used this approach of reduction speeds in their research.
2. Do wet pavement conditions that result from snow and ice control operations extend the amount of time until vehicle speeds return to normal speeds? How does this issue correlate with the bare pavement standard that is used by Mn/DOT? This issue also must be addressed in the final analysis.

Enough data was available to be gathered from various data bases to begin the analysis of two frost events. As a result, two graphs (preliminary) have been prepared for the frost events (December 21, 2007 and March 13, 2008) for the test section. These two graphs are Figures 3 and 4. Each graph shows the vehicle speeds for both the west bound and east bound traffic on their respective driving lanes. In addition, the pavement temperature and the dew point temperature are plotted so that one can interpolate the beginning and ending of frost on the roadway. The timing of application of prewetted salt to the roadways is also shown. This information was taken from the operators' logs.

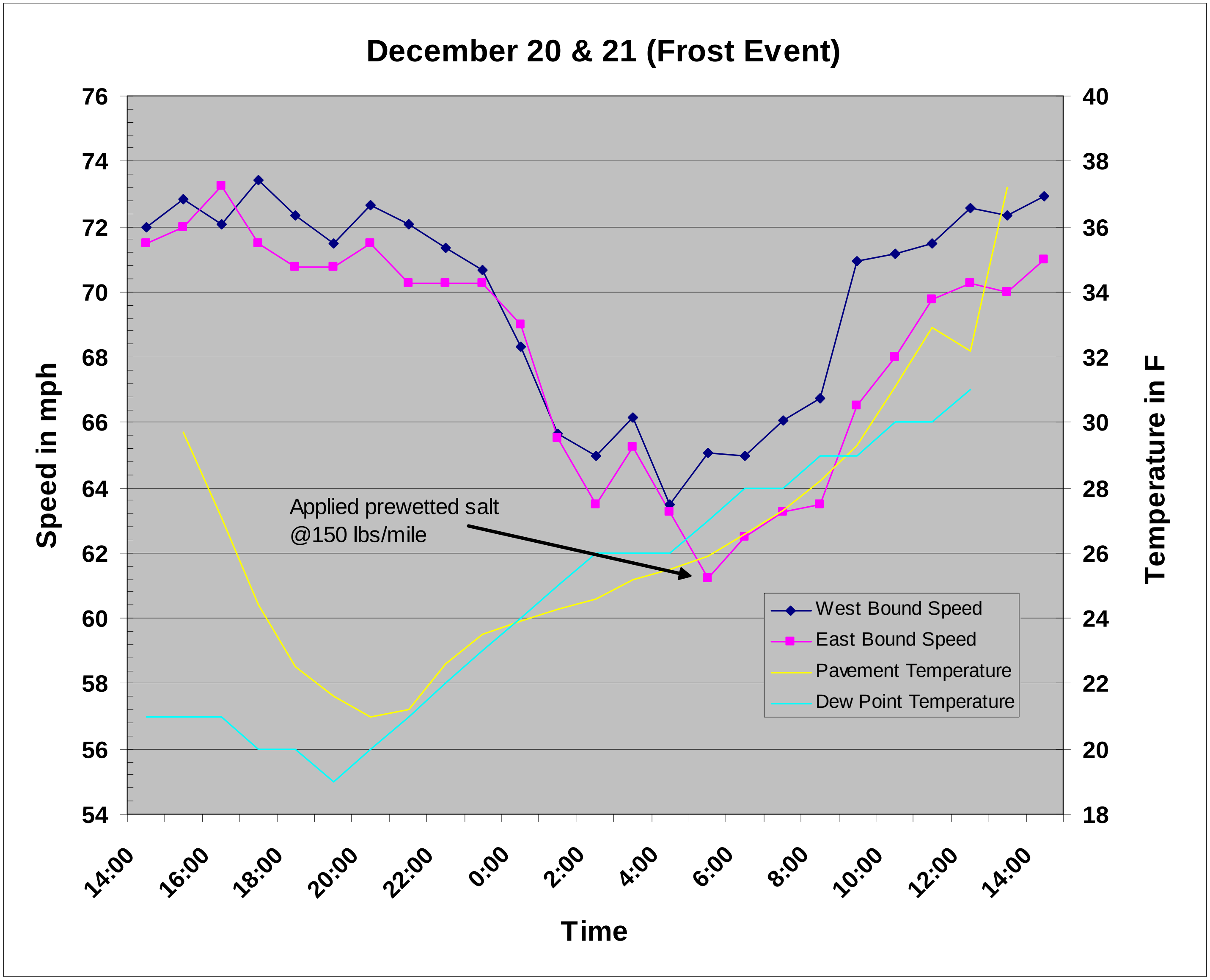

Figure 3, Data Concerning the Frost Event on December 20 – 21, 2007 on the Test Section

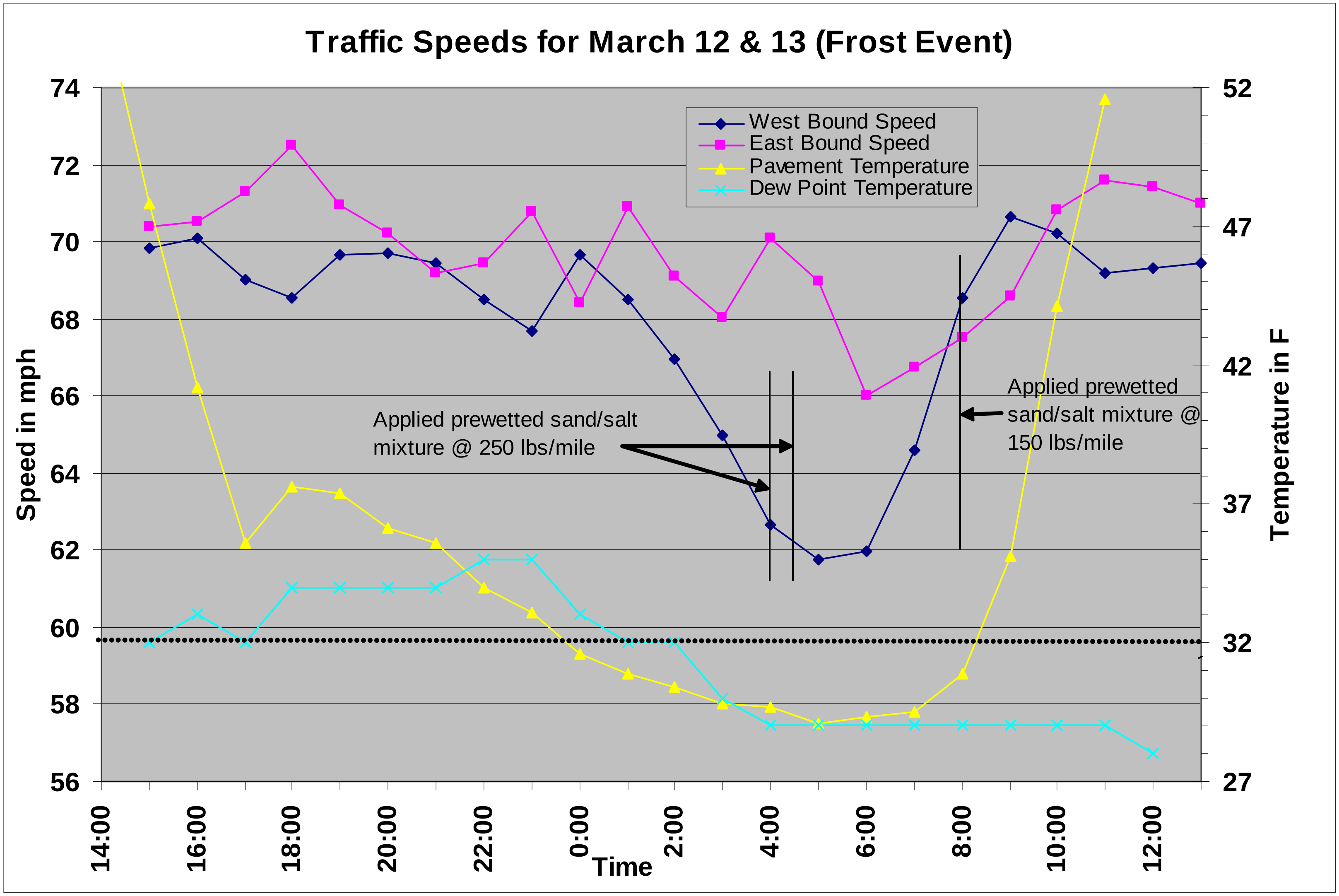

Figure 4, Data Concerning the Frost Event on March 12 -13, 2008 on the Test Section

Section 4
Problems Encountered

The research team was has not received the operator logs in a timing manner so that analysis could be completed.

Section 5
Activities Planned for the Next Quarter

During the next quarter, the research team will complete the analysis of the winter events that were identified in this reporting quarter. The analysis will include both “Pavement Snow and Ice Condition” and speed reductions.