Clarus Multi-State Regional Demonstrations

Evaluation of Use Case #2: Seasonal Load Restriction Tool

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16. Abstract

This report presents the results of an evaluation of the demonstration of an experimental seasonal load restriction decision support tool. This system offers state DOTs subsurface condition forecasts (such as moisture, temperature, and freeze-thaw trends) to support their decisions to place and remove load restrictions in a timely and effective way. The tool has been developed by Meridian Environmental Technology, Inc. and is being demonstrated in Montana and North Dakota as part of the Clarus Multi-State Regional Demonstration Program under the auspices of the Road Weather Management Program (RWMP) of the Federal Highway Administration (FHWA). The use of this tool was independently evaluated under contract to the RWMP. This evaluation report identifies the hypotheses tested, the approach to data collection and analysis, results from the evaluation, and lessons learned.

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Preface/ Acknowledgements

The Road Weather Management Program (RWMP) within the Federal Highway Administration (FHWA), under the auspices of the *Clarus* Initiative, has sponsored a multi-state demonstration of *Clarus*-enhanced experimental tools that offer state Departments of Transportation (DOTs) new ways to mitigate the effects of adverse weather events on the operation of their transportation systems. The RWMP sponsored independent evaluations of each of these "use case" demonstrations, and this report focuses on the results of one of those demonstrations; namely, the seasonal load restriction decision support tool. Findings from this evaluation, as presented in this report, are encouraging regarding the potential benefits of a tool that offers DOTs, for the first time, enhanced subsurface forecast information.

The authors of this report would like to acknowledge and thank the members of the demonstration teams, the state representatives, and members of the traveling public who collaborated in support of this evaluation and generously gave of their time and expertise. While many individuals deserve recognition, we want to particularly acknowledge a few individuals for supporting the demonstration and our evaluation. Leon Osborne, John Mewes, and Bob Hart of Meridian Environmental Technology, Inc. led the demonstration team for Use Case #2 and worked closely with the evaluation team. Representatives of the states in which the demonstration and evaluation took place generously offered their time and support, including Brandi Hamilton and Theresa Bousliman of Montana DOT and Brent Muscha and Ed Ryen of North Dakota DOT, as well as a number of District Engineers and Maintenance Chiefs in selected districts in these two states. Finally, Paul Pisano of the RWMP has provided ongoing support of this effort with a guiding vision of how *Clarus*-enhanced weather information can improve traffic operations and contribute to the safety and mobility of all travelers.

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List of Acronyms

ADT .....Average Daily Traffic
CVO .....Commercial Vehicle Operations
DOT ..... Department of Transportation
dTIMS ..... Deighton Total Infrastructure Management System
EICM.....Enhanced Integrated Climate Model
ESS .....Environmental Sensor Station
FHWA .....Federal Highway Administration
FWD..... Falling Weight Deflectometer
HPMS ..... Highway Performance Monitoring System
IRB .....Institutional Review Board
MDT ..... Montana Department of Transportation
NDDOT.....North Dakota Department of Transportation
NHS ..... National Highway System
NOAA .....National Oceanic and Atmospheric Administration
NWS .....National Weather Service
OS/OW .....Over Size/Over Weight
RWIS .....Road Weather Information System
RWMP .....Road Weather Management Program
SLR ..... Seasonal Load Restriction

Executive Summary

The *Clarus* Multi-State Regional Demonstration Program leverages the quality-checked data available through the national network of Environmental Sensor Stations (ESS) called the *Clarus* System to test and provide road weather management applications for state and local agencies. This document describes the approach and findings from an independent evaluation of the use and benefits of Use Case #2 – Seasonal Load Restriction Decision Support Tool, a tool developed and tested under the *Clarus* Multi-State Regional Demonstration Program. This tool provides enhanced monitoring and prediction capabilities to state DOT personnel involved in monitoring freeze-thaw conditions in the pavement and base materials below the roadway surface to determine when to begin and end seasonal load restrictions.[1] The independent evaluation of this use case tool examined how users in Montana and North Dakota could use the tool and how DOT personnel and motor carriers responded to the availability of this new information, in terms of its potential value and benefits in protecting the roadway infrastructure while not unduly burdening commercial vehicle operators.

Evaluation Approach

The approach to evaluating this use case began with the development of an Evaluation Strategy that identified the expected benefits of the tool's use and developed a set of testable hypotheses. It continued with preparing a detailed Evaluation Plan to guide the data collection and analysis, which required refinement as more information about the demonstration and opportunities to collect data became available. The evaluation was a validation exercise, seeing how a user need might be met or improved, and not a verification study that would look at system or tool performance (accuracy, false alarm rate, availability, etc.). Also, the evaluation did not perform a cost-benefit analysis. Montana and North Dakota were selected as the states to participate in the evaluation of the use case tool during the spring of 2010. The evaluation solicited information from motor carriers using highways in these two states to investigate the impacts of seasonal load restrictions on their operations. This approach offered extensive participation among these northern tier states.

The three main objectives of this evaluation were as follows:

- Understand how the seasonal load restriction tool could benefit state DOTs and commercial vehicle operators,
- Understand the value added by the tool beyond information already available to DOTs in these states, and
- Document the lessons learned from the evaluation to help guide further development and deployment of the forecast tool beyond this demonstration.

This evaluation specified four hypotheses for testing, three of which were related to customer satisfaction with the tool (both state DOTs and motor carriers). The first hypothesis fits in the three goal areas of mobility, efficiency, and productivity. Testing the hypotheses relied on results from interviews with DOT maintenance decision-makers in the two states and a web survey of motor carriers. The state DOT stakeholders who participated were in the Great Falls, Lewistown, and Missoula Districts of the Montana Department of Transportation (MDT) and in the Dickinson and Grand Forks Districts of the North Dakota Department of Transportation (NDDOT).

[1] Note that the terms "weight restriction" and "load restriction" may be used interchangeably.

Evaluation Findings

The results from the motor carrier survey and questions for the state DOT users are presented in detail in this report. While overall support from the two state DOTs for this new seasonal load restriction tool was positive, the DOTs wanted to apply it for a few more seasons before giving it their full endorsement. Input from motor carriers indicated that most of them are affected by seasonal load restrictions and they respond to these restrictions in a variety of ways. They would benefit from a shorter restriction period and improved notification of the beginning and end of seasonal load restrictions. Table ES-1 shows results of the tests of the hypotheses:

Table ES-1. Identified Level of Support for the Hypotheses

Hypotheses	Evidence	Level of Support
1. The tool allows state decision-makers to more accurately determine when to place and remove load restrictions, preserving both the pavement integrity and commercial vehicle operator productivity.	• Use of the tool by NDDOT increased user confidence in restriction placement. Following an unseasonably warm period in February, a maintenance chief decided to delay restriction placement by 14 days when he might otherwise have placed it sooner. • A MDT maintenance chief was able to decide to place restrictions at least 7 days in advance based on his interpretation of the tool's subsurface temperature profiles. • Four state DOT personnel who responded to a survey on their experience with the tool reported their perception of "reliability and/or accuracy of the tool and the information it provides" with an average score of 7.3 on a scale of 0 to 10. • Maintenance chiefs believe the tool will help them better understand when to remove restrictions, so it will provide assistance when defending removal decisions to motor carriers rather than just using a Falling Weight Deflectometer (FWD) alone. • NDDOT decision-makers believe they need more modeled locations to be able to achieve the optimum resolution from the tool and use it for their operations. They had only a small set of Enhanced Integrated Climate Model (EICM) sites set up for this demonstration. • The Grand Forks District of NDDOT was able to use the tool immediately and confirm the consistency of its outputs with their usual data from such sources as FWD and FrezTrax. • The tool did not provide recommendations for the timing of restriction placement or removal; thus, decision makers used the tool in conjunction with other information sources, tools and expert judgment to support their decisions.	Moderate Support

Hypotheses	Evidence	Level of Support
2. States are satisfied with the tool and have a level of confidence in using it in their decision-making process.	• Four users of the tool who responded to survey questions reported their average level of trust in the tool as 6.8 (scale 0-10), which is fairly positive but with variation across users. • Users of this experimental tool report that they expect trust and confidence in the tool to increase with additional use and experience. NDDOT maintenance chiefs believe their conservative approach results in earlier restriction placement and later removal than may be required to protect the pavements. They expect over time that the use of this tool can shorten the restriction period and support more advance notice at the beginning and end of the restriction period of 7 to 10 days. • A maintenance chief with MDT said that the tool's forecasts were "likely accurate," based on his observations and opinion. MDT would definitely use it again next winter/spring and is most anxious to get good forecasts in addition to their current measurements of existing conditions. • NDDOT: "I think that the tool, although still in its infancy, has the foundation to develop into another useful tool in our 'toolbox.' As with any new concept or tool – trust, accuracy, adaptability, user friendliness, education, and understanding are necessary for acceptance." • MDT: "[I] believe the subsurface frost forecasts from the system were likely accurate." This maintenance chief used the tool to proactively place and remove restrictions.	Moderate Support
3. States experience improved coordination and consistency between jurisdictions due to the tool.	• Currently, the maintenance chiefs communicate with adjacent districts to coordinate restriction decision making and increase their awareness of impending weather conditions. This process is independent of the tool and is expected to continue. • The motor carriers expressed their desire for a more consistent application of restrictions across jurisdictions.	Uncertain due to limited coordination to date

Hypotheses	Evidence	Level of Support
4. Commercial operators value the potential reductions to restriction durations and/or improvements to the restriction process.	• Seasonal Load Restrictions (SLRs) cause 72% of motor carriers to change their routes (more mileage) and 66% to alter/divide loads (higher costs) to meet restrictions. • Reducing the length of time of the restriction period was important to 86% of the responding motor carriers. They said, in response to the survey, that shorter restriction durations and earlier notifications would save them time and money. • There was an even split across responses from the motor carriers regarding improvements to the restrictions process. About 53% indicated no improvements were necessary, and the remainder (47%) indicated that improvements were needed for the process. Improvements noted by the respondents included facilitating permitting convenience, adjusting weight policies, additional coordination between state and counties, use of speed restrictions instead of load restrictions, and upgrading of roads and eliminating restrictions. They said they would value greater consistency and fairness in the restriction process. Most carriers appreciate the need for restrictions but want them to be less burdensome and of shorter duration.	High Support

Conclusion

This demonstration of a seasonal load restriction tool can be viewed as reasonably successful. States and motor carriers perceive the experimental tool as needed and of significant potential value. State DOTs that may be considering the features offered by this tool should benefit from the findings and suggestions offered in this report.

1 Introduction and Background

The *Clarus* Multi-State Regional Demonstration Program leverages the quality-checked data available through the national network of Environmental Sensor Stations (ESS) called the *Clarus System* to test and provide road weather management applications for state and local agencies. Five use cases were developed as part of the demonstration:

- Use Case #1 – Enhanced Road Weather Forecasting
- Use Case #2 – Seasonal Load Restriction Decision Support
- Use Case #3 – Non-Winter Maintenance Decision Support System
- Use Case #4 – Multi-State Control Strategy Tool
- Use Case #5 – Enhanced Road Weather Traveler Advisories

The use case development was led by two deployment teams. Each team was comprised of a private-sector system developer and several state agencies where the use case has been tested. Two independent evaluations were also conducted. The first evaluation assessed the improvements in road weather forecasting in use case #1 from a meteorological perspective. The second set of four evaluations assessed the value of the remaining four use cases to the state Departments of Transportation (DOTs) during 2010 and early 2011. The evaluation of the four use cases (#2 to #5) sought to understand the systems' impacts and benefits experienced by the state agencies and end users, including transportation managers, related agencies, and travelers.

This document describes the approach and findings from an independent evaluation of the use and benefits of *Use Case #2 - Seasonal Load Restriction (SLR) Decision Support Tool*, a tool developed and tested under the *Clarus* Multi-State Regional Demonstration Program.

The overall objective of the use case was to improve the techniques used to forecast the need for truck load restrictions and the timing of the placement and removal of restrictions on specific roads that are prone to pavement damage due to subsurface freeze/thaw actions. To achieve this objective, the demonstration team developed a tool to monitor surface and subsurface conditions to forecast two-meter thermal profiles of subsurface conditions up to two weeks into the future. System functionality includes the following:

- Verified and quality checked *Clarus* system data (state ESS data and national data such as air temperature).
- SLR model capability incorporating enhanced prediction of weather, subsurface temperature, and other pavement strength indicators. Two week forecasts of various subsurface indicators are provided.
- Subsurface condition information provided to states through a multi-state web-page portal.

2 Description of the Use Case

The tool for Use Case #2 couples a pavement and subsurface temperature prediction model with a long-range atmospheric model to forecast thermal profiles of subsurface conditions up to 2 meters in depth and two weeks into the future and to incorporate restriction decision policies to provide decision support to state DOT personnel.

The demonstration has made this tool available to state DOT decision-makers in the early spring warming period to help forecast the timing of subsurface thawing in order to avoid the potential pavement damage that can be caused by heavy truck traffic when pavements are most vulnerable. Figure 1 illustrates the potential for damage to pavements. The use case tool was also available to support decisions to remove load restrictions in late spring and early summer as the subsurface firmed sufficiently to support heavier vehicle traffic. It was intended that this new tool offer a scientific and accurate basis for supporting restriction placement and removal with the objective of minimizing the duration of restricted travel while adequately protecting the pavement integrity from heavy vehicle damage. The tool was deployed and evaluated in parallel with traditional methods used by the selected states, such as visual observations of water seeping to the road surface, Falling Weight Deflectometer (FWD)[2] readings, and monitoring of subsurface temperature probes.

Source: Courtesy of Texas Transportation Institute

Figure 1. Pavement Damage Caused by Heavy Vehicles

[2] A FWD is a testing device used by pavement engineers to evaluate the physical properties of pavements by dropping a weight of prescribed magnitude from a standard drop height and measuring the pavement deflection response. The objective of the process is to calculate stiffness-related parameters of the pavement structure. The load is applied using a circular load plate that is similar to a passing wheel load. Deflection sensors measure the surface deformation. Data gathered from a FWD is useful in determining when thawing is underway but it cannot provide advance warning of when to expect thawing to begin.

2.1 The Seasonal Load Restriction Tool

State DOTs currently use a combination of tools and techniques to estimate the appropriate time for placement and removal of restrictions. These include:

- Direct measurements of subsurface conditions through sensors. Such sensors are typically few and far between.
- FWD readings that provide a direct estimate of pavement strength. However, these readings are often obtained via a sampling approach, and the timing of the sampling may hinder effective use in placement decisions.
- Field observations of soil conditions, looking for signs of moisture weeping at the pavement surface, pavement deterioration due to truck traffic, etc. In many instances the damage to the pavement may already have occurred by the time visual observations are made.
- Other ESS and atmospheric temperature readings to estimate the appropriate time to remove restrictions. These may be combined in heuristic tools that estimate the thaw conditions based on consecutive warming days (days when air temperature exceeded a specific threshold).
- Conditions experienced in adjacent districts as weather progresses across a state, along with the restriction decisions made in those districts.

To support the decision making process, Meridian Environmental Technology, Inc. (Meridian) developed the experimental SLR decision support tool and provided, for testing purposes, the prototype system demonstration in three states – Montana, North Dakota, and South Dakota. The SLR tool adds the following capabilities to the current restriction process:

- Modeled subsurface temperatures up to 48 inches below the pavement surface at specific pre-determined locations.
- Modeled soil strength parameters (resilient modulus, phase conditions such as % ice, % water) to the same depth.
- Forecasted subsurface conditions up to two weeks in advance

The tool does not directly provide restriction imposition or removal recommendations nor does it provide notification or alerts. The SLR tool currently is restricted to providing site-specific soil profile information for the maintenance chiefs considering their decision to place or remove load restrictions.

As such, the SLR tool and its associated website include the following three components:[3]

1. Site specific soil temperature, percent ice, percent water, and resilient modulus[4] profiles generated through a model called the Enhanced Integrated Climatic Model (EICM). The EICM was developed by the University of Illinois for FHWA and simulates pavement (top 4”), sub-base (4” to 11”), and subgrade (11” to 34”) conditions based on observed weather conditions and weather forecast parameters. The SLR tool provides graphic profiles of subsurface conditions down to 48 inches and forecasts up to about two weeks.

[3] Meridian Environmental Technology, Inc. 2009. *Clarus Multi-State Regional Demonstration: Use Case 2.* A one-page descriptive handout flyer.

[4] The resilient modulus is a measure of the strength of the materials under the pavement and their ability to support heavy vehicle traffic without pavement damage. The resilient modulus of frozen soils is typically around 1, and dry soils may yield

2. Multi-state display of the current seasonal load restriction status by county gathered through user input.
3. User interface to update SLR status by county.

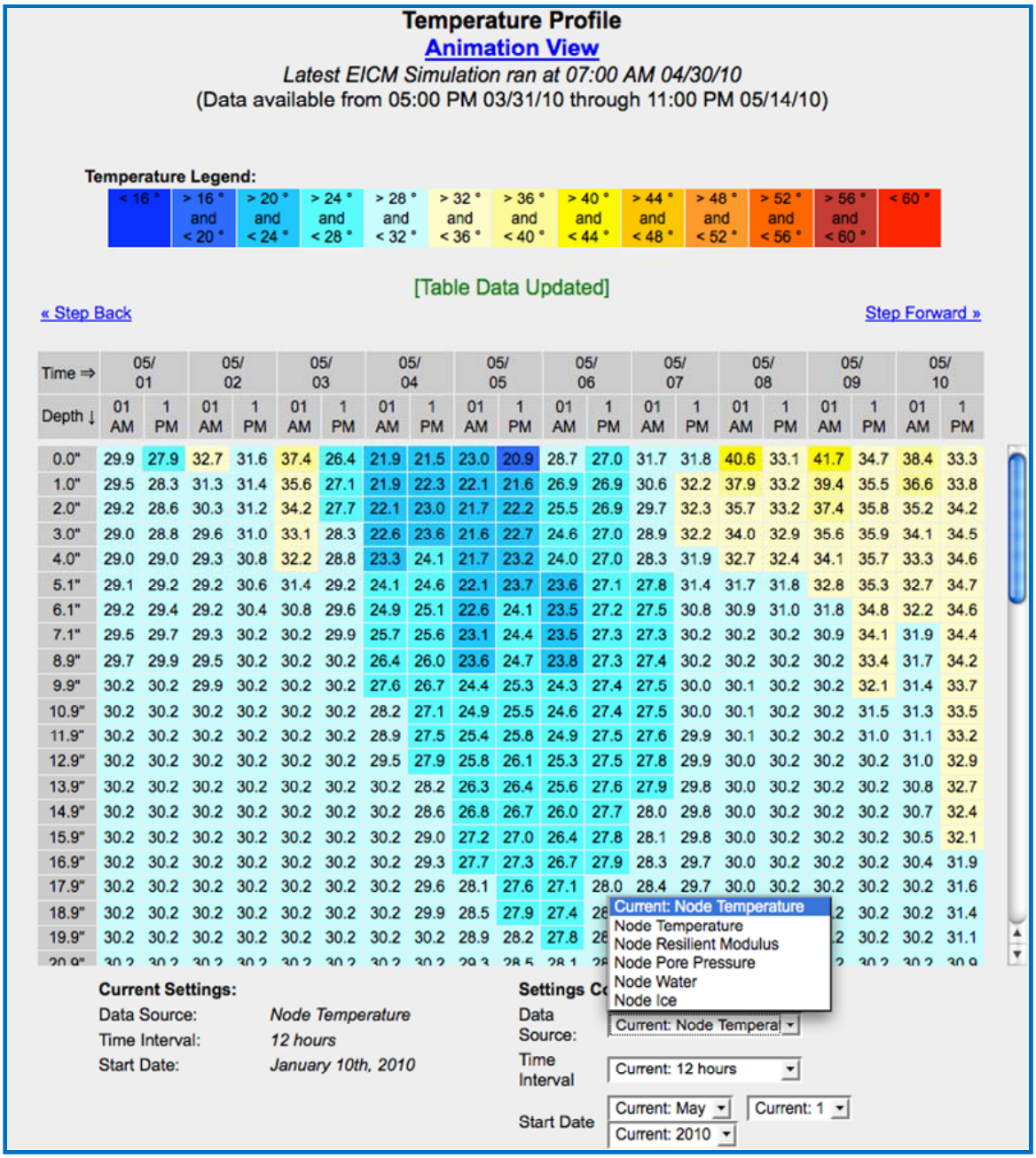
Inputs to the EICM model include the *Clarus* System data as well as the results of the Use Case #1 – Enhanced Road Weather Forecasting. The addition of quality-checked *Clarus* data as input to the EICM model is intended to improve the prediction of frost depth.

Meridian asked the three states to consult with their respective district and division officials to identify the preferred locations where they would like soil profile information through the EICM. The states were encouraged to identify these EICM locations close to their load restriction problem areas and close to where they had subsurface temperature probes installed, typically associated with Road Weather Information System (RWIS)/ESS sites. Montana requested more EICM locations than were likely to be manageable in terms of the data requirements, and Meridian suggested limiting the number of sites to 59. Included in their selection were their 10 subsurface probe locations. Montana has 35 RWIS sites. North Dakota identified 6 EICM sites that corresponded with particular problem areas for their load restriction decision making, one of which is collocated with their only probe site. NDDOT manages 17 RWIS sites in their state.

Figure 2 provides a screen shot of a detailed subsurface temperature profile generated by the tool with data from the EICM model, providing forecasts out to 10 days from the user selected start date shown on the x-axis and depth in inches from the surface down to four feet shown on the y-axis. The user can select the start date/time, time interval and various other parameters in addition to temperature for display in this format, including resilient modulus, pore pressure, and percentages of water and ice. This display may also be shown in animated form to convey a sense of changing subsurface trends over time in the selected parameter. Figure 3 provides a screen shot of the resilience profile with all other conditions set the same as in Figure 2. These two examples were captured on April 30, 2010, and they illustrate how a drop in atmospheric temperature occurred during a longer warming trend. As the warming continued and began raising the temperatures in the sub-base, the resilient modulus began to drop (from 1.0 to 0.6), indicating increased vulnerability of the pavement to potential truck damage.

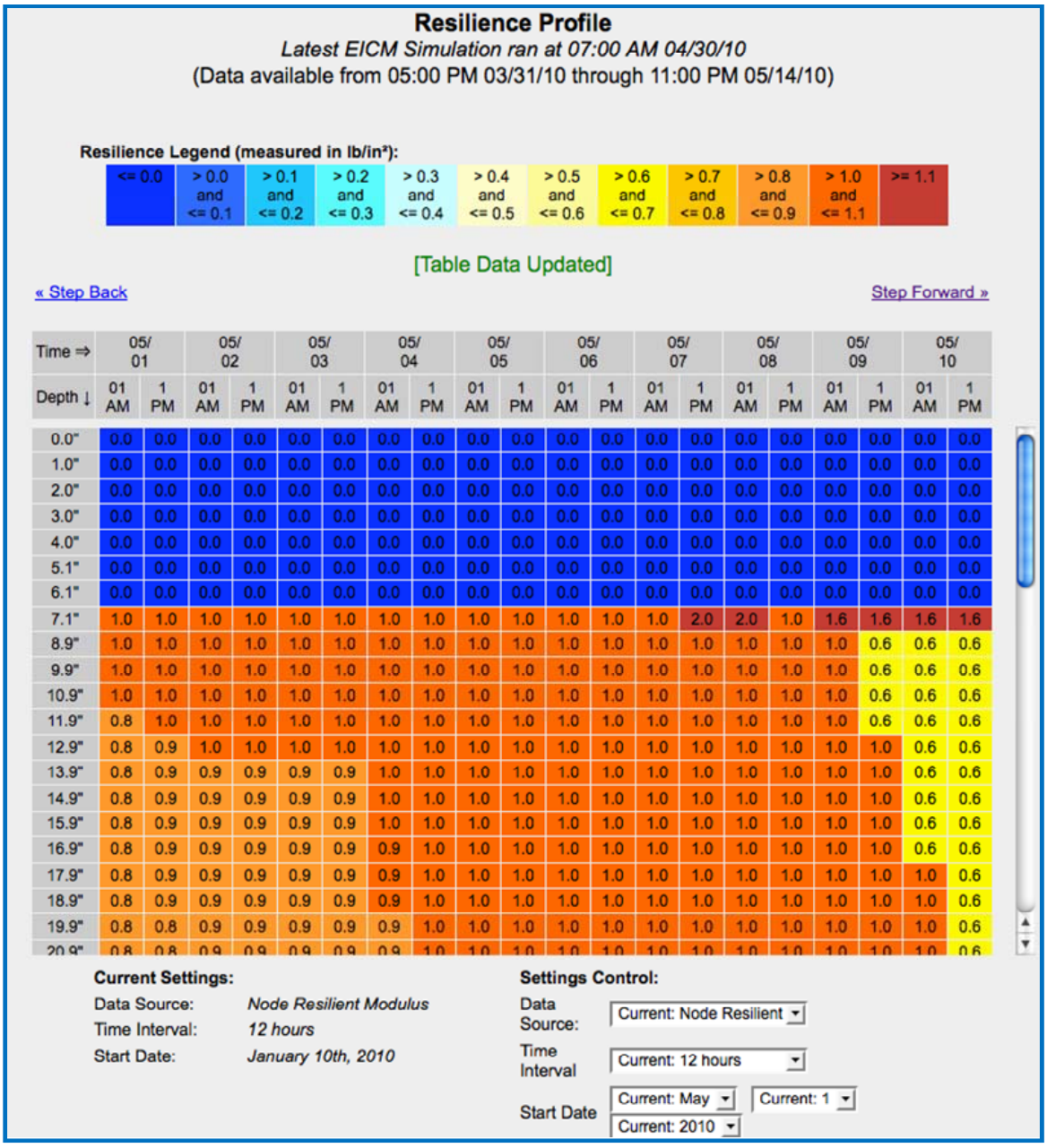
These two examples were captured on April 30, 2010, and they illustrate how a drop in atmospheric temperature occurred during a longer warming trend. As the warming continued and began raising the temperatures in the sub-base, the resilient modulus began to drop (from 1.0 to 0.6), indicating increased vulnerability of the pavement to potential truck damage.

higher values. As subsurface thawing occurs, the resilient modulus drops to around 0.3, which reflects a low ability to resist compaction and lateral shear. These conditions require careful monitoring.



Source: Meridian Environmental Technology, Inc. Experimental Website Screenshot

Figure 2. Example EICM Temperature Profile



Source: Meridian Environmental Technology, Inc. Experimental Website Screenshot

Figure 3. Example EICM Resilience Profile

3 Evaluation Approach

This use case tool provides state DOT load restriction decision-makers with a forecast of subsurface conditions that offers advance notice of the need to either place or remove restrictions in order to minimize potential damage to the pavement and subsurface. In placing restrictions, decision-makers currently rely on various pieces of information that are available to inform them about the conditions under the pavement. This information includes visual observations of moisture seeping through surface cracks, atmospheric temperature trends, ESS readings of subsurface temperatures in limited locations, historical restriction patterns, and conditions and decisions in neighboring districts. This use case tool offers the potential for information on subsurface conditions up to a week or more in advance, including moisture content and freezing/thawing at depth.

Currently, when a DOT decides to place restrictions based on observed pavement conditions at the onset of warming spring conditions, it is likely to be too late to fully protect the pavement from vehicle damage, as subsurface thawing is likely to have occurred several days prior to observed evidence at the surface. Furthermore, state DOTs may have in place an administrative process that can take several days before restrictions are actually posted after the decision to restrict has been made, adding further delay and potential risk to the pavement. This use case tool can forecast the day on which restrictions should take effect, thus allowing the DOT to make the decision sufficiently in advance to accommodate any administrative requirements and allow placement on the optimal day.

When the time to remove restrictions approaches in the late spring, DOTs use a combination of decision strategies such as FWD readings, field observations of soil conditions, and ESS and atmospheric temperature readings to estimate the appropriate time to remove restrictions. Typically DOTs are inclined to leave restrictions posted longer than may actually be necessary to protect the pavement, especially since visual observations are not much help in removing restrictions. This use case tool is designed to allow decision-makers to base removal decisions on forecasts of subsurface strength and integrity. Normally, when the subgrade reaches about 80% of full strength, DOTs are comfortable removing load restrictions.

Figure 4 illustrates the potential value of the tool for improved notification timing. In the restriction placement decision, the DOT needs to provide advance notice to motor carriers to allow them time to make the necessary adjustments in equipment, routing, and scheduling. In this case, the decision (and the notice to motor carriers) precedes the restriction by 4 to 7 days (or more). The value of “X” in restriction placement (upper part of the figure) represents a length of time prior to visible signs at the pavement surface that thawing has already begun and during which the tool’s prediction would likely preserve the integrity of the infrastructure. Without the tool, pavement damage would be expected.

Restriction removal would also likely be different with the tool. As the lower part of Figure 4 indicates, the restriction might remain in place longer than actually needed (by “X” days) without the tool, further burdening motor carriers with unnecessary restrictions. In considering how to quantify these kinds of benefits, it is important to acknowledge that the SLR tool did not provide maintenance chiefs with recommended decision timing, but rather showed them forecast subsurface conditions that they could take into account, along with their other tools and sources of information. This is further explained in Section 4.1.

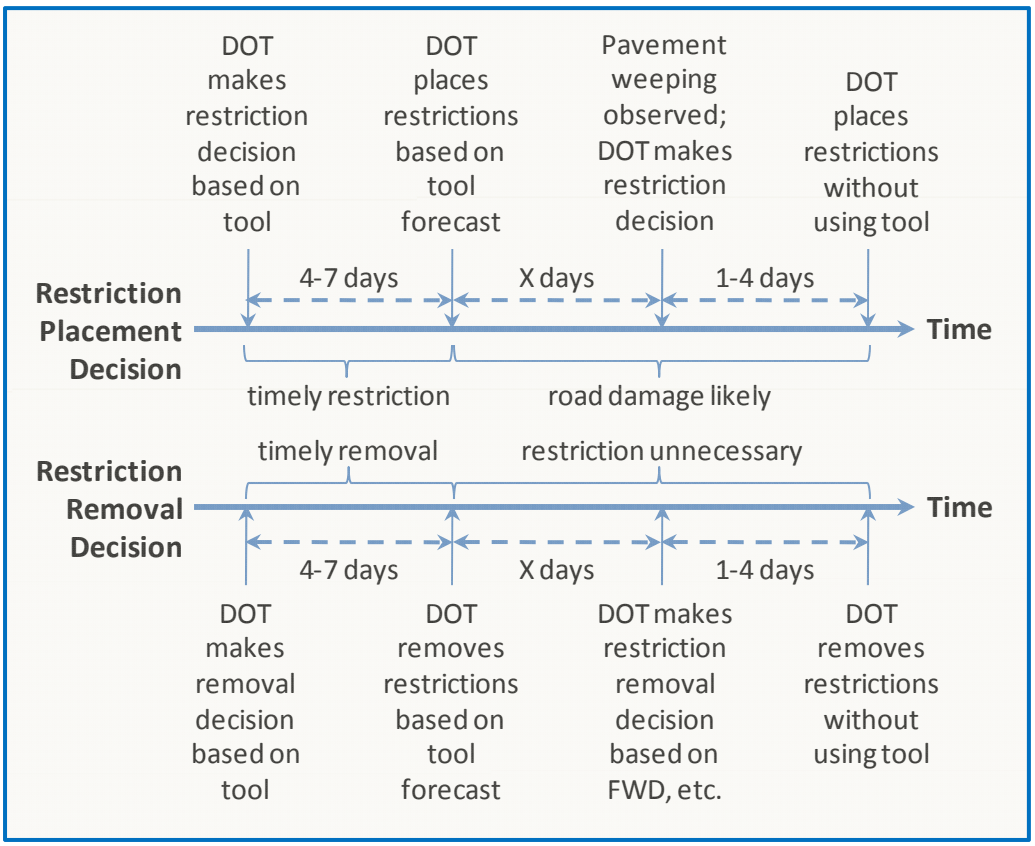


Figure 4. Load Restriction Placement and Removal Decision Diagram

3.1 Evaluation Setting

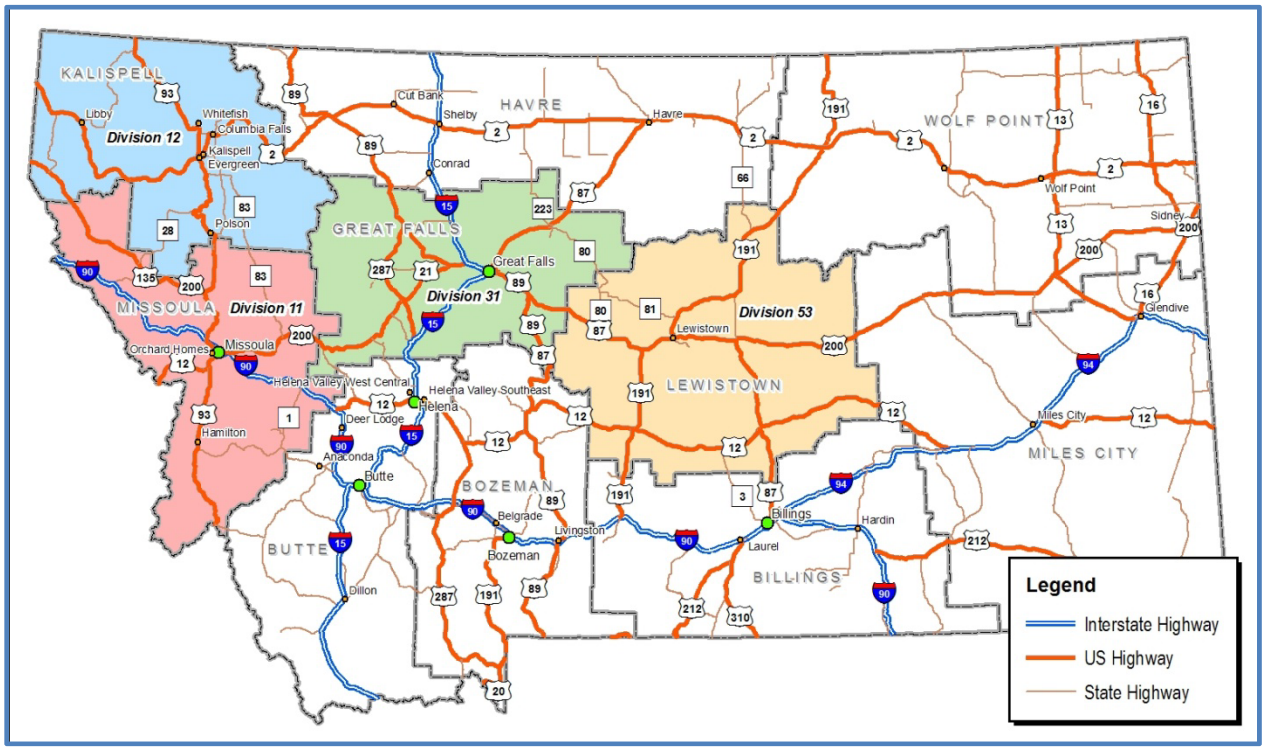
After discussing the potential for testing Use Case #2 in Montana, North Dakota, and South Dakota, Montana and North Dakota were selected for the evaluation. South Dakota chose to participate in another use case on this same evaluation project but not Use Case #2.

3.1.1 Montana

MDT has access to several RWIS stations that could be even more beneficial with the use of the Meridian SLR tool. Montana is already contributing data to *Clarus,* and this system provides quality checked data before providing them as input to the Meridian model. This evaluation sought to identify the advantages to MDT of using the tool.

MDT has five districts and 10 maintenance divisions. MDT selected four of these divisions to be the focus of the SLR demonstration and evaluation. Figure 5 indicates these four divisions by shading; they include Division 11 (Missoula), 12 (Kalispell), 31 (Great Falls), and 53 (Lewistown). The general trend in Montana has been a reduction in the number of restrictions compared to previous years, as their aggressive pavement rehabilitation program in recent years has reduced the number of route-miles requiring load restrictions. Prior to the introduction of this tool in the spring of 2010, MDT used National Weather Service (NWS) and RWIS

data for decisions made around the state for placing and removing load restrictions in an ad-hoc manner across the districts.



Source: Montana DOT, Map modified by authors for this study.

Figure 5. Montana DOT Maintenance Divisions

A phone conversation with four MDT maintenance chiefs revealed the proportion of total route-miles that might be restricted during any given spring thaw. Table 1 summarizes these findings, indicating that for these four districts, only 240 miles (2.2 percent) might be restricted out of the 10,796 miles of roads owned by the state of Montana. Restricted route segments are typically older pavements and weaker sub-grades that are more vulnerable to freeze-thaw cycles. As stated earlier, annual improvements to roadbeds have led to a reduction over time in the miles of roadway needing to be restricted.

Table 1. Summary of MDT Route-Miles Typically Restricted

Area	Restricted Miles	Comments
Lewistown	100	Two weak pavements built in the 1930s to 1940s require close monitoring; use RWIS to monitor subsurface temperatures. On roads with no RWIS, visual monitoring is conducted by driving the road.
Kalispell	40	Limited impact on truck mobility.
Great Falls	25	Only a couple of secondary routes are monitored closely.
Missoula	75	None.

MDT decision-makers believe that they cannot, and do not need to, restrict all roads, so they focus on the older pavements (also tend to be thinner pavements with weaker under-structure) and allow trucks to continue to operate on most roadways without major inconvenience. Their RWIS stations allow them to monitor temperatures under the pavement for some routes and at least provide decision support for when to begin restriction placement. Another input these district decision-makers use is water seeping out of cracks in the pavement. District and division personnel believe that when air temperatures reach the high 30s they need to pay closer attention because the restrictions will need to be imposed soon.

In Lewistown, the average daily traffic (ADT) is low compared to other districts such as those with interstate routes. This division has some National Highway System (NHS) routes, but MDT does not put restrictions on those roadways since they are strong enough to resist damage from freeze-thaw action and from heavy traffic. In general most trucks traveling in Montana are not impeded by SLRs because they travel on the stronger primary routes where MDT does not impose restrictions. One of the routes into Canada, U.S. 81, is about 50 miles long and is usually a problem due to the number of heavy trucks using the route.

MDT determines when and how to make restrictions on roadways without RWIS (e.g., MT 12) by having maintenance personnel drive the roadways daily while being mindful of the temperature. If they start to see evidence of pavement weakness or moisture weeping, they recommend placement of the restrictions. For longer-term evidence of developing problems, the department has a program that it runs every two years that uses inputs of ride (longitudinal roughness), rutting, and cracking.

In the Kalispell area, MDT monitors MT 83 closely. Western MT generally thaws three weeks earlier than eastern MT, and the freezes are not as deep in the west. Sometimes divisions to the east make decisions to impose load restrictions based on the earlier decisions by divisions to their west. In most cases, field personnel are their first alert, letting headquarters know of imminent problems.

The types of activities that typically create the biggest challenges for MDT are logging operations, oil and energy-related shipping, and agriculture. Logging traffic regularly uses roads with thin pavements and can do significant damage since these trucks can exceed standard legal weights. Other specific commodity transports that can be problematic are hay and grain.

MDT district personnel recognize that the SLR tool, with its ability to forecast subsurface conditions, could be extremely beneficial because damage could have already occurred by the time the evidence is visible. The tool would be essential from about mid-February to the end of March, and by then all or almost all of the state is past the thawing cycle. The actual timing of restriction placement and removal of course depends on variable weather patterns year-by-year.

Use of the SLR tool could improve relations between MDT and the carriers and shippers. It is in the interests of the motor carrier community to have minimal load restriction constraints placed on their operations. Carriers have expressed their concerns about load restrictions, so providing them more unrestricted days of operations should be received favorably. For example, U.S. 81 is part of an oversize/overweight (OS/OW) load route into Canada. The section of U.S. 81 that the OS/OW loads want to use is 42 miles in length, but it is an old road with pavement depth of about 5 to 6 inches of asphalt on a weak sub-base.

The Montana 511 program is the mechanism for providing restriction notification on over-dimensional loads. A shipper might request permits for 25 loads at a time, so notification of restrictions is critical. Some of these loads are 24 ft wide and 18 ft tall; hence, they are large units that need to use U.S. 81 regularly. The other option for these large loads involves traveling several hundred additional miles through Saskatchewan, Canada.

3.1.2 North Dakota

The NDDOT uses a somewhat different approach than that used in Montana. The current method of using FWDs in North Dakota provides information to the decision process but it risks coming after the damage has started. The NDDOT has been investigating a method to predict frost formation and thawing using subsurface temperatures and a pavement model. The intent of the pavement model is to predict when the soils beneath the pavements are going to thaw. NDDOT equipped six cities across the state with subsurface temperature probes (Crosby, Emerado, Grassy Butte, Rugby, Sterling, and Wahpeton). The temperature probes were installed in the pavement structure to monitor temperature readings from 4 inches down to 77 inches below the surface of the pavement. These subsurface probe data are used to initialize the model and then verify how well the model can predict subsurface temperatures. While testing of the data and model is taking place, anyone is able to view the data.

The southwest corner of the state of North Dakota is usually the earliest to begin thawing and therefore the first to place restrictions (see Figure 6). NDDOT typically begins to monitor the subsurface during the second half of March. Three districts were available to the research team for this evaluation – Dickinson (southwest), Bismarck (central), and Grand Forks (northeast).

Source: North Dakota DOT, Map modified by authors for this study

Figure 6. North Dakota DOT Maintenance Districts

In contrast to Montana, which only restricts 240 miles of roadway mileage in the four districts included in this study (less than 4 percent of the state roads in those districts), NDDOT restricts 100 percent of its 7,350 state roadway miles (not including interstates) during the spring thaw. NDDOT uses pavement management software, referred to as Deighton Total Infrastructure Management System (dTIMS). This software is based on current and projected pavement structural integrity and generates the following outputs:

- Recommended maintenance or construction projects by year,
- Recommended maintenance treatments by project and year, and
- Overall summaries of:
  - Condition,
  - Backlog,
  - Treatment cost, and
  - Treatment length.

dTIMS serves as a decision-support tool to schedule construction projects but not as a decision-maker. Its functionality does not include subsurface freeze/thaw conditions or the load restriction process.

District personnel use visual inspection in deciding what to restrict, although they also use FWDs in some cases. They look at rutting, cracking, and evidence of water seepage. FWD readings are used more in support of the restriction removal decision. Districts conduct FWD runs on a weekly basis and remove restrictions

based on the readings when pavement strength approaches 80% of the baseline. The earliest dates for restricting truck weights in North Dakota are typically around mid to late March, but the date depends on weather patterns and the decision-makers. Removal of restrictions typically occurs in mid-May to early-June.

3.2 Evaluation Design

The evaluation of the Use Case #2 tool was based primarily on MDT and NDDOT user perceptions based on limited use during the spring of 2010. In addition, the evaluation conducted a survey of commercial motor carriers who use Montana and North Dakota roadways to move goods and equipment. Thus, the evaluation was a validation exercise, seeing how a user need might be met or improved, and not a verification study that would look at system or tool performance (accuracy, false alarm rate, availability, etc.). Also, the evaluation did not perform a cost-benefit analysis. The following sections describe the evaluation design to assess the use and impacts of Use Case #2.

3.2.1 Objectives and Hypotheses

Evaluation Objectives. The objective of this evaluation was to assess quantitatively and qualitatively how DOTs use the Use Case #2 tool to make their restriction placement and removal decisions. It also sought to understand the perspectives of decision-makers on the benefits of the tool and its ability to offer a more reliable, scientifically-based decision process. Whether following the tool's guidance resulted in changes in the duration of restrictions compared to durations that would have occurred using traditional decision making approaches was also of interest in the evaluation. Table 2 lists the goal areas and hypotheses of interest to the evaluation.

Evaluation Hypotheses. As specified in the Evaluation Strategy and considering the timeframe of this demonstration, this use case tool was expected to yield measurable benefits primarily in four out of six potential goal areas, namely: mobility, efficiency, productivity, and customer satisfaction (state DOTs and commercial operators). Because there are two main customers for the information offered by the tool, for the purposes of the evaluation, customer satisfaction was divided into state DOT satisfaction and commercial operator satisfaction. Measurable benefits were not expected in the remaining goal areas of safety or energy and environment. Table 2 lists the hypotheses that were tested in each of the customer satisfaction goal areas. These hypotheses are essentially the same as those initially specified in the Evaluation Strategy before the tool was fully developed and deployed in the demonstration.

Table 2. Evaluation Goal Areas and Hypotheses

Goal Areas	Hypotheses
Mobility Efficiency Productivity	• The tool allows state decision-makers to more accurately determine when to place and remove load restrictions, preserving both the pavement integrity and commercial vehicle operator productivity.
Customer Satisfaction (Agency Users: State DOTs)	• States are satisfied with the tool and have a level of confidence in using it in their decision-making process. • States experience improved coordination and consistency between jurisdictions due to the tool.
Customer Satisfaction	• Commercial operators value the potential reductions in restriction durations and/or

(Commercial Operators)	improvements to the restriction process.

Hypothesis Testing Approach. The first hypothesis relates to the ability of the tool to assist decision makers in adjusting the timing and placement of restrictions. While not necessarily implying a shorter restriction period, the hypothesis tests whether the tool allows agency users to place restrictions before visible signs of thaw appear on the road surface (which is acknowledged by maintenance personnel as being too late, as sub-grade strength has been weakened several days before visible weeping) and remove restrictions based on an estimate of sub-grade strength. Placement and removal of restrictions is more "art" than "science," with maintenance chiefs using a combination of heuristic methods (like FrezTrax), ESS (current observations of surface and subsurface temperature, where available), FWD observations, and visual field observations. The first hypothesis was tested by looking at projections of subsurface conditions from the tool and the corresponding current condition data from the ESS and visual observations. The goal was to see if the tool was able to provide an earlier indication of subsurface thawing than existing tools (ESS and visual observations). As a means of tracking tool forecasts, repeated screenshots of the tool's web interface were gathered during the spring of 2011 in selected locations. The screenshots, further explained in the next section, consisted of composite daily views of subsurface profiles (temperature and modulus) by depth. The maintenance chiefs responded to weekly email questions from the evaluation team that provided a record of their crews' visual observations. ESS archived data were compiled by Meridian and shared with the team.

The customer satisfaction hypotheses in Table 2 were mostly aimed at eliciting qualitative feedback from decision-makers at state DOTs on the use of the tool and both qualitative and quantitative feedback from commercial operators. For the latter, the questions were directed at determining the response of motor carriers to the imposition of seasonal load restrictions. The evaluation used survey feedback from a sample of motor carriers to test this hypothesis. MDT placed a link to the survey on its web page, after receiving almost no response from the initial direct mail-out survey to motor carriers using email. NDDOT experienced the opposite response, using direct email to their list of motor carriers (N=2,417) and achieved a reasonable response rate using the email approach (215 responses or 8.9%).

Information gathered through phone interviews with maintenance personnel in Montana and North Dakota provided input for assessing the other two hypotheses. The research team asked questions to determine DOT experience with using the tool for one season – the spring of 2010. In some cases the person interviewed had access to the tool for both the placement and removal of the restriction and in other cases only the placement of the SLR was involved. Information from this evaluation is available to the demonstration team and the DOTs to help guide their decision on whether to seek to fully deploy the tool and how best to integrate the information into their future decisions related to seasonal load restrictions.

The hypotheses were tested by analyzing responses to prepared questions for DOT users of the tool and a different set of questions prepared for motor carriers that operate through Montana or North Dakota, or both, and that could have been impacted by seasonal load restrictions. The DOT interviews occurred in March-April 2010 for the pre-deployment interviews and in June 2010 for the post-deployment interviews. The intent of the motor carrier survey was primarily to determine the impact of seasonal load restrictions on motor carrier operations. By implication, if the tool reduced the amount of time for SLRs or gave motor carriers additional advance notice of the beginning or end or restrictions, it would have a favorable impact on carriers and thus be favorably received by them. Responses from the motor carrier survey were received during May 2011.

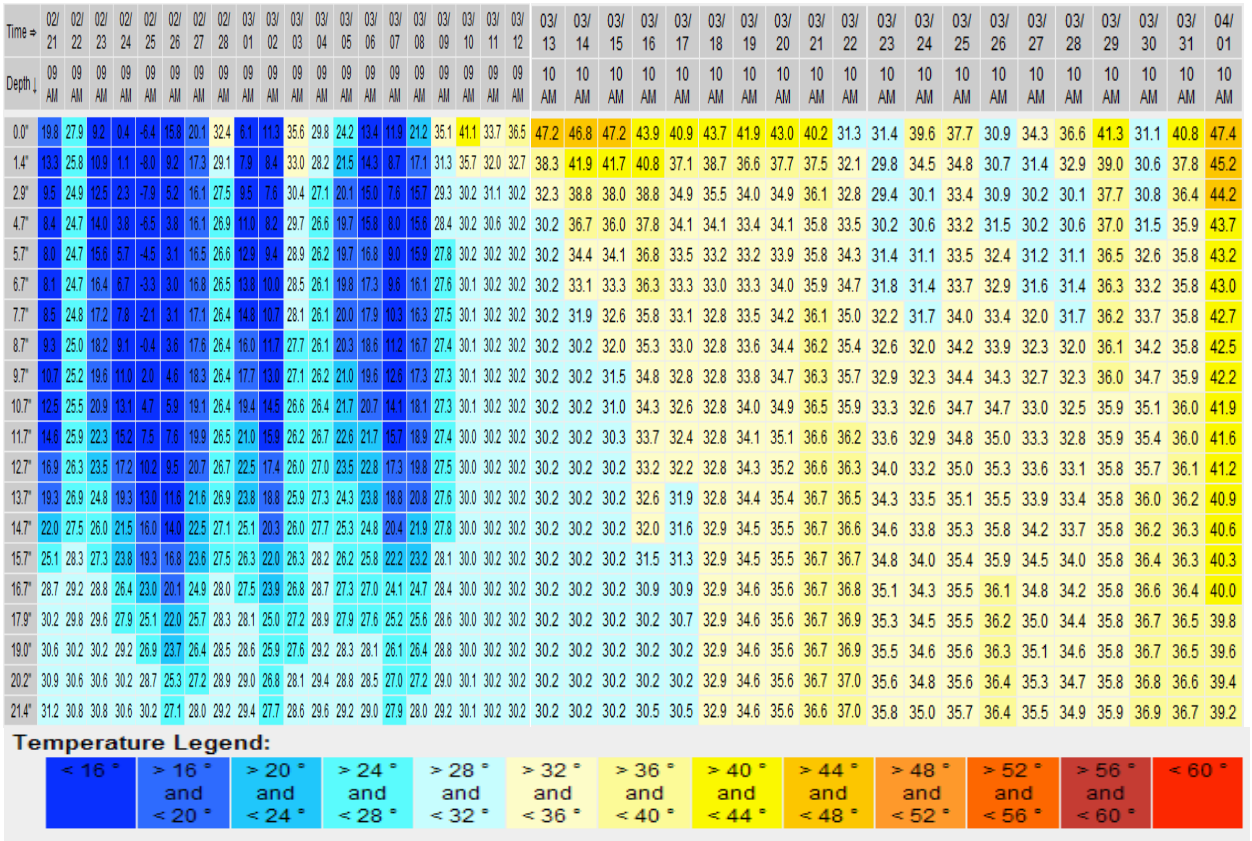
3.2.2 Data Collection

Data were collected from multiple sources, as described in this section.

System Screenshots. During the spring of 2011, the tool provided forecasts of subsurface conditions through a web interface. The users could select a location of interest where subsurface conditions were available. These locations, called the EICM sites, were the locations identified by the states where the subsurface modeling was conducted. The tool updated the models everyday and provided a two week forecast. To capture these forecasts at various locations, screenshots of the web interface were taken for the following EICM sites in Montana and North Dakota on March 13th and then again on April 30th and May 15th.

- MT-043 (Location: MT-83 – P-83 – MP 14.0 to MP 23.5)
- MT-008 (Location: Mt-200 – P-6 – MP 35.0 to MP 46.0)
- ND-7 (Location: N. of Grand Forks)
- ND-5 (Location: FWD Site)
- ND-1 (Location: Wishek at ND 3 and ND 13)

These screenshots showed the current and previous weeks' subsurface condition and forecasts up to two weeks in advance. Figure 7 illustrates the type of information provided in the screenshots of the tool.



Source: Screenshot from Meridian's Use Case Tool

Figure 7. Example Subsurface Road Condition Screenshot

This screenshot was taken on March 15th and shows the conditions from February 21st up to that date and then the two week forecast until April 1st. The figure shows the subsurface temperature by depth modeled each day at 9 AM. Similar screenshot figures for the resilience modulus were also compiled. While the screenshots show a daily temperature reading, the model estimates them on an hourly basis, so the users had access to hourly modeled estimates of subsurface conditions.

Maintenance Chiefs' Visual Observation Reports. These reports are based on weekly emails sent from February 21st to March 30th of 2011 asking for a record of visual reports about thawing. Emails were sent out to the maintenance chiefs during the course of the evaluation. Responses were obtained from 2 of the 3 maintenance areas in North Dakota and 3 of the 4 maintenance areas in Montana (see Table 3).

Table 3. Maintenance Chiefs for North Dakota and Montana.

North Dakota	Montana
Larry Gangl (Dickinson – SW ND)	Jack May (Missoula, MT)
Les Noehre (Grand Forks – NE ND)	Dave Hand (Great Falls, MT)
Kevin Levi (Bismarck, NE ND)	Doug Lutke (Lewiston, MT)
	Kyle DeMars (Kalispell, MT)

The following questions were asked weekly:

1. Did your field personnel report any signs of moisture on the ground (pavement surface and surrounding road shoulder area), weeping, or other thaw-related visual observations this week (mm/dd/2011 to mm/dd/2011) in your district? Yes/No.

   If Yes, describe where and the type of observations or concerns related to restriction placement

2. What other data have you examined this week to support your restriction decision making, such as NWS, local forecasts, FWD readings, information from adjacent districts, other? Please describe.

3. Have you been looking at the Use Case tool?

   No
   Yes

   - More than once a day
   - 6-7 times this past week
   - 3-5 times this past week
   - 1-2 times this past week

4. Have you decided this week to place any restrictions? (Yes/No) –new or changes since last week?

   If Yes. Please answer the following:

   - Which roads?
   - Timing?

ESS Records. ESS records were collected for three specific locations that were traditionally of interest to the maintenance chiefs while making the seasonal load restriction decision. ESS records were collected from February 1st to April 1st.

- RWIS Site at Swan Lake South on MT 83 at MP 47
- RWIS Site at Trout Creek on HWY 200 at MP 30.9
- Bowman (North Dakota)

System Alerts and Notifications. During the spring of 2011, Meridian sent out manually generated system updates and alerts to all their subscribers for this use case. The alerts and notifications provided updates on the extended weather forecasts, EICM indications, and thaw reports for various maintenance districts. The updates were sent out on the following dates – 02/09/2011, 02/14/2011, 02/21/2011, 02/23/2011, 02/28/2011, 03/01/2011, 03/18/2011, and 3/29/2011.

DOT Interviews. The research team conducted phone interviews with maintenance personnel who had used the SLR tool in a pre- or post-deployment scenario or both, using a list of prepared questions for each interview. The list of interview questions is provided in Appendices A and B. Interview respondents were identified by the respective DOTs as follows:

Montana: MDT's State Maintenance Engineer provided names and contact information to researchers to make the follow-up contacts to set up meetings in Montana. The research team contacted District Maintenance Chiefs in Great Falls, Lewistown, and Missoula for the interviews. The individuals were the same ones whom researchers had contacted earlier to discuss the Use Case #2 tool and its intended purpose to set the stage for subsequent data collection. These pre-deployment interviews occurred on March 17, 2010 in Lewistown; March 18, 2010 in Great Falls, and April 5, 2010 in Missoula. The post-deployment interview for Montana occurred on June 2, 2010 in Lewistown.

North Dakota: As with MDT, the NDDOT State Maintenance Engineer provided names and contact information to researchers. The research team contacted District Maintenance Chiefs in Dickinson and Grand Forks for the interviews. The individuals were the same ones whom researchers had contacted earlier to discuss the Use Case #2 tool to set the stage for data collection. These pre-deployment interviews occurred on March 16 in Grand Forks and March 18 in Dickinson. The post-deployment interview for North Dakota occurred on June 18, 2010 in Dickinson.

Web Surveys. A need arose in 2010 to extend the period of study and evaluation for Use Case #2 into 2011 to provide additional opportunity to evaluate user response to the new tool. The additional time allowed the research team to develop a survey instrument directed at motor carriers operating in either Montana or North Dakota, or both. A requirement for use of human subjects in research is to develop the survey protocol and submit it for review by an Institutional Review Board (IRB) for approval.

Upon approval by the IRB at Texas A&M University, the research team provided the approved survey form to the State DOT evaluation contacts in each of the two states. In both cases, the DOT sent the survey to an existing e-mail list of motor carriers. The e-mail lists were maintained by both DOTs as part of their traveler information services. After almost no response from the Montana mail-out, the research team requested that MDT place a link on its web site for motor carriers to voluntarily complete (Figure 8). The survey was active for approximately a month in each state, primarily during the month of May 2011. Since these respondents are self-selected, and given that commercial vehicle operations (CVOs) from other states operate in and through North Dakota, the results are not representative of all carriers that use NDDOT roadways. Voluntary responses

to the MDT website also do not constitute a random sample. Nevertheless, their opinions provide useful information about the impacts of spring load restrictions on their operations. Appendix C contains the survey questions that researchers developed for soliciting input from the commercial operators.

Source: Montana DOT

Figure 8. Montana DOT's Link to the Web Survey

4 Evaluation Findings

4.1 Load Restriction Placement and Removal Impacts

Use of the tool by maintenance chiefs. While the tool was made available during the spring of 2010, it was not in time to be used in supporting restriction decision-making during that spring. The demonstration was extended to spring 2011, and users were trained in February of 2011. During this spring, the use case tool was effectively used by maintenance chiefs during the evaluation. In the weeks leading up to the restriction period, the maintenance chiefs in the states participating in the demonstration reported using the tool 1-2 times a week and, in some cases, increasing their use up to 3-5 times a week. Only one of the seven maintenance chiefs reported not using the tool during the restriction period.

The following comments provided by the users show a high degree of confidence in understanding and using the capabilities of the tool:

- I have been comparing the SLR tool to the current tool used by the DOT, FrezTrax. From my observations it appears SLR does a better job at predicting load restriction conditions a week in advance when compared to FrezTrax. The question remains how accurate the "present soil conditions" actually are, but when comparing the tool's forecast for a week in advance and then observing the "present soil conditions" when they come about, the model seems fairly accurate in its own prediction.
- One additional feature I enjoy is being able to overlay different conditions such as, Air Temp, Thaw Depth, etc. at the same time on the entire state map.
- Another way of presenting the information would be to display soil conditions on the plan view of the state maps. Let's say you want to see the resilient modulus at 11 inches below the surface for the entire state. Being able to select the depth of interest, a soil condition and having it displayed in contours across the entire state would be beneficial.
- One annoyance I have with the system right now is having to select each site specifically to see soil conditions. The above mentioned map would alleviate some of that issue. I realize this is already partially available for freeze and thaw depths, but adding it for the other soil properties would be beneficial.
- We have been monitoring the tool's information and based on the base temperature forecasts we determined to place load restrictions on Montana routes 80 & 81 in the Lewistown and Great Falls areas beginning next week on March 14th. We will continue to monitor information from the tool as the spring temperatures fluctuate and ultimately as the thaw continues to progress to determine when we can safely remove the limits later this spring.

Impact of tool in load restriction placement and removal. The tool had some significant impacts on the imposition of load restrictions this season in North Dakota and Montana. While other sources such as NWS and ESS observations continued to be used by the maintenance chiefs, the tool was able to provide the following key benefits to maintenance chiefs.

a. Tool helped increase NDDOT's confidence in delaying restriction placement by about two weeks following an early warming period

On February 14th, based on a warming trend in early February, NDDOT issued a notification alert indicating that restrictions might be placed in the next couple of weeks. NDDOT indicated that they may place restrictions on some state highways beginning as early as the week of February 28, depending on weather. Analysis of the numerical models in the tool indicated that the period of warmer weather would continue only for a short period before cooler conditions return. The likelihood of temperatures above 32 degrees was very small through the remainder of February. The EICM indicated that the current warming period would permit the thaw to reach 8 to 16 inches but the much cooler conditions would refreeze this zone by the 22nd of February. A slight warm up on the 24th and 25th would cause pavement temperatures to rise above freezing but the model only indicated a shallow, partial thaw in the base layer on the 25th and 26th. Colder temperatures at the end of the month would likely keep the sub-pavement profile frozen going into March.

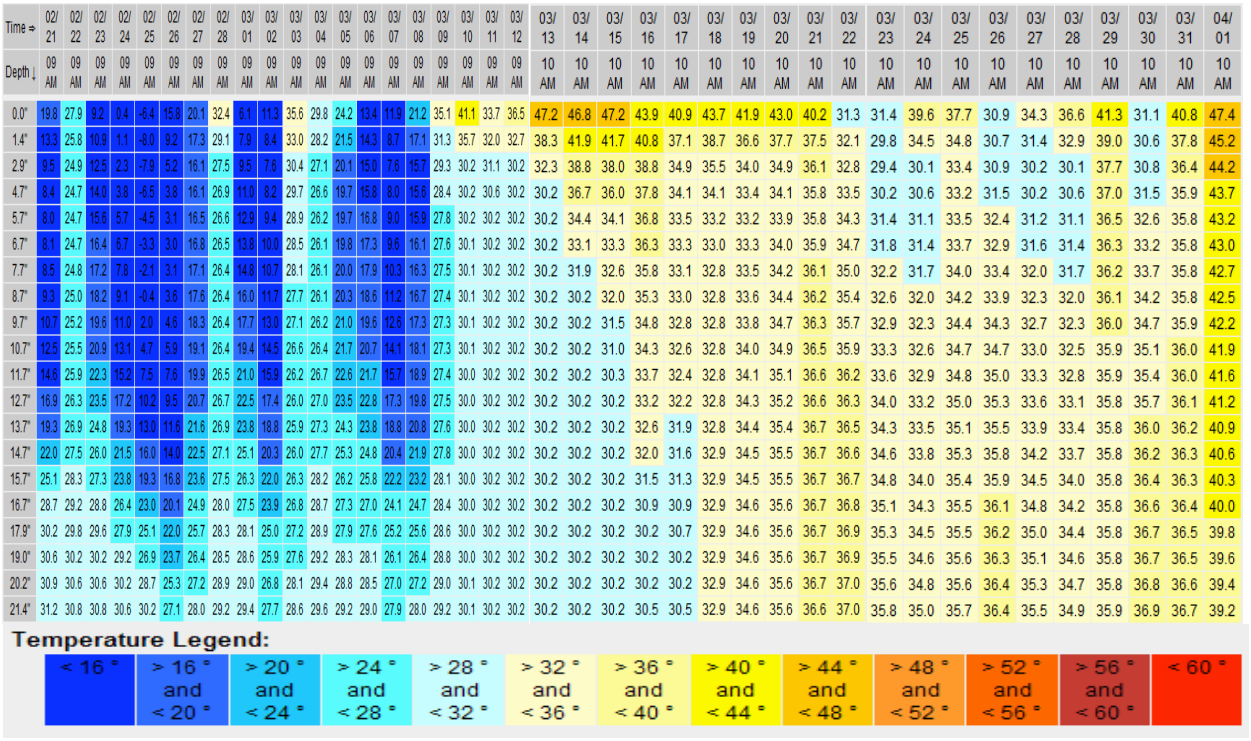
This information proved to be consistent with weather conditions that unfolded and restrictions did not go into effect until March 16th (and March 21st in some places). Information about the long-term trends in subsurface conditions helped ease some of NDDOT's fears about early warming in February which could have led to the restrictions being placed earlier than warranted. While the new tool increased their confidence in their decision to delay restriction placement during this brief warming period, it is difficult to assess whether the decision would have been different if they didn't have access to this tool. Given the maintenance chiefs' tendency to make such decisions conservatively, they might have placed restrictions sooner than they actually did with the tool.

b. Forecast information from the tool was used to proactively place restrictions in MT.

In the Lewiston area in Montana, while there were no significant signs of moisture or weeping observed in road surfaces, the maintenance chief looked at the tool a couple of times a week as the weather had slowly been modifying into more of a spring-mode temperature. Based on the information provided by the tool, the chief placed a restriction on MT-80 & MT-81 within the Lewistown Area on March 14th, and the Great Falls chief placed the same restriction on their portion of MT-80 on the same day. Figure 9 shows a screen shot of subsurface temperatures taken on March 15th for MT-80. A clear pattern of thawing is seen for significant depths below the pavement surface. It is noted that the figure might be a bit misleading with such a clear pattern of thaw as it is just a daily snapshot (taken at 10 am). Looking at hourly variations reveals a much more complex thawing and freezing pattern (as nighttime temperatures drop). Though difficult to interpret, this information allowed the maintenance chief to confidently place his restrictions.

He noted that they were seeing more sunny days, warmer temperatures above freezing, including warmer overnight temperatures resulting in melting of snow cover and more bare ground, all indications that the frost would begin to come out. He also reviewed long range forecasts from the NWS to verify a long term general warming trend, and subsurface temperature probe information from their local RWIS sites on MDT's system.

One of the key benefits of the tool reported by the users was the ability to "see into the future" the subsurface conditions. For example, in Figure 9, the maintenance chiefs would have been able to see the warming trend as early as March 5th (using the two-week forecast window). At that time, there were no visual observations reported by the chiefs in their weekly email reports to the evaluator. ESS observations at a nearby site used by the maintenance chiefs showed consistent, above freezing subsurface temperatures only after March 12th (see Figure 10).



Source: Screenshot from Meridian's Use Case Tool

Figure 9. Screenshot Captures of EICM Location on MT-80 from February 21st to April 1st (captured on March 15th)

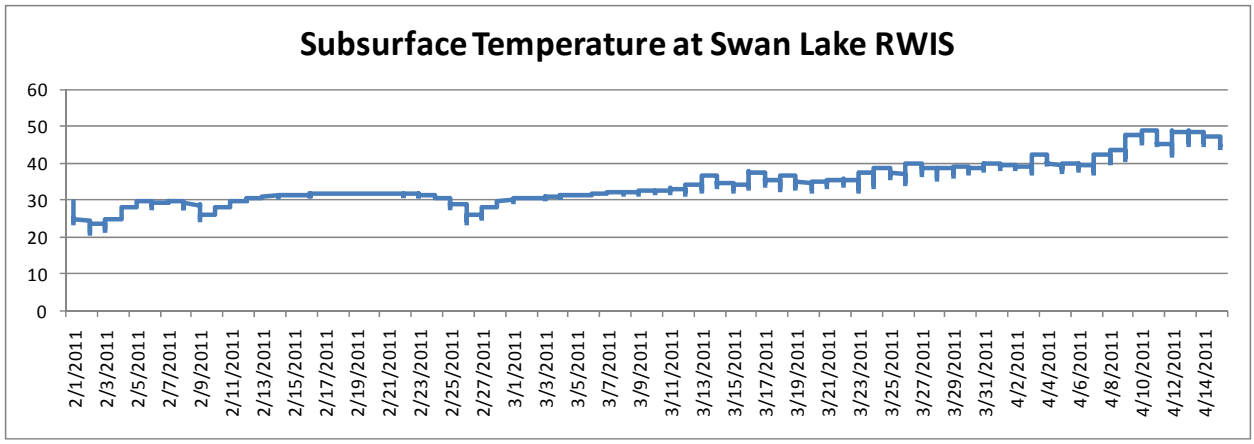


Figure 10. Subsurface Temperatures at Swan Lake RWIS Station in Montana

This trend was noticeable throughout the evaluation area for all active EICM sites that were monitored. They all provided advance indication of thaw that was consistent with actual conditions when they occurred. As a result, this notification greatly increased the ability of maintenance chiefs to be proactive.

The bottom line for restriction placement was that the tool allowed the maintenance chief 7 days of advance warning that enabled him to be proactive about his restriction placement. In addition to the seven day notification period, the tool allowed the chief to communicate and place the restrictions by the 14th. If he had waited for the surface ESS observations that were noted on the 12th, the restrictions would not have been placed before the following Monday (21st), due to the normal administrative delays. Thus, the tool caused the restriction placement to be made earlier by at least 7 days than it would have without the tool, thus enhancing pavement protection.

The maintenance chief's overall comment offers a clear indication of the potential of the tool: "All of this lead me to believe the subsurface frost forecasts from the system were likely accurate. So in an effort to be proactive and limit surface damage to our most susceptible roadways, I placed the load restrictions. I will continue to monitor the system, as well as our subsurface monitors for our RWIS sites to help me determine when to consider removing the restrictions."

c. The tool can inform restriction removal but further validation tests are needed.

The placement of the restrictions is generally easier than removal for two reasons. First, visual observations can support the placement decision, as weeping and moisture on the pavement surface indicate clear signs of thaw. Secondly, the commercial operators expect the restrictions to be placed as the weather warms up so they are not surprised when the restrictions go into effect. The lifting of restrictions is more problematic. Visual observations are not reliable in assessing whether pavement strength has recovered. FWD information is a helpful source for such information but many areas do not have timely access to FWD. Secondly, the carriers are impatient when they observe consecutive days of warm weather. The tool provides a solid rationale for removing restrictions, as the maintenance chiefs can use the resilient modulus information to estimate the recovery of pavement strength. Similar to the restriction placement, they can become aware of the improving strength 7-10 days in advance of it occurring, helping them proactively lift restrictions.

FrezTrax is a heuristic tool developed by Meridian Environmental Technology, Inc. that sets criteria regarding when load restrictions may be imposed and lifted based upon the deficit of heat units over the period from fall to spring. Comparing the use case tool with FrezTrax revealed that the dates suggested by the tool and by FrezTrax vary significantly depending on the selection of the appropriate EICM resilient modulus threshold.

For the use case tool, with the EICM model being a new development, a clear threshold for removal has not yet been determined for use. Over the past two years, the developer has noted that values of the resilient modulus in the top 2 to 4 feet of the sub-grade layer establish a reasonable indication of structural stability adequate to handle traffic loading without soil compaction or lateral shearing. For this evaluation, based on the developer's direction, a resilient modulus of ≥0.4 lbs/in^2 was considered adequate to handle loading due to traffic without pavement deformation, and anything under 0.4 was defined as insufficient and therefore load restrictions should remain in place.

The demonstration reveals the need for field testing where an agency can conduct validation testing of EICM data with FWD measurements and pavement observations over the course of a season. Once these thresholds are set and the forecasts validated, the tool can be expected to provide as reliable a forward-looking indication of the timing to remove restrictions as to place them.

4.2 State DOT Interviews

The interviews with state DOT maintenance personnel from Montana and North Dakota provided the input for assessing the usefulness of the tool.

4.2.1 Qualitative Findings from Montana

The research team scheduled and conducted phone interviews involving maintenance decision-makers in the Great Falls, Lewistown, and Missoula Districts of the Montana DOT. As noted earlier, maintenance decision-makers with MDT noted a general trend over the last several years in upgrading their roadbeds, so the need for a monitoring and prediction tool is not quite as critical as in the past but nonetheless still useful. Restricted roads are typically older and in poorer condition. Currently, MDT has relied on a total of 70 RWIS sites across the state over the past 10 years to assist in making restriction decisions. These sites have subsurface probes[5] to assist maintenance personnel in monitoring thawing. However, no forecast mechanism has been available. Besides the temperature probes, the decision to limit weights also uses input from visual observations, adjoining districts, NWS, National Oceanic and Atmospheric Administration (NOAA), the Weather Channel, and local TV forecasts.

Multiple MDT comments indicated that placing and removing load restrictions "…is more art than science." The magnitude of the standard restriction in loading reduces the allowable non-permit load from 600 lb per inch of tire width to 400 lb per in. MDT might start initially with reducing speed limits for trucks and then reduce load limits if that is also needed.

The administrative delay of about 4 days from the time of the decision to place the restriction is likely a factor that causes additional damage to pavements. Being able to predict the conditions that lead to load restrictions is critical, since MDT needs to allow some time for motor carrier notification.

Specific findings based on analysis of the Montana data indicate the following:

- The primary check on the tool's accuracy was from an RWIS site. Findings indicated that the tool was "relatively accurate" and the user was "fairly comfortable" using it. The user did not check the tool daily due to lack of time.
- MDT will definitely use it again next winter/spring, and they are most anxious to get good forecasts instead of just good measurements of existing conditions.
- Upon removal of the restriction, MDT immediately saw a spike in permit load requests. This finding suggests that the commercial operators abide by the restrictions.
- MDT will be able to provide better confirmation of the tool's usefulness and accuracy after using it for about five more years.

4.2.2 Qualitative Findings from North Dakota

A member of the research team also scheduled and conducted phone interviews involving maintenance decision-makers in the Dickinson and Grand Forks Districts of North Dakota DOT. As with Montana DOT, each

[5] Subsurface probes for the sites in Montana are supposed to be at 18 inches but interviews revealed a high-degree of uncertainty regarding the actual probe depth.

interview involved calling ahead to schedule the conversation and the follow-up call to ask the individual the prepared list of questions.

North Dakota Department of Transportation traditionally initiates load restrictions in the southwest corner of the state (Dickinson) then the restrictions migrate north-easterly throughout the other seven districts. Input to the restriction decision process within NDDOT comes from RWIS data, pavement classification, field conditions such as pavement joints weeping, snow melt, county restrictions, historical data, and actual break-ups. Changes that might affect restriction decisions include roadway strength improvements and abnormal flooding. One challenge is determining how much to change restrictions based on improvements to a specific roadway such as adding an inch of pavement overlay.

Another tool used by NDDOT in the 2010 restriction decision process was FrezTrax, but it served more as a back-up to visual input from section supervisors. The Dickinson District uses four RWIS probes – two in North Dakota, one in South Dakota, and one in Montana.

NDDOT only has one FWD for use in the state, so it uses a sampling approach to collect data in the western four districts one week and the eastern four districts the following week. For the Dickinson District, the FWD process only samples two routes. The interviewee noted that NDDOT would need to use the FWD daily to accurately capture the beginning of the spring thaw, so it is used more for removal than for beginning the restriction. Strength readings from FWD close to 70 to 80 percent of the baseline value constitute conditions for removal of the restriction. NDDOT typically monitors pavement strength with FWD on a two-week cycle during the restriction period but reduces the interval to 1 week approaching the end of the period.

NDDOT tries to provide a notice to commercial operators about a week ahead of the actual restriction but it is sometimes less (e.g., 2 to 4 days). Motor carriers can register with NDDOT and will be sent a notice of intent to restrict roadways once the decision is made, along with a map of affected roads. NDDOT also sends out an impending restrictions notice several weeks in advance. This notice is intended to alert the carriers that NDDOT has started to consider restrictions and they may occur as early as two weeks from the notice.

The major industry segments affected by the restrictions in North Dakota are grain haulers, the oil industry, and overweight permit loads. Restrictions by NDDOT cause commercial operators, in some cases, to migrate to county roads even though those roads are also restricted. Some industry segments apparently ignore the restrictions and pay the fines. Pressure from motor carriers comes at the end of the restriction period rather than at the beginning, especially if the removal is later than usual or as warmer weather and dust become more prevalent.

As with Montana, the interviewees in North Dakota noted that the restriction decision is “never likely to rely on a single factor.” NDDOT decision-makers do not believe they could remove human judgment or engineering judgment from the decision.

Specific findings based on analysis of the North Dakota data indicate the following:

- Overall, NDDOT needed and appreciated the ability to consider a particular pavement structure and establish how much that pavement can support and the magnitude of the restriction. This process needs a more scientific basis. NDDOT has a high degree of variation in pavement types, sub-base, and age.
- Comparing the tool with other input values after its use indicated close agreement with other data.

- Confidence in the tool will come from additional comparisons with current practice. The tool will help NDDOT better understand when to remove restrictions, so it will provide assistance when defending removal decisions to motor carriers rather than just using FWD data alone.
- NDDOT decision-makers believe they need more probe sites to be able to achieve the optimum resolution from the tool. They have only six EICM sites and one ESS site with multiple probes, one extending to 72 inches below the surface.
- The Grand Forks District was able to use the tool immediately and confirm other data.
- FrezTrax includes a map display and, overall, its output was easier to understand than the use case tool's output. Training by Meridian seemed to help but several maintenance personnel initially had difficulty understanding the tool, especially what the subsurface conditions thresholds meant in terms of decision-making.
- Restrictions placed during the spring of 2010 caused more concern from commercial operators than usual, primarily from the oil industry. The Dickinson District is on the southern edge of a large oil field with 130 oil rigs in operation. Each rig generates about 1,000 truck loads during the one-month period of well development. NDDOT's "6-ton" restriction represents a significant reduction in allowable loads to this industry.
- NDDOT decision-makers believe the current process is conservative. In other words, they could probably either begin the restriction later or end it sooner, or both, if they had better information such as that provided by the Use Case #2 tool. They would like to offer more advance notice both at the beginning and at the end of the restriction period. The tool should be able to do exactly that, but NDDOT needs more training and experience with it.

4.3 Web Survey – Motor Carriers

Evaluation findings come from a survey of commercial operators who transport loads in and/or through Montana and North Dakota. Each state DOT was responsible for making the surveys prepared by the research team available to operators in their states. There were no stipulations placed on the survey recipients that they operate only in the respective state, so the mix of intra-state and interstate operators is not known. Questions in the survey attempt to determine the size of the carrier in terms of number of power units, but other details are not known. Other questions on the survey gather information on the impact of seasonal load restrictions on carrier operations.

Following Institutional Review Board review and granting of an "exempt" status, the research team sent the completed motor carrier survey to MDT and NDDOT on April 28, 2011 for dissemination to each state's list of commercial operators. MDT maintains a list of only about 100 subscribers to the email list whereas North Dakota's list has over 2,400 email contacts. Both of these lists are subscription-based and are used for broad traveler notifications.

Researchers monitored the completed surveys and found that survey responses began coming in almost immediately from the NDDOT mail-out and the number increased daily as expected. This effort resulted in a total of 205 fully completed surveys (a response rate of 8%). However, those sent out from MDT, including the web link to the survey, resulted in only one completed survey. The reason for this discrepancy is unclear, but discussions with MDT indicated that the use of the listserv is decreasing as more travelers become used to the website, 511 and the facsimile alert. The research team then asked the MDT to place the survey to motor carriers on its web site for access on a voluntary basis. On June 1, 2011, MDT added the link to its web site. As

of June 10, 2011 no additional responses had been received. It is highly probable that some of the commercial operators who responded to the NDDOT mail-out also operate in Montana but the extent of that potential overlap is unknown.

4.3.1 Montana Survey

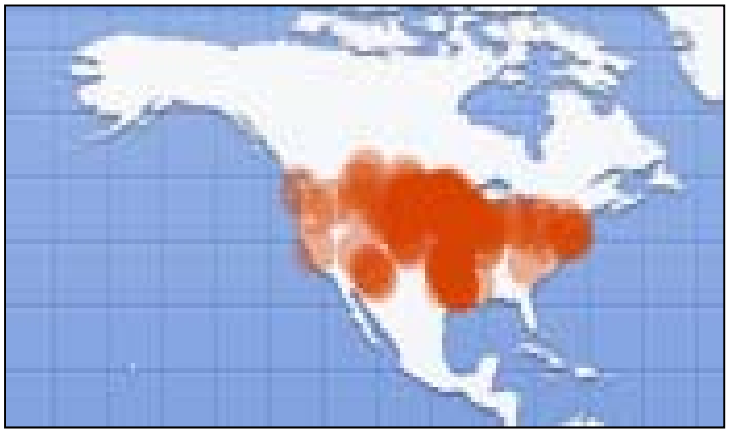
The lack of survey responses to the MDT mail-out and web link prevented the full qualitative analysis of both states that was originally planned. Therefore, the analysis focuses on North Dakota responses.

4.3.2 North Dakota Survey

The objectives of the survey were to determine:

- How much impact the current process for establishing spring thaw load restrictions imposes on the operations of motor carriers, and
- How changing these restrictions might impact their operations.

The survey was developed using a web-based software tool (www.surveygizmo.com), and was conducted online over the period of May 2 through 31, 2011. The survey included 14 questions, and should have taken approximately 10 to 15 minutes to complete. A total of 216 surveys were completed. Figure 11 shows the geographic distribution of responding companies. Each circle on the map represents the location of one or more carrier headquarters, and the darker circles indicate more carriers from that geographic location compared with the lighter shaded circles.



Source: Survey Gizmo, with specification by authors

Figure 11. Geographic Distribution of Responding Motor Carriers

The map indicates that restrictions in North Dakota potentially affect long-distance carriers from coast to coast. Other northern tier states that use seasonal load restrictions might have a similar effect, although it should not be assumed that survey responses from carriers operating in North Dakota apply anywhere else. This section presents the questions prepared for motor carriers and a summary of answers. The survey included a total of 13 questions, so the following results start with a statement in bold type of the question followed by response summaries. Again, these responses came from the survey sent out by NDDOT only, but the effect of

restrictions in North Dakota is felt across the country. Appendix D has the specific comments from motor carrier representatives.

Responses to each of the motor carrier survey questions are presented and analyzed in this section.

Q1. Is your company impacted by weight restrictions during the spring thaw?

A total of 205 motor carriers (95% of the total 216 responses received) indicated that their operations were impacted by load restrictions during the spring thaw. For further analysis of survey results, this evaluation uses responses of only these 205 motor carriers that were impacted by spring load restrictions.

Q2. Please specify the relative percentages of cargo types your company hauls.

Table 4 and Figure 12 summarize the responses.

Table 4. Relative Percentages of Cargo Types

Item	Average
Metals, metallic goods	46%
Timber, wood	34%
Aggregates	55%
Heavy equipment	60%
Minerals, chemicals, fossil fuels	67%
Manufactured goods	42%
Agricultural commodities	83%
All other	53%

For the carriers responding to the survey question about the types of products they carried (N=201), Table 4 shows the relative portion of all cargo types that are carried among this sample of respondents who carry at least some of the cargo types. Agricultural commodities have the highest relative average percentage (83%) of all cargo types. Other significant cargo types include heavy equipment, minerals, and aggregates. Metals, manufactures goods, and timber are also important but represent a somewhat lower relative percentage of hauled cargo. Figure 12 provides additional information about the number of carriers that carry any amount of each type of product, and also shows the subset of each of those carrier groups that carry 100 percent of that product; that is, it is the only product they carry. For example, 100 respondents, representing half of the 201 valid responses to this question, reported carrying heavy equipment and 26 of those carry only heavy equipment. For the 59 carriers of agricultural products, 36 of them (61%) only carry agricultural products; hence, the average among all carriers who carry those products is quite high (83 percent, as shown in Table 4).

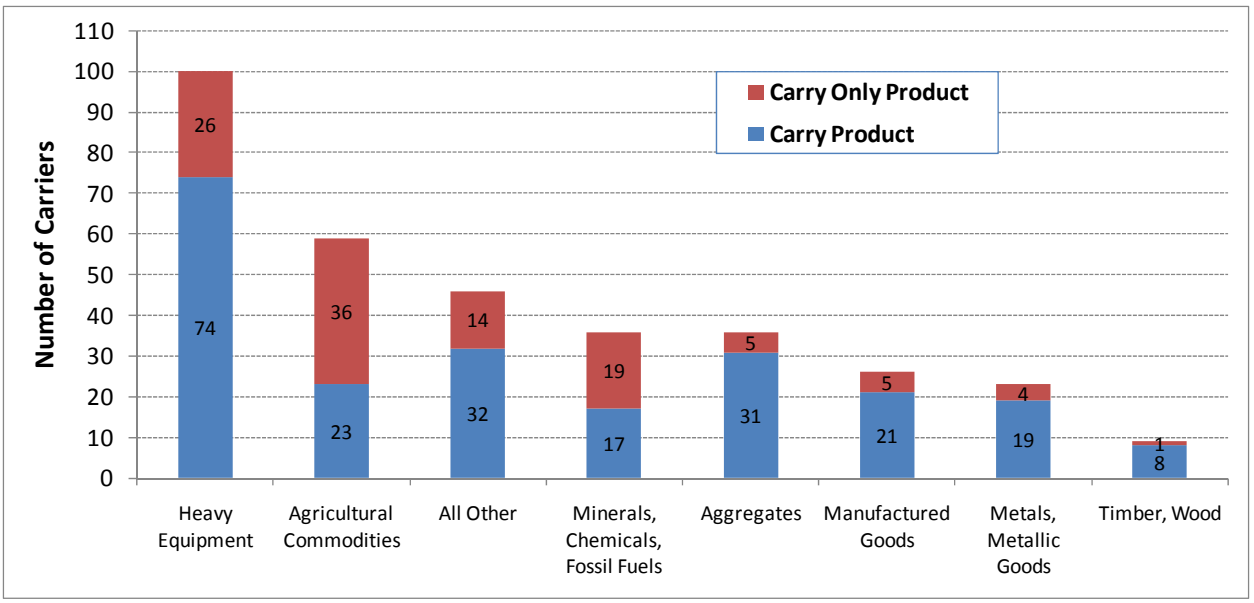


Figure 12. Number of Carriers by Type of Products Transported (N=201)

Q3. How many power units does your company operate that travel within or through North Dakota?

Table 5 summarizes some basic statistics, including minimum, maximum, average, median, and standard deviation of the number of power units.

Table 5. Number of Truck-Tractors and Straight Trucks

Statistic	Truck-Tractors[a]	Straight Trucks[b]
Minimum	0	0
Maximum	1,500	500
Average (Mean)	48	12
Median	7	0
Standard Deviation	147	44

[a] Truck-tractor is a vehicle with two or more axles with engine and cab, used to pull one or more trailers or semi-trailers.

[b] Straight truck is a single-unit truck with engine, cab, and body (or "bed") connected by a single chassis with two or more axles for hauling goods, but has no trailer.

The values in Table 5 as well as the relative frequency distribution in Figure 13 show that the numbers of truck-tractors and straight trucks vary greatly among motor carriers and have highly skewed distributions. The median number[6] of truck-tractors is 7 among 192 respondents to this question, and 95% of respondents report having at least one truck-tractor in their fleet. Fifty-four percent of respondents (N = 104) report having no

[6] The median is the value above and below which half of all values occur in the distribution of responses.

straight trucks. The distribution shown in Figure 13 is truncated at 100 power units. Fifty-four percent of the responding companies report having 10 or fewer power units operating in North Dakota while 15 percent report operating between 100 and 1,500 units. This sample of companies operates 11,435 power units at least part time in North Dakota, representing a substantial volume of commercial traffic that could, potentially, be affected by spring load restrictions. There are many other companies not included among these respondents that also operate in North Dakota.

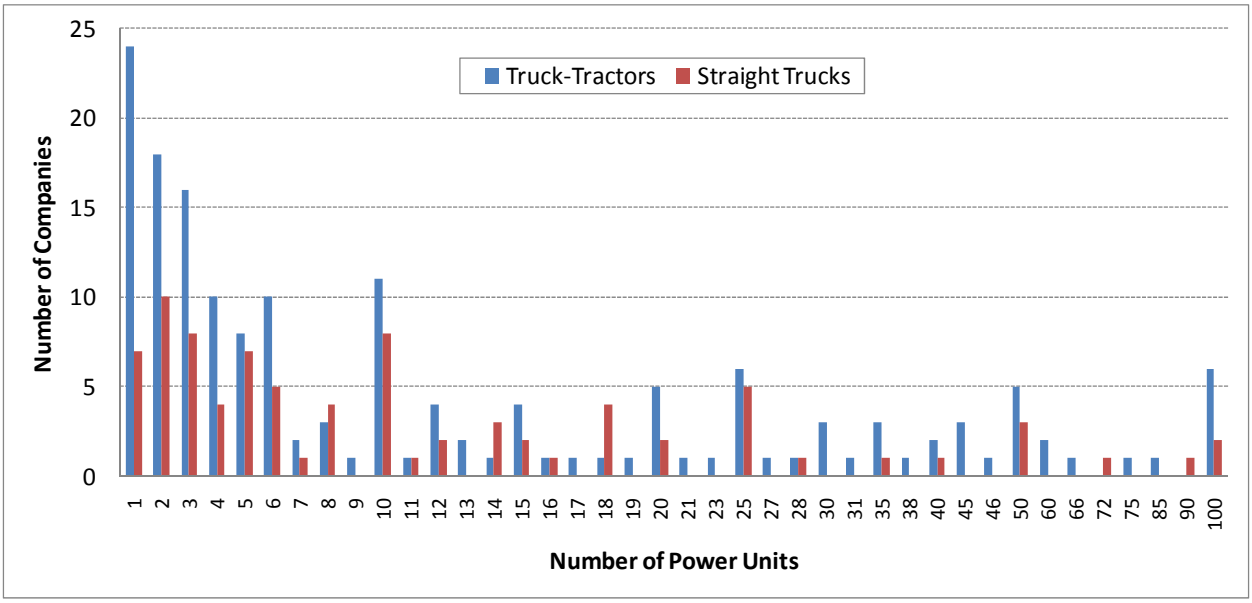


Figure 13. Frequency Distribution of Power Units that Travel within or through North Dakota

4. What percent of your annual shipments occur during the spring load restriction season?

Figure 14 shows the distribution of responses to the question regarding the percent of annual shipments occurring during the spring load restriction period. The presumption is that these are shipments in or through North Dakota, though some respondents may have interpreted this question to refer to their nation-wide shipping during this period. The distribution is skewed to the right. More than half (58%) of the responding motor carriers claim they haul from 0% to 25% of their annual shipments during the spring load restriction period. About 14% of carriers claim they haul more than half of their annual shipment during spring load restriction. Given the relatively short length of this restriction season in any given year, coupled with the disincentive to operate under restricted travel conditions, these data, reflecting significant shipment activity during restricted periods, need to be interpreted with caution, and the results are not representative of all shipments in North Dakota.

In order to better understand the distribution by shipment type during restrictions, the results presented in Figure 14 are examined in three groups to be able to see how shipment types are distributed by companies that have small, intermediate and large portions of their shipments occurring during the restriction season. Figure 15 shows that companies that say they ship a high portion of all their shipments during the restriction season in North Dakota (14% of respondents say they ship 60% or more during restriction season—the green bars) are shipping mostly agricultural commodities, manufactured goods, and other unspecified products, compared with the shipping patterns of companies that ship smaller portions of their shipments during

restriction season (57% of companies say they ship 25% or less during restriction season—the blue bars). Look at heavy equipment for example. As shown in Figure 12, heavy equipment is the product type most of the survey respondents said they ship. Figure 15 shows that the companies shipping heavy equipment are much less likely to make these shipments during the restriction season than at other times of the year. The explanation for these patterns may be associated with the flexibility carriers have in timing their shipments according to the type of materials they have to ship. Agricultural commodities may be more time sensitive than heavy equipment, for example. Or alternatively, heavy equipment and aggregates, for example, may be much more costly for shippers to accommodate when having to ship on restricted roadways.

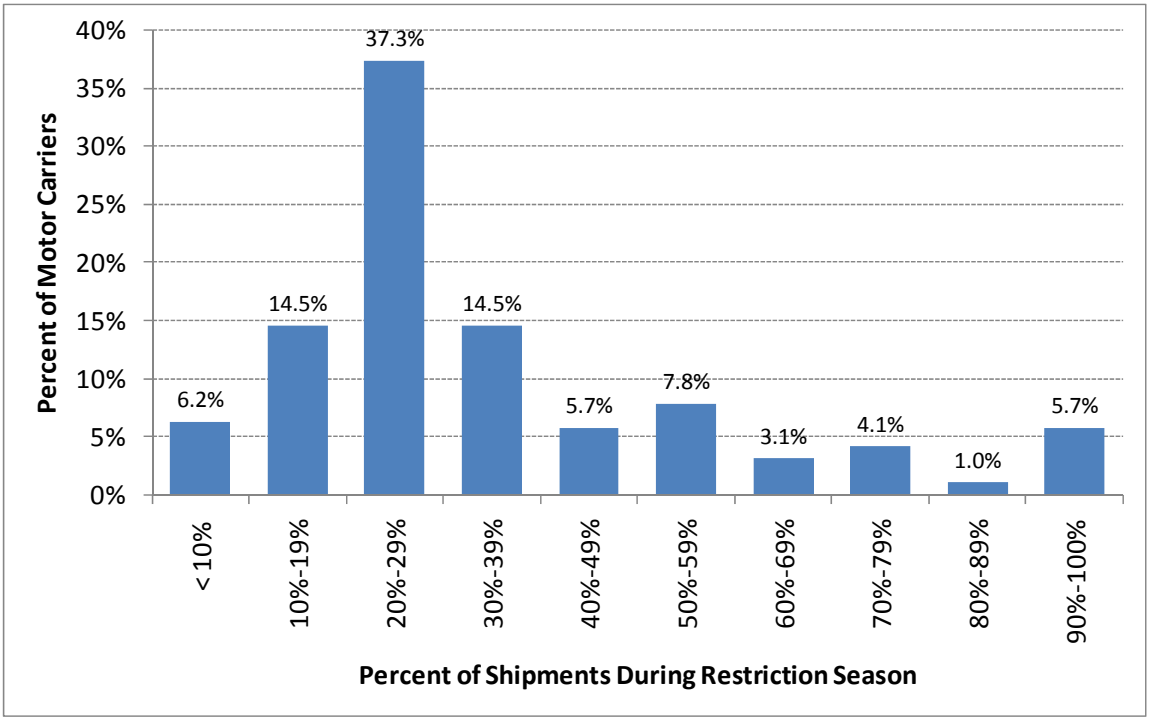


Figure 14. Percent of Annual Shipments during Spring Load Restriction Season

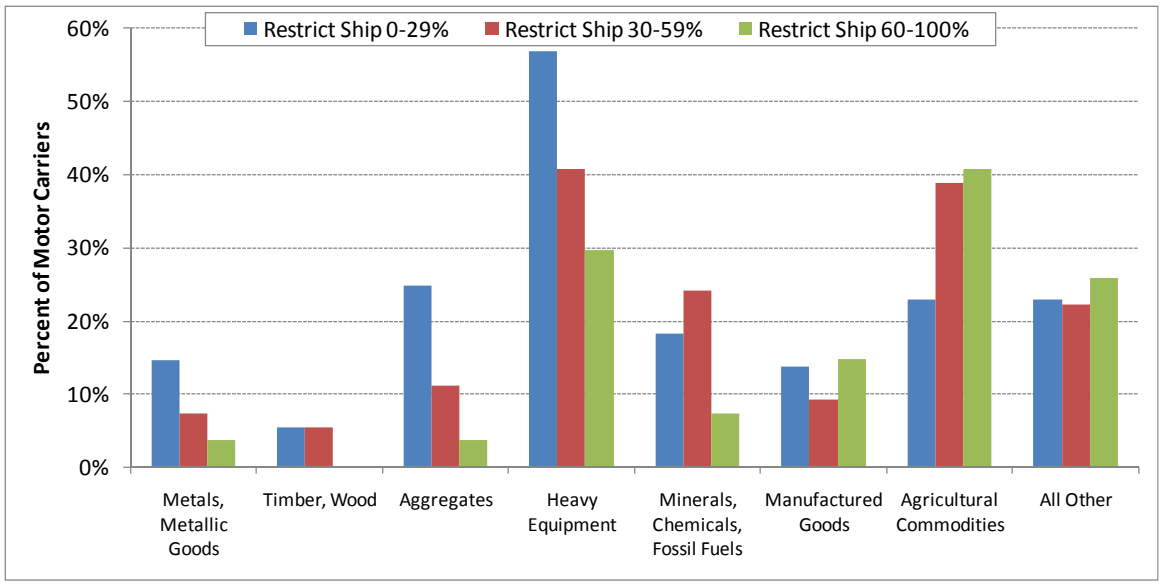


Figure 15. Distribution of Shipments by Type during the Restriction Season

Q5. How does your company usually respond to the seasonal load restrictions?

Figure 16 shows the distribution of motor carriers' responses to the seasonal load restrictions, in terms of their operational responses to those restrictions.

The two most common responses were:

- Chose different routes (used by 72.2 %), and
- Alter/divide loads to meet restrictions (used by 66.3%).

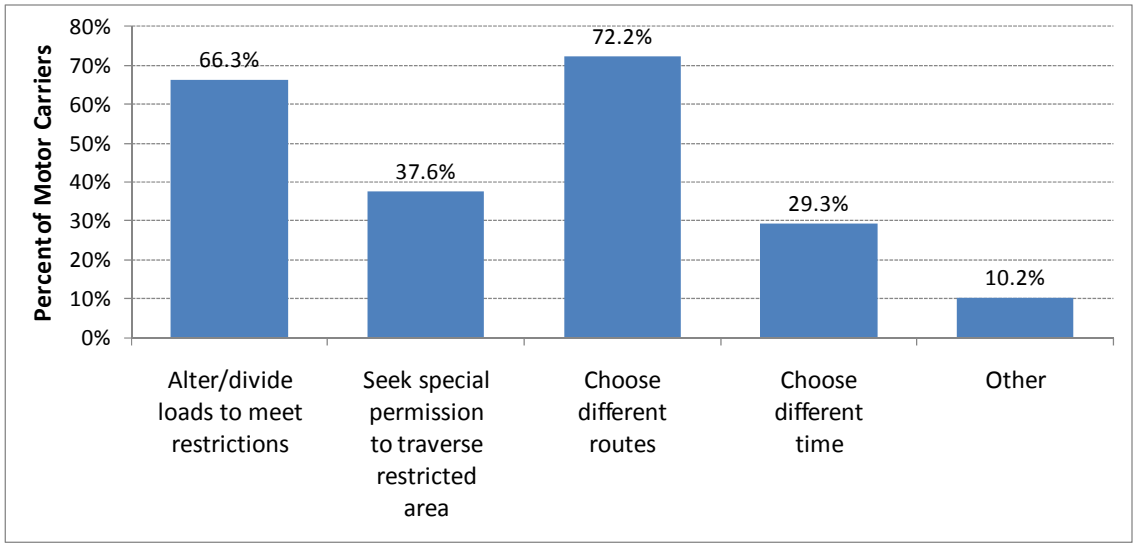


Figure 16. Motor Carriers' Responses to Seasonal Load Restrictions (N=205)

Motor carriers that chose different routes during seasonal load restrictions (N=148; 72.2%) were also asked how many total additional miles during the entire restriction season they have to travel. Figure 17 provides the distribution of their responses.[7] The average miles traveled by over-the-road combination trucks vary from about 100,000 miles to 200,000 miles per year depending on several factors. The Highway Performance Monitoring System (HPMS) data indicate that, for 2008, combination trucks traveled an average of about 184,000 miles during that year and straight trucks a little more than half that amount[8]. To estimate the impact of SLR in terms of the extra miles incurred by the carriers who responded to this survey, the carriers' mix of trucks was assumed to travel the national average. Those carriers who chose alternate routes to avoid restrictions and also provided the number of trucks by type in their fleet (N=140), averaged about 3,200 additional miles per year (calculated from the data shown in Figure 17, using the category mid-points). Taking account of the mix of trucks in each carrier's fleet and the number of truck-miles estimated that they traveled per year, these carriers on average are estimated to have experienced 0.03 percent additional miles a year due to the extra miles they said they traveled to avoid restrictions. For smaller carriers or carriers operating primarily in North Dakota, their annual miles traveled may be less than the national average, and as a result the additional miles traveled to avoid restricted roads could represent a higher portion of their total miles traveled. Notwithstanding that this is a very approximate estimate, the overall impact to the carriers, in terms of additional miles incurred due to SLW is relatively small. Regardless, for some carriers the burden could be much greater, and as a generalization across the industry, motor carriers operate on very tight profit margins.

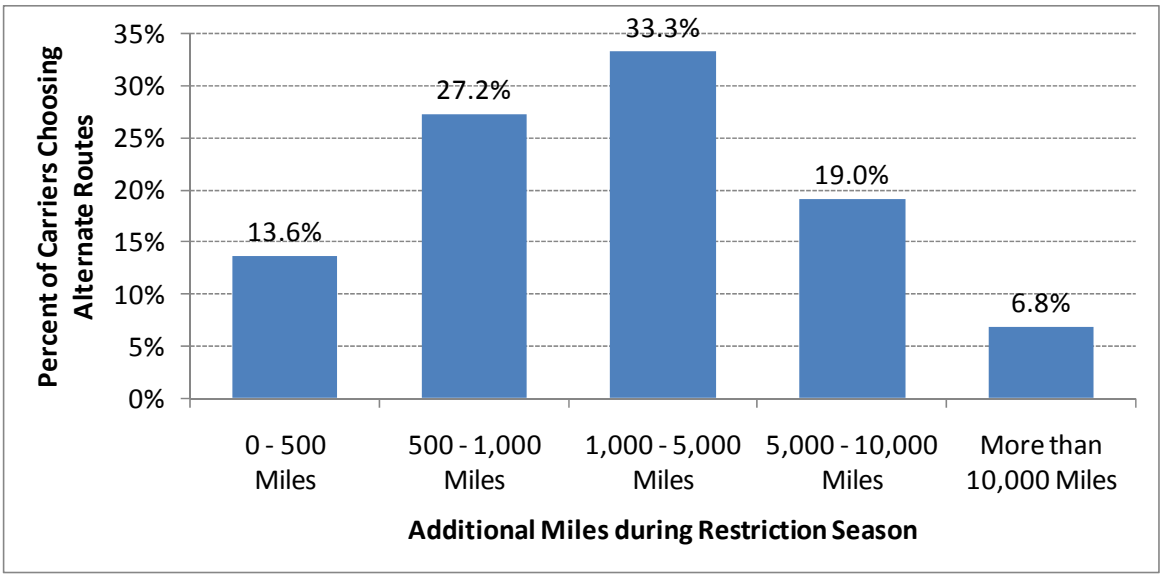


Figure 17. Additional Miles per Season for Choosing Different Routes (N=147)

Finally, of the 205 respondents answering how they respond to restrictions (Q5, Figure 16), 21 respondents (10.2%) chose the "other" category, and of those, 14 explained how they responded. Appendix D lists the

[7] Note that the categories for responses to this question were discovered to have been improperly specified, as the categories overlap and should have been mutually exclusive. Thus, these results need to be interpreted with caution, though the overall effect on category groups is expected to be small, given the large range of values covered by each category.

[8] http://www.fhwa.dot.gov/policyinformation/statistics/2008/vm1.cfm#foot5. Since obtaining data from this site, it now appears to not be operational. The authors are seeking an updated link.

detailed responses to the "other" category, and these responses are further categorized and presented in Figure 18. Because some respondents offered several alternative operational responses, there are more items in the categories (16) than there are individuals responding (N=14). The predominant response under "other" was the comment that, in order to avoid restrictions altogether, some motor carrier won't conduct shipments in North Dakota during the period when restrictions are in place (6 of the 16 responses). However, this number represents only 2.9 percent of all the respondents, and those six carriers say they carry a variety of load types such that the type of load can't explain the reluctance to ship during restricted load conditions.

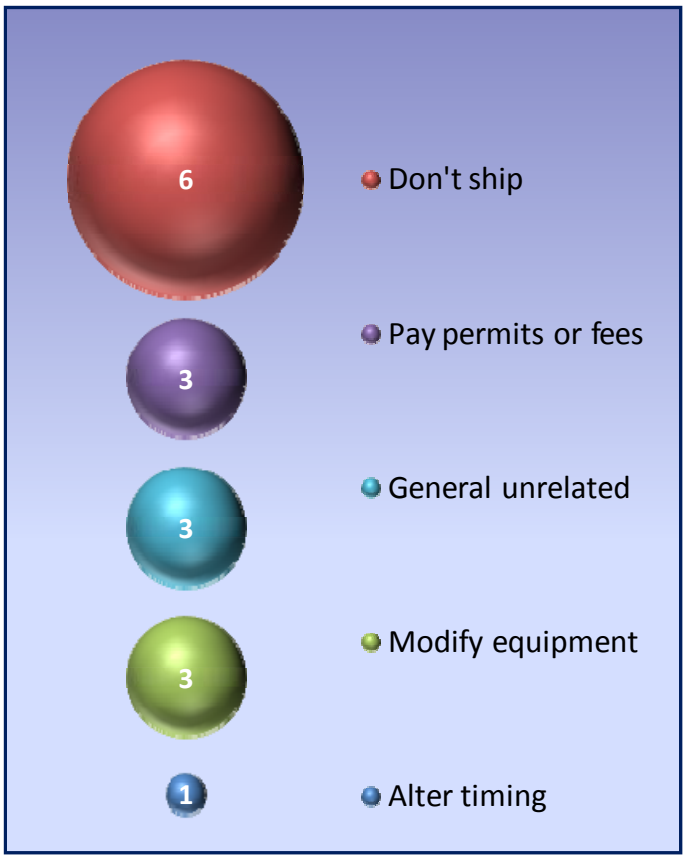


Figure 18. "Other" Responses to Q5 (N=14)

Q6. Is divisible load permitting available during the spring thaw?

As shown in Figure 19, nearly one quarter (24%) of motor carriers have divisible load permitting available. Those who had this option (i.e., answered *Yes)* were also asked if they actually used it. Three quarters of them (33, or 17% of all carriers responding to this question) indicated that they used divisible load permitting during the spring thaw.

All states and a few other jurisdictions around the U.S. offer *non-divisible* load permitting throughout the year to allow movement of OS/OW loads that cannot be reasonably disassembled for movement. Examples of non-divisible OS/OW loads are earthmoving equipment, large oil well components, large generators, and wind energy generation components. A motor carrier can request a permit for moving such non-divisible loads, but

will be required to pay the required permit fee and, in many cases, must follow a prescribed route and abide by certain time-of-day restrictions.

A limited number of states also allow more weight for *divisible* loads. In this case, the state offers permits to qualified motor carriers, that allows them to haul more than the statutory axle and/or gross vehicle weight limits. Many of these programs do not limit the movement of such loads by route or by time of day as in the case of non-divisible load permits. With divisible load permitting, a motor carrier pays a fee to haul additional weight for general commodities (e.g., sand, gravel, and agricultural commodities). In states where seasonal load restrictions are imposed, one way to continue legally hauling more than the restricted load is to purchase a permit. This permit would reduce the weight-limiting impact of the load restriction on the carriers that find the need to use them and are willing to pay for them. States like North Dakota have to assess the tradeoffs involved in issuing permits for OS/OW loads with the risk of pavement damage, especially during periods when the roads are restricted, and they are carefully selective of the over-weight amounts to allow and the specific roads on which they are allowed.

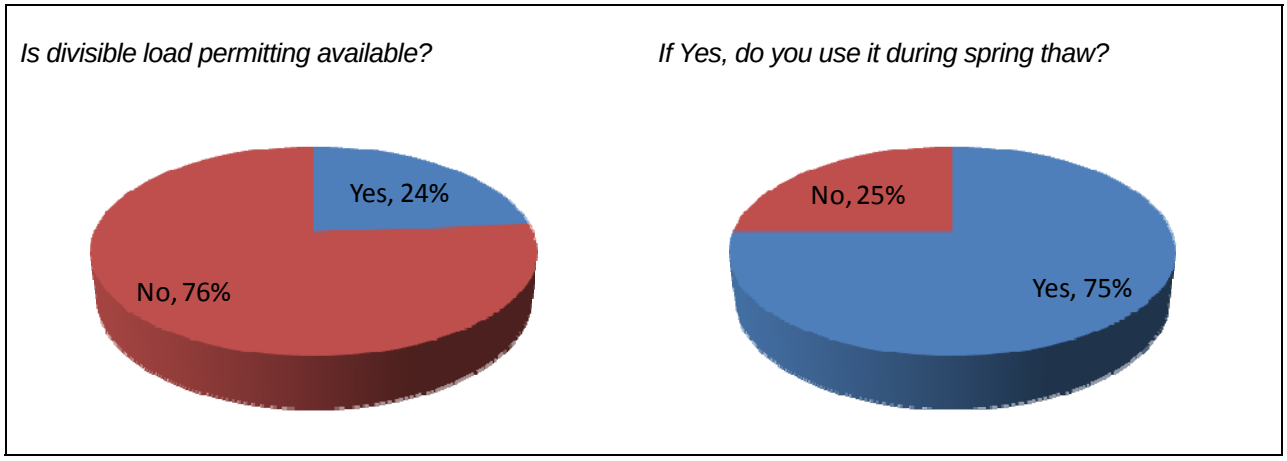


Figure 19. Divisible Load Permitting During Spring Thaw (N=190)

Q7. What other impacts do the restrictions have on your operation?

Figure 20 shows a distribution of the answers pertaining to other impacts of seasonal load restrictions besides those already covered above. The most prominent response was increased hours of operation for hauling the same freight (70.5%), followed by additional drivers (41.0%) and changes in equipment (33.5%).

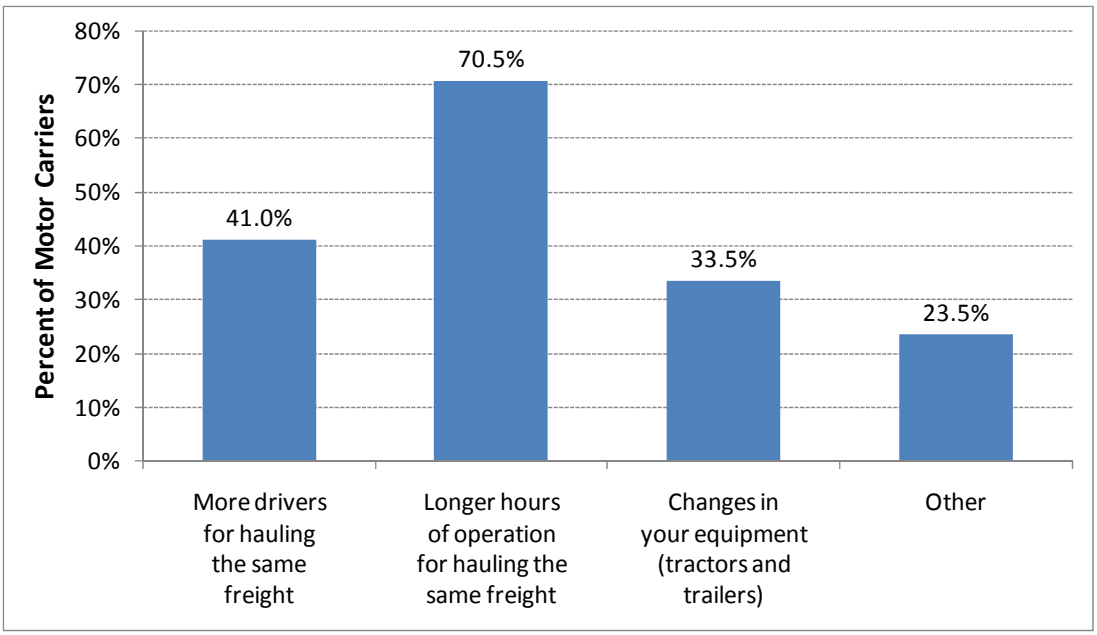


Figure 20. Other Impacts of Load Restrictions on Motor Carrier Operations (N=200)

Motor carrier respondents who said they made changes in their equipment in response to load restrictions were asked to indicate what kinds of changes they made. Of the 67 respondents (33.5%) who said they changed equipment, 53 offered more details. Appendix D provides the detailed responses to this question by these 53 respondents, and Figure 21 summarizes those responses. Since some respondents included more than one type of equipment change, the number of changes shown in Figure 21 is 58. Most of the equipment changes involve adding additional axles to carrier trucks, and many also reconfigure their equipment to use smaller or lighter trucks. Some reduce load size without altering their equipment, but many use a combination of smaller trucks and lighter loads. A number of these respondents noted that they experience higher costs associated with having to make these changes, mainly because the transport of a given amount of material requires more trips to complete. A few carriers noted that they have had to purchase special equipment to meet the restriction requirements, and one had to pay for a third party to haul their material.

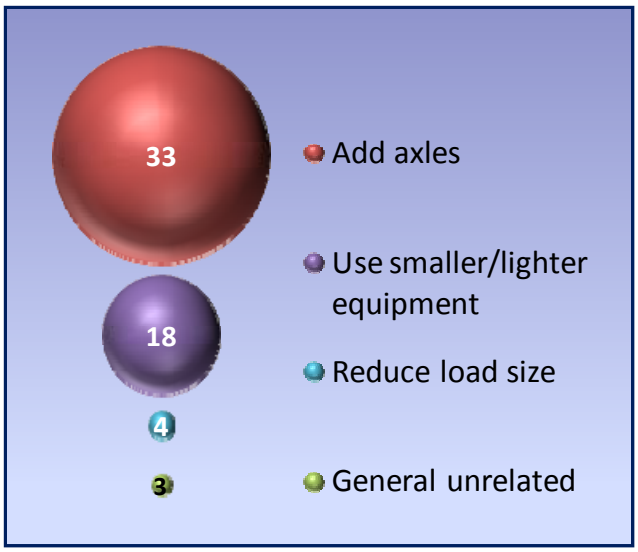


Figure 21. Description of Equipment Changes, from Q7 (N=53)

Finally, of the 200 respondents answering Q7 regarding the impacts that SLRs have on their operations, 47 (23.5%) checked the category "Other" (see Figure 20) and 42 of those respondents provided additional comments. Appendix D lists the detailed responses to the "other" category, and these responses are further categorized and presented in Figure 22. Because some respondents offered several alternative "other" responses, there are more items in the categories (45) than there are individuals responding (N=42). The predominant response under "other" was the comment that having to deal with load restrictions is costly and leads to reduced profits for the carrier. This includes added costs of configuring equipment and loads, lost business opportunity, longer routing, overtime pay, fuel expenses, more trips, weight permits, and other such cost factors. Reduced or delayed shipments were cited by many (14) respondents, along with the need to adjust shipment timing and routing, and these factors also contribute added costs to the carrier.

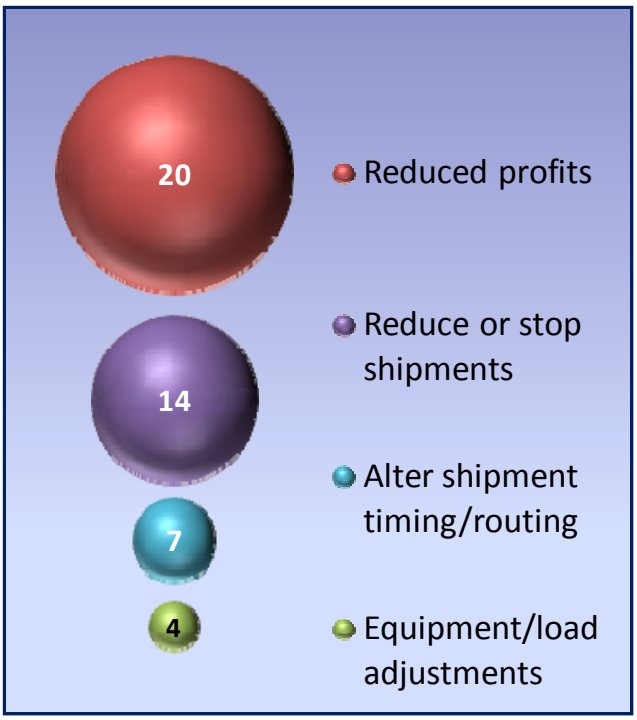


Figure 22. "Other" Responses to Q7 (N=42)

Q8. How do you usually learn about load restriction information?

Figure 23 shows a distribution indicating how the motor carrier respondents said they learned about seasonal load restrictions.

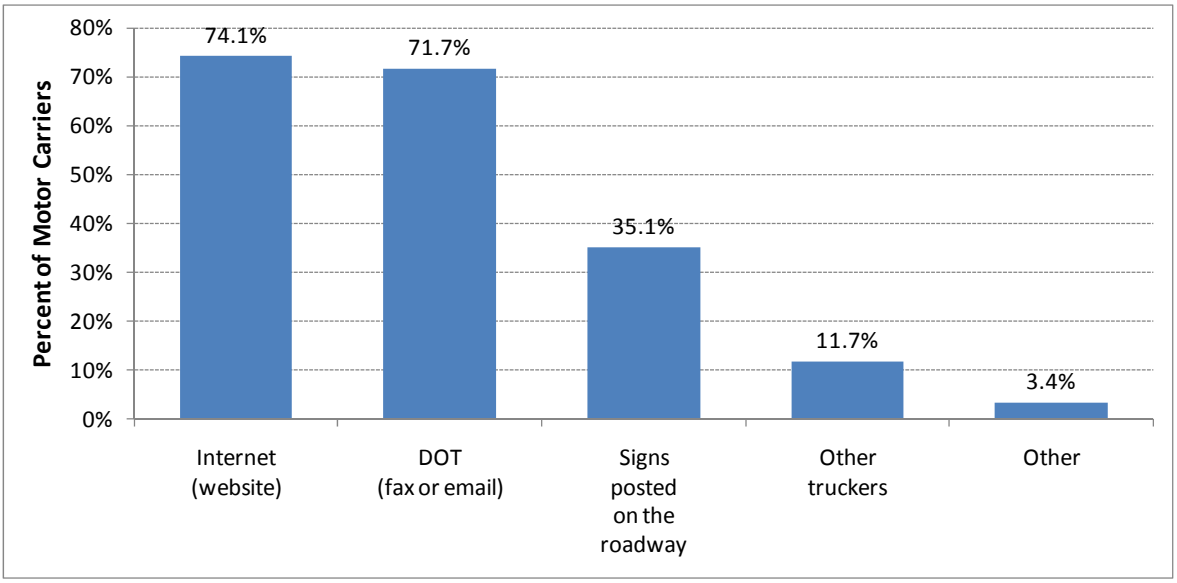


Figure 23. Information Sources for Learning about Load Restrictions (N=205)

Most respondents said they learned about the SLRs from notices posted by the DOT on the internet, by a direct fax or email from the DOT, or both. About a third (35.1%) of the respondents said they saw restriction signage on the roadway, and a few (11.7%) said they learned of the restrictions from other truckers. An even smaller number of respondents mentioned other sources of SLR information (7 respondents, or 3.4%), and the comments from six of those respondents are included in Appendix D and summarized in Figure 24 below. Some of the respondents offered more than one way they learned about the SLRs.

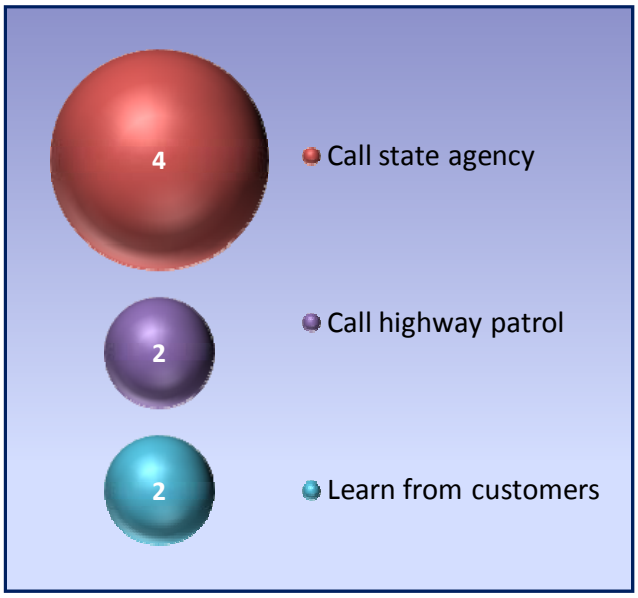


Figure 24. "Other" Responses to Q8 (N=6)

Q9. How much advance notice do you usually receive about load restrictions before they are imposed?

Unfortunately, the response categories for this question were ambiguously specified such that the responses cannot be properly categorized. NDDOT indicated that typically 3-5 days notice is given prior to restrictions going into effect with a variance of a few days either way depending on the year. NDDOT does send out news releases several weeks in advance, warning the industry of the upcoming load restriction season.

Q10. Would earlier notice regarding upcoming load restrictions be of value to you?

As indicated in Figure 25, the majority of motor carriers (61.6%) reported that earlier notice would not be of significant value to them. This response may be due to the fact that NDDOT sends advance news releases several weeks in advance that restrictions are likely to be imposed which might provide enough warning for the carriers. Those who said earlier notification would be useful to them were asked to describe how that would be of value. Sixty-nine carriers (34% of respondents to Q10) provided their comments, and these are listed in Appendix D and summarized in Figure 26 below. The most common reasons stated were that more time is needed to plan the trip, schedule loads, identify alternate routes, and inform customers in advance. The data further suggest that carriers responding to the survey that earlier notice would be of value also reported receiving somewhat shorter advance notice of impending restrictions (average 3.8 days) compared with carriers who say earlier notice would not be of great value (average 4.9 days).

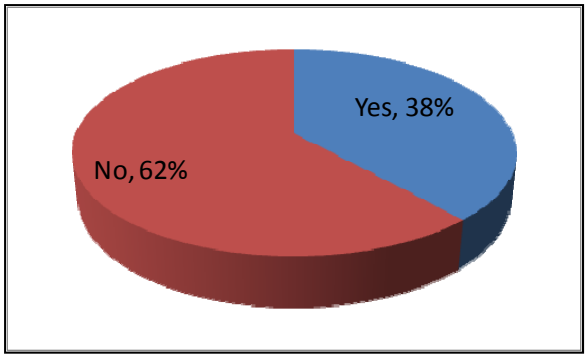


Figure 25. Percent of Motor Carriers that Would Benefit from Earlier Notice of SLR (N=203)

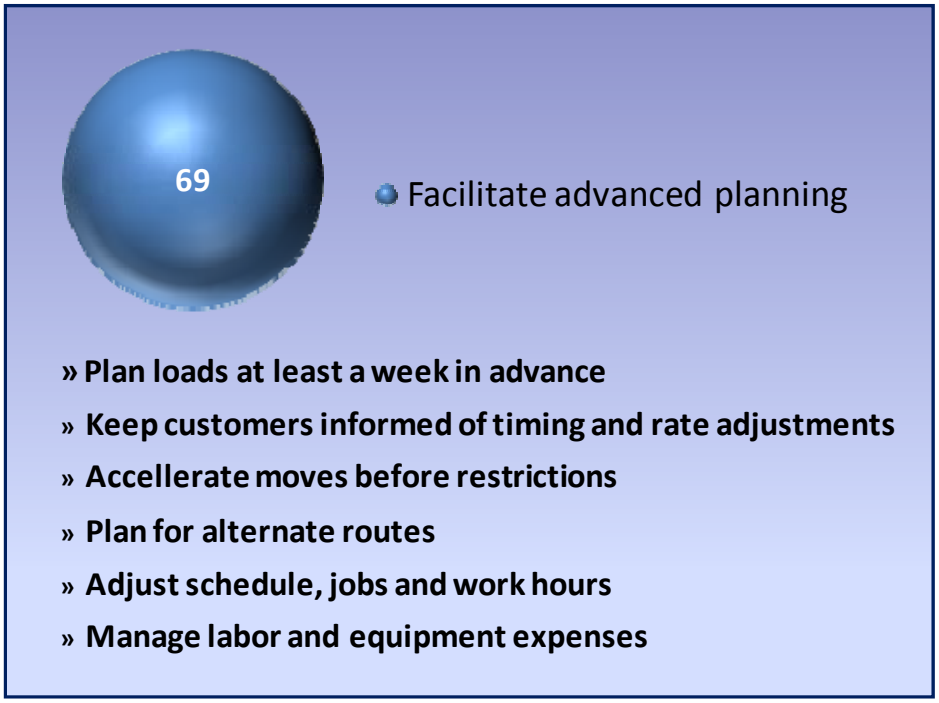


Figure 26. Benefits of Earlier Notification of SLRs (Q10; N=69)

Q11. Would shortening of the duration of load restrictions be of value to your company?

Reducing the length of time of the restriction period was important to 86% of the responding motor carriers as indicated by Figure 27. Those who said shortening the duration of load restrictions would be of value to them were asked to describe how that would be of value. One hundred forty-five carriers (71% of respondents to Q11) provided 178 comments, and these are listed in Appendix D and summarized in Figure 28 below. These comments fell broadly into two main categories: 1) Shortening the duration of load restrictions would result in lower costs or higher revenues, and 2) it would also reduce operational impacts and increase efficiencies. There is overlap conceptually across many of these responses (e.g., more efficient use of equipment leads to reduced costs and increased productivity; reduced need to re-route to avoid restricted roads leads to more timely shipping and reduced costs). While all respondents would value fewer restricted roads and shorter (or

no) restriction periods, many also said they recognize the value of load restrictions in helping protect the integrity of the pavements. The imposition of the minimum restrictions necessary to protect the roads would likely be respected by most carriers as a necessary cost of doing business, and this use case tool offers the states the capability to do just that.

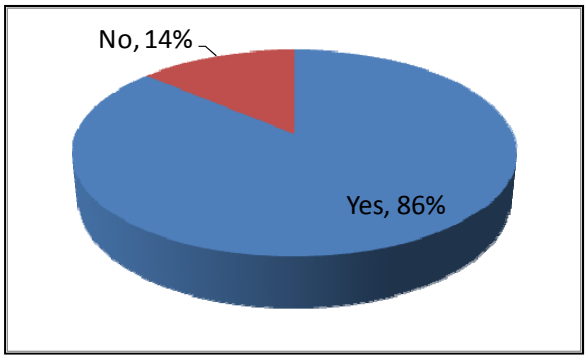


Figure 27. Percent of Motor Carriers that Would Benefit from Reducing the Time of SLR

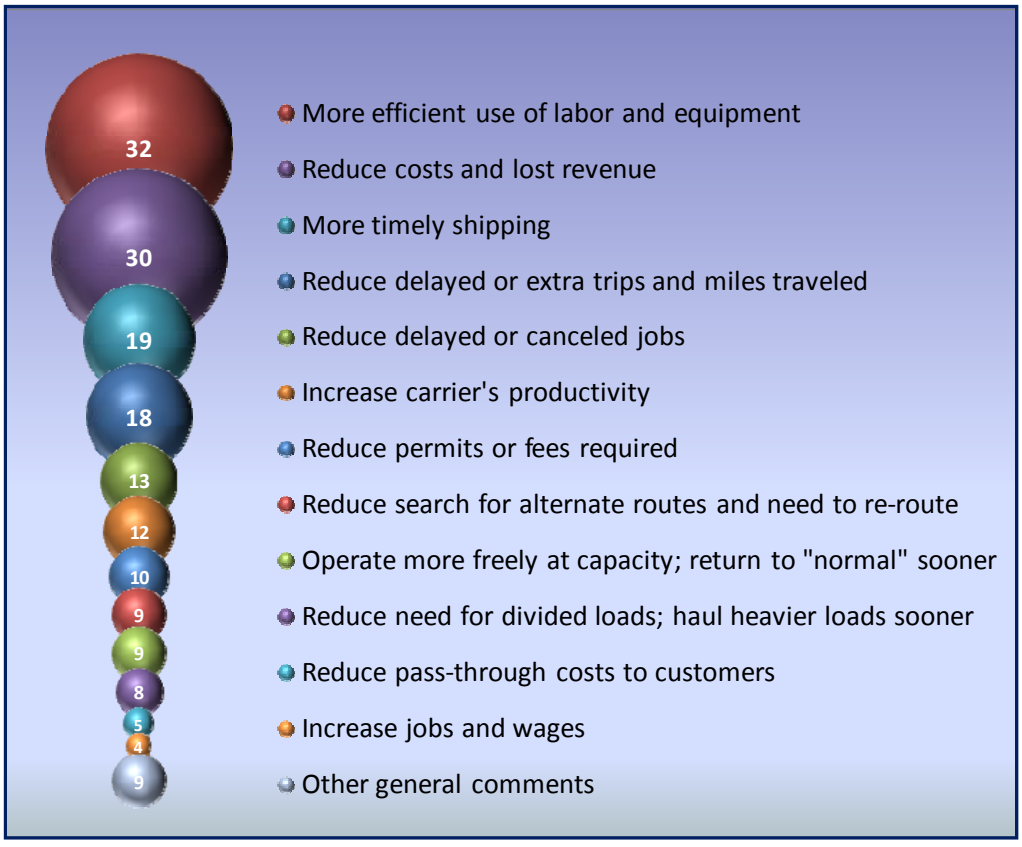


Figure 28. Carriers' Description of Value of Shortening SLR

Q12. Are there other improvements in restriction policy that need to be made?

As indicated by Figure 29, this question led to an almost even split across responses from the motor carriers. A little over half (53%) had no improvements in restriction policy to recommend while the balance did offer suggestions.

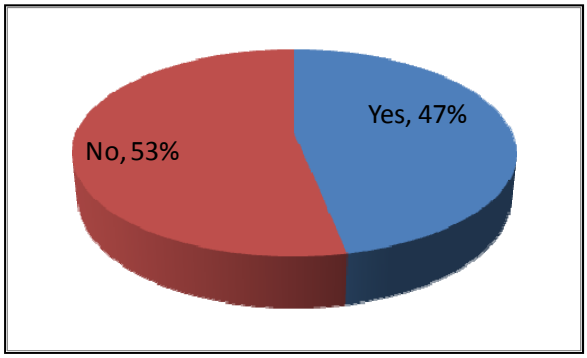


Figure 29. Percent of Motor Carriers that Want Changes in SLR Policy

Of the 89 respondents (out of 190 who answered question 12) who said they could suggest other improvements to SLR policy, 83 offered specific suggestions, and these are summarized in Figure 30. While there were many modifications suggested, most carriers responding accepted the need for some restrictions.

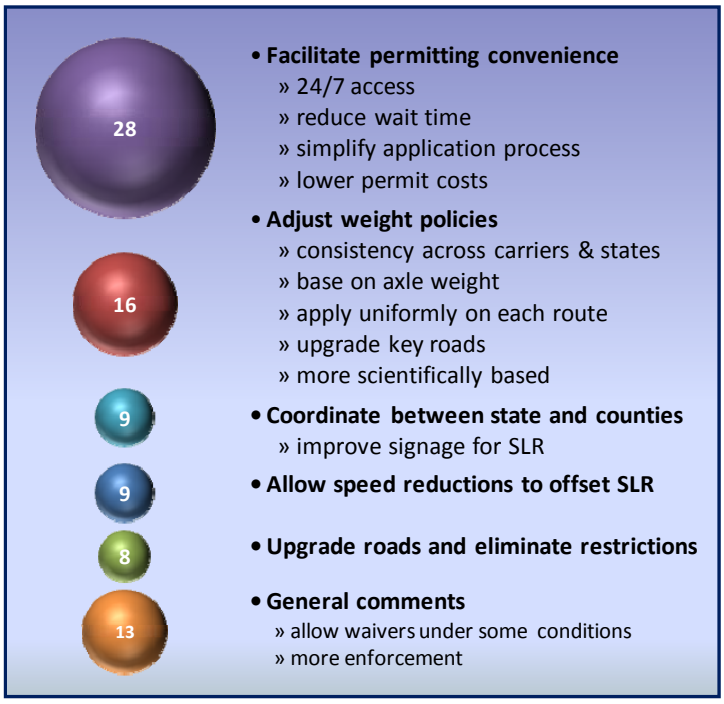


Figure 30. Carriers' Suggested Improvements to SLR Policy

13. The final question asked respondents for any additional comments.

A quarter of the carriers (51, or 25%) offered additional comments at the end of the survey. Many of these comments reiterated comments provided to the earlier questions. The key points are illustrated in Figure 31, and the full set of comments is contained in Appendix D.

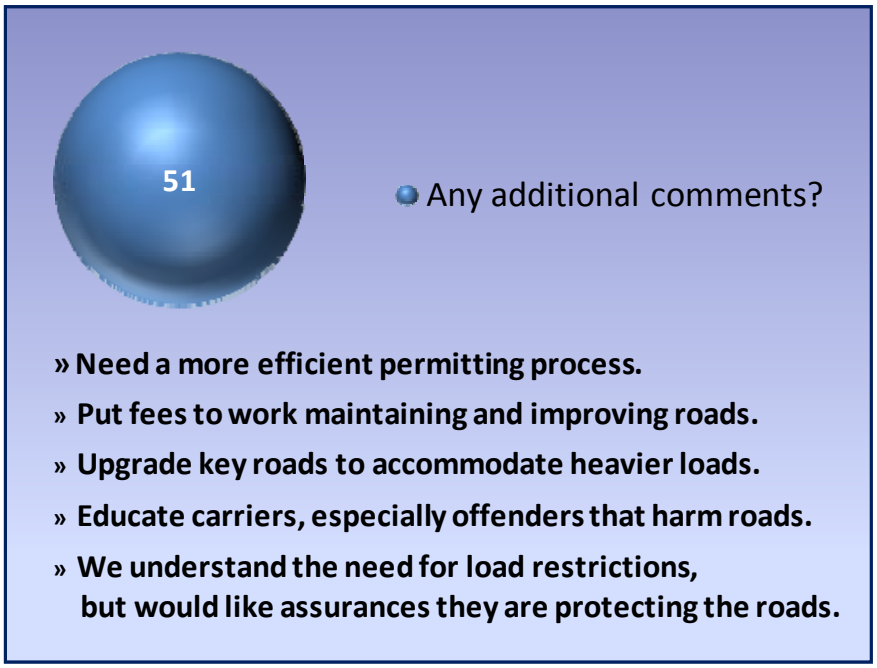


Figure 31. Carriers' Additional Comments

Several illustrative comments are quoted below:

- "As time goes on it is getting harder for freight companies to make a profit, with having to run extra miles or proceed with restricted payload as well as the higher fuel costs, everything is noticed right away when margins are tight. But also realize that without restrictions roads would be destroyed! End of the day this is something that has to be done and we as trucking companies will just have to deal with it!"
- "It is a tough situation. It will take time, resources and patience and planning to work through."
- "I understand the reason for the Spring Load Restriction and it's a good thing. But these roads are already beat up and with the growing production of the OIL and GAS and all the trucks that have to travel these roads I greatly think it is time that the state of North Dakota needs to start improving all of its roads. The revenue that is being generated for the oil & gas boom has to be very good."

4.4 Agency Level of Satisfaction

In June 2011 the research team supplemented the information previously gathered through interviews with state DOT personnel with additional data to quantify the maintenance chiefs' perceptions of and experience with the tool. This involved an additional set of questions sent independently to the maintenance personnel involved in this demonstration in each of the two states as an email message. Four out of the 10 recipients of this short set of questions sent the evaluations back with the requested information.

Figure 32 indicates the responses from the two states, indicating their assessment of the **concept** behind the SLR tool (the idea of providing maintenance supervisors the detailed information from the experimental tool for load restriction decision support). The state maintenance directors were asked to rank each of the questions from 0 to 10 based on their perceptions of the concept, where 0 was the lowest rating and 10 was the highest rating. Average ratings in terms of the need of the concept (6.8) and the potential of the concept (7.3) indicated a fairly high degree of perceived value of the concept. Adaptability (6.5) and acceptability (5.5) ratings were rated a little lower and accompanying comments indicated a need for validation of the information provided by the tool. Improving safety was not a major expectation for this tool and was rated appropriately lower than the other dimensions.

Figure 33 shows the responses from the two states indicating their assessment of the tool's **readiness** for deployment and use. Maintenance personnel had used the tool during the previous spring thaw (spring 2010). Again, researchers asked the two states' maintenance directors to rank each of the questions from 0 to 10, based on their perceptions of readiness for use, where 0 was the lowest rating and 10 was the highest rating. Their perceptions of reliability (7.3) and trust (6.8) were rated positively. There was a spread of responses on the ease of operation of the use case tool (5.8 with only moderate agreement), probably based on whether users were able to attend the training sessions conducted as part of this demonstration. Accompanying comments also revealed uncertainty in setting thresholds for decisions based on the tool. Apparently during the demonstration the users were still figuring how to interpret the subsurface information provided by the tool and how best to apply it in support of their decision-making.

Both of these figures regarding perceptions of the concept and readiness show the average of the responses to each question, along with a measure of agreement across the respondents on each question. To better show the degree of agreement or disagreement, a measure of variability around the average response is shown as the inter-quartile range.[9] The closer these two dotted lines are to the average for each question, the greater the degree of agreement among all respondents on the question.

[9] The first quartile is the point on the score scale (0 to 10) below which 25 percent of the cases fall, and the third quartile is the point on the score scale below which 75 percent of the cases fall. Thus, the first and third quartiles contain half of all the response scores.

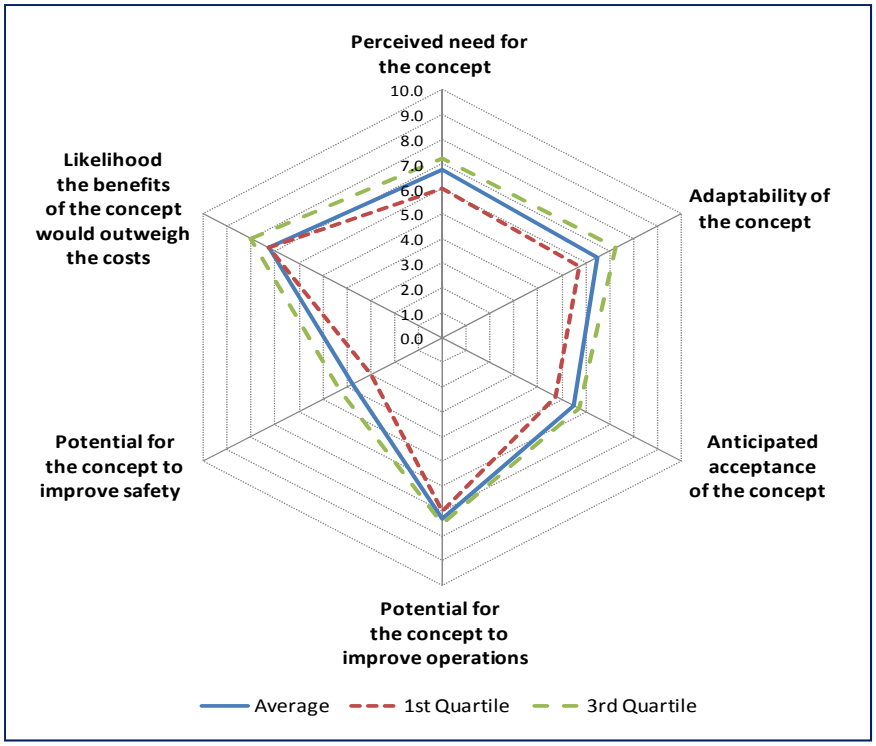


Figure 32. State Users' Assessment of the Concept of the Tool

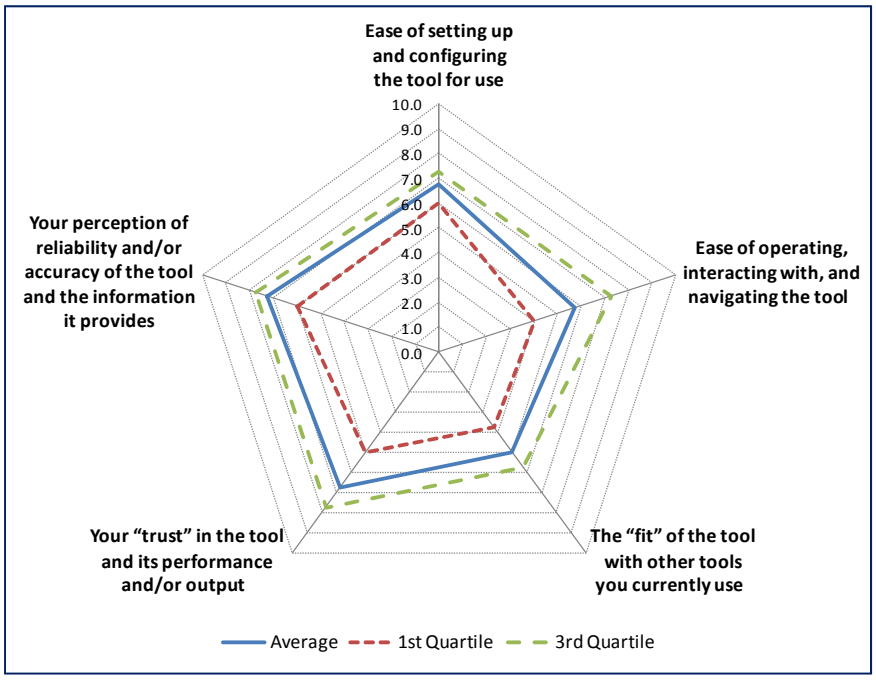


Figure 33. State Users' Assessment of Tool's Readiness for Use

4.5 Hypotheses Test Results

The hypotheses presented at the outset were tested to the extent that the available data would allow. The data from the motor carrier survey, along with comments received from the participating DOTs, were assessed in terms of the support they offered for each of the hypotheses. Table 6 presents the results of these tests and the degree of support for each hypothesis.

Table 6. Identified Level of Support for the Hypotheses

Hypotheses	Evidence	Level of Support
1. The tool allows state decision-makers to more accurately determine when to place and remove load restrictions, preserving both the pavement integrity and commercial vehicle operator productivity.	• Use of the tool by NDDOT increased user confidence in restriction placement. Following an unseasonably warm period in February, a maintenance chief decided to delay restriction placement by 14 days when he might otherwise have placed it sooner. • A MDT maintenance chief was able to decide to place restrictions at least 7 days in advance based on his interpretation of the tool's subsurface temperature profiles. • Four state DOT personnel who responded to a survey on their experience with the tool reported their perception of "reliability and/or accuracy of the tool and the information it provides" with an average score of 7.3 on a scale of 0 to 10. • Maintenance chiefs believe the tool will help them better understand when to remove restrictions, so it will provide assistance when defending removal decisions to motor carriers rather than just using a Falling Weight Deflectometer (FWD) alone. • NDDOT decision-makers believe they need more modeled locations to be able to achieve the optimum resolution from the tool and use it for their operations. They had only a small set of Enhanced Integrated Climate Model (EICM) sites set up for this demonstration. • The Grand Forks District of NDDOT was able to use the tool immediately and confirm the consistency of its outputs with their usual data from such sources as FWD and FrezTrax. • The tool did not provide recommendations for the timing of restriction placement or removal; thus, decision makers used the tool in conjunction with other information sources, tools and expert judgment to support their decisions.	Moderate Support

Hypotheses	Evidence	Level of Support
2. States are satisfied with the tool and have a level of confidence in using it in their decision-making process.	• Four users of the tool who responded to survey questions reported their average level of trust in the tool as 6.8 (scale 0-10), which is fairly positive but with variation across users. • Users of this experimental tool report that they expect trust and confidence in the tool to increase with additional use and experience. NDDOT maintenance chiefs believe their conservative approach results in earlier restriction placement and later removal than may be required to protect the pavements. They expect over time that the use of this tool can shorten the restriction period and support more advance notice at the beginning and end of the restriction period of 7 to 10 days. • A maintenance chief with MDT said that the tool's forecasts were "likely accurate," based on his observations and opinion. MDT would definitely use it again next winter/spring and is most anxious to get good forecasts in addition to their current measurements of existing conditions. • NDDOT: "I think that the tool, although still in its infancy, has the foundation to develop into another useful tool in our 'toolbox.' As with any new concept or tool – trust, accuracy, adaptability, user friendliness, education, and understanding are necessary for acceptance." • MDT: "[I] believe the subsurface frost forecasts from the system were likely accurate." This maintenance chief used the tool to proactively place and remove restrictions.	Moderate Support
3. States experience improved coordination and consistency between jurisdictions due to the tool.	• Currently, the maintenance chiefs communicate with adjacent districts to coordinate restriction decision making and increase their awareness of impending weather conditions. This process is independent of the tool and is expected to continue. • The motor carriers expressed their desire for a more consistent application of restrictions across jurisdictions.	Uncertain due to limited coordination to date

Hypotheses	Evidence	Level of Support
4. Commercial operators value the potential reductions to restriction durations and/or improvements to the restriction process.	• Seasonal Load Restrictions (SLRs) cause 72% of motor carriers to change their routes (more mileage) and 66% to alter/divide loads (higher costs) to meet restrictions. • Reducing the length of time of the restriction period was important to 86% of the responding motor carriers. They said, in response to the survey, that shorter restriction durations and earlier notifications would save them time and money. • There was an even split across responses from the motor carriers regarding improvements to the restrictions process. About 53% indicated no improvements were necessary, and the remainder (47%) indicated that improvements were needed for the process. Improvements noted by the respondents included facilitating permitting convenience, adjusting weight policies, additional coordination between state and counties, use of speed restrictions instead of load restrictions, and upgrading of roads and eliminating restrictions. They said they would value greater consistency and fairness in the restriction process. Most carriers appreciate the need for restrictions but want them to be less burdensome and of shorter duration.	High Support

5 Lessons Learned

The evaluation of this use case demonstration offers lessons and conclusions that provide insights potentially useful both for future demonstrations of road weather tools and for DOTs that might seek to implement this pavement condition forecast tool on a long-term basis.

- **The demonstration tool fills a need in supporting seasonal load restriction decision making.** A demonstration of a new road weather tool is likely to be better received and valued as more beneficial if it offers a new capability that users (e.g., state DOTs) want and previously did not have. Two week forecasts of subsurface conditions have not been included in the suite of weather information content typically available to state DOTs. The enthusiasm for this feature among the DOT users, and carriers' desire for a more consistent and transparent process, as seen in this evaluation strongly suggest the potential value of this capability. This tool provides the maintenance chiefs a way to move from an ad-hoc to a robust scientific and data-driven approach to load restriction management.
- **The demonstration tool shows promise for providing advance notification of thawing conditions.** By providing advance notification of thawing conditions, the tool allows maintenance chiefs to be proactive in their decision-making. Instead of waiting for visual evidence such as weeping, the tool allows for restrictions to be placed in a more timely manner. While this notification was generally viewed as accurate and was used by the maintenance chiefs this year, especially for restriction placement, additional validation and verification will increase the likelihood that the tool can be relied upon for more proactive decision-making during both placement and removal of restrictions.
- **The tool provides State DOT personnel with additional information during early spring thaws and refreezes.** One of the challenges with seasonal load restrictions is the occasional days of warm weather in early spring. The transition from cold winters to spring warming is never uniform, and typically involves cycles of thawing and refreezing. In the absence of the tool, these conditions represented a difficult decision point for maintenance chiefs. While long-range atmospheric forecasts would indicate whether the air temperatures would cool considerably, it was unknown how far the thaw had occurred during the occasional warm days and how far down the refreeze had occurred once the temperatures had cooled again. This tool provides estimates for how far below the pavement surface the thaw has penetrated, the presence of moisture in the soil, and the strength of the subsurface.
- **The tool provides State DOTs with an approach for determining return of pavement strength.** The placement of the restrictions is generally easier than removal for two reasons. First, visual observations can support the decision, as weeping and moisture on the pavement surface indicate clear signs of thaw. Secondly, the commercial operators expect the restrictions to be placed as the weather warms up so they are not surprised when the restrictions go into effect. The lifting of restrictions is more problematic. Visual observations are not reliable in assessing whether pavement strength has recovered. FWD information is obviously a helpful source for such information but many areas do not have timely access to FWD. Secondly, the carriers are impatient when they observe consecutive days of warm weather. The tool provides a more

defensible rationale for removing restrictions, as the maintenance chiefs can use the resilient modulus information to estimate the recovery of pavement strength. This was the case in the demonstration but additional verification of the resilient modulus information from the tool is needed to build operator and carrier confidence.

- **Improvements to the user-interface can have major benefits.** The demonstration tool was effective in showing the complexity of subsurface temperatures, resilient modulus, and other soil phase details such as "percent ice" and "percent water". However, several improvements were suggested by the users of the tool during the demonstration period including:
    1. Alert capabilities when sub-grade conditions reach designated thresholds.
    2. Map-based overview of subsurface conditions. Currently, the user has to click each EICM location to see the conditions.
    3. Being able to select a depth of interest and obtain conditions for the entire state.
- **Seasonal load restrictions have a major impact and are viewed unfavorably by carriers.** The commercial carrier survey revealed the major impact these restrictions have on commercial operations. A single state's restrictions affect carriers based all over the country. While the comments from some carriers indicate a desire to not have any restrictions, several respondents indicated the importance to their smooth operations of maintaining good condition of the states' roadways. Balancing these conflicting objectives is a challenge for the state DOTs, increasing the pressure on them to make transparent and defensible restriction placement and removal decisions. The ability of the tool to provide an auditable approach to restrictions was seen as a positive outcome.
- **Having new data implies learning new interpretation methods.** Some of the challenges involved in the demonstration stemmed from the fact that there were new data points such as the resilient modulus, pore pressure, percent ice, and percent water, all of which provided useful information but were new to the maintenance chiefs. The chiefs were unclear about how to interpret changes in these parameters and what thresholds are critical for decision-making.
- **Verification and validation of the tool is still a challenge.** Related to the above finding, the developers were not yet prepared to offer threshold information for validation and verification of the tool because additional research is needed. Overall, at a qualitative level, some maintenance chiefs indicated that the tool forecasts were consistent with what happened over the spring of this year but they expressed a need to validate the forecasts through the use of more probes and sensors. If they could build trust in the information about subsurface conditions provided by the tool through testing and comparison with subsurface probes, they anticipated more buy-in and reliance on this tool. A verification and validation approach for this use case tool is needed and can provide significant impetus for increased support and adoption.
- ***There are advantages of a coordinated multi-state approach.*** Many surveyed users commented on the need for a multi-jurisdictional method to coordinate the beginning and end of the load restriction period, along with other details such as the amount of the allowable load. Commercial operators have a myriad of rules to obey to operate legally, even when restrictions are not in place. These operators have to go to multiple DOT sources, each with different conventions and notations, to piece together the "common denominator" of dimensions and weight that they must abide by in all seasons. The winter and spring seasons add to the complexity by adding rules due to subgrade freeze and thaw. One way to simplify the commercial operating environment would be for northern states to use a common approach to specifying, placing and removing seasonal load restrictions that would include a common set of tools, with one perhaps being the Use Case #2 tool. These kinds of cross-state integrated approaches are

being actively discussed by the Northwest Passage Transportation Pooled Fund group (eight northern tier states).

- ***Evaluate again after deployment.*** The Use Case #2 tool was only available for a limited time during the spring of 2010 and once again in Spring/Summer 2011. State DOTs need more time and more seasons to build trust and fully incorporate it into their practice. Given the very limited exposure of DOT maintenance personnel to this tool and a lack of a more complete evaluation of the tool's measurement and prediction accuracy, conclusions can only be based on user perceptions and opinions. To thoroughly evaluate this tool, DOTs need to fully deploy the tool and assess its long-term value and impact on the key transportation goals of mobility, productivity, efficiency, and customer satisfaction. In addition, a longer timeframe would offer the opportunity to assess the effectiveness of the tool in protecting the integrity of the states' pavement conditions.

In conclusion, the *Clarus* Use Case #2 seasonal load restriction tool demonstration can be viewed as reasonably successful and perceived by state DOTs and motor carriers as having great potential value. The capabilities of this tool have been well demonstrated, and the challenge now is to build confidence in the tool and make a business case for more widespread deployment.

References

Meridian Environmental Technology, Inc. 2009. *Clarus Multi-State Regional Demonstration: Use Case 2.* A one-page descriptive handout flyer.

Appendix A

Pre-Deployment Telephone Interview Questions for Motor Carriers

Understanding your current approach

1. Describe how you make your restriction decisions now.
    - Does your decision process vary across Districts? If so, how?
    - What tools and information to you rely upon to support your current decision process? e.g., FWD, visual inspection, weather forecasts, specialized software, consultant services, frost probes, observation in other districts, etc.
    - Do you use historical data to support restrictions, and if so, how?
    - How do you weight the different kinds of information in arriving at a decision?
    - How do you determine the amount of the restriction to place?
    - How much lead time do you provide the CVOs/truck operators before imposing restrictions?
    - Do you have any procedures in place to guide the decisions, or is it made primarily subjectively?
    - Who are the actual decision makers?
    - Do districts consult with other (adjacent?) districts or with the state DOT in making these decisions?
2. How do you inform the truckers and others about weight restrictions?
3. What are the main concerns of the truck operators, and how does your current decision process try to address those concerns?
4. What are types of freight that are most affected by restrictions in your region?
5. Do you try to assess pavement condition as it is affected by your restriction decisions? If so, how do you do that?
6. Have you conducted any type of evaluation to assess the effectiveness of your current restriction decision process? If yes, what have you learned and how has that affected your decision making?

How well has this approach worked for you?

1. Do you believe that the restriction decisions are generally made at the right times, at the right levels, and on the right roads?
2. How have you managed to reach a balance between the needs of truck operators and your need to protect pavement integrity? Has that worked out well, or could it be improved?
3. What other pressures do you face in making these decisions?
4. What are the main barriers or challenges in your current system to making optimal restriction decisions?
5. How satisfied is the CVO/trucking community with your restriction decisions?
    - What changes would they like to see, if any?

What would enable you to make a better decision?

1. What new information or capabilities that you currently lack would you like to have in support of your restriction decision making?
2. What is your understanding of the value that using *Clarus* data adds to the value of this tool, if any?

3. Would you like to see restriction decision making become more scientifically grounded? If so, how and why?

How do you expect to use this tool?

1. How will you weight the information provided by the tool with all the other information you traditionally have used to make your restriction decisions?
    - Do you anticipate that you might eventually rely solely on this tool for making your decisions? If so, why? Or why not?
    - What might it take to give you the confidence to rely more on this tool?
2. What changes do you anticipate, or hope for, after you have access to the new tool?
    - Ability to notify CVOs/truck operators sooner than before (i.e., offer more advance warning of restrictions).
    - Ability to shorten the overall duration of restrictions.
    - Ability to fine tune restrictions to specific road segments.
    - Ability to better preserve your road surfaces and prevent thaw damage.

Planning for post-interviews

1. How long a period is likely to elapse between your first restriction decision and your last (to either place or remove restrictions)?
2. What role did the tool actually play in influencing your restriction decision making?
3. When should we plan to come back to re-interview you to learn about your experiences with the new tool?
4. Starting now, please keep notes on how you are making your restriction decisions to help you support your answers to these questions, as appropriate.
    - Date when you began discussing the need to place or remove restrictions.
    - Who participated in the decision process?
    - Specific information you used to support your deliberations and the eventual decision.
    - When you made the decision.
    - When you posted notification of the decision (so we can calculate the time between advance notice and actual restriction placement).
    - Information on any pavement testing done (FWD, seepage, other), and assessment of pavement damage, if any (type of data collected, when collected).

Appendix B

Post-Deployment Telephone Interview Questions for Motor Carriers

[Prior to each interview, review notes from baseline interview and try to tailor the discussion to the interviewee's situation and the particular points discussed in that interview.]

Review restriction removal details

1. Describe the restrictions that were in place and which ones have been removed.
   - Remind us of the route(s) where you had restrictions in place.
   - Are all your restrictions now removed? If not, what remains to remove?
   - Let's review each restriction removal decision one at a time (if more than one).
     i. When did you first consider or discuss removing your restrictions?
     ii. When did you decide to remove the restriction?
     iii. What date was set for the actual removal?
     iv. When was notice of the removal (or intended removal) posted?
     v. How was the removal information communicated?
     vi. Continue with any additional removal decisions if different from the above.
2. Describe how you made your removal decision(s).
   - What information or tests did you rely upon to support your removal decision?
   - Whom did you consult as part of your decision (e.g., other districts; the state; others)?
   - What evidence did you use to support your decision (e.g., visible moisture; FWD)?
3. Did you use the new *Clarus* tool? If so, describe how you used it to support your decision.
   - How important was the information from the tool in influencing your decision?
   - Would you say you made a different decision with this tool than you would have made without the tool? For example, did the tool cause you to remove restrictions sooner than you otherwise might have? How much of a timing difference did the tool make?
   - Alternatively, did you use the tool mainly to confirm your other data?
   - Give us a sense of how heavily you relied on the tool versus other information to support your restriction removal decision making?
   - Even though your exposure to the *Clarus* tool has been brief and limited, tell us what you think about its value to you in supporting both restriction placement and removal decisions?

Do you have any suggestions regarding this *Clarus* tool?

1. What new information or capabilities that you currently lack would you like to have in support of your restriction decision making?
2. Would you like to continue to use the *Clarus* tool in the future to support your decisions? If so, how do you think the tool might affect your restriction placement and removal decisions over the coming years? For example, is it likely to alter the duration of restriction placement? If so, how?
3. Are there any changes or improvements you would like to see in this tool?

Appendix C

Seasonal Load Restriction Impact Survey for Motor Carriers

Instructions: Please complete this survey as accurately as possible. This survey is not for enforcement purposes and your identity is not important to us. However, accuracy in your answers is important to the purposes of this survey.

Is your company impacted by weight restrictions during the spring thaw?

( ) Yes

( ) No

If yes, please complete the remainder of the survey. If no, please submit the survey without filling in the remainder of the survey.

Please specify the relative percentages of cargo types your company hauls:
(Each entry may be 0 to 100%, but they must total 100%)

_____Metals, metallic goods

_____Timber, wood

_____Aggregates

_____Heavy equipment

_____Minerals, chemicals, fossil fuels

_____Manufactured goods

_____Agricultural commodities

_____All other

How many power units does your company operate that travel within or through North Dakota (or Montana)?

Truck-tractors:: _____

Straight trucks:: _____

What percent of your annual shipments occur during the spring load restriction season?

_____

How does your company usually respond to the seasonal load restrictions? (Check all that apply)

( ) Alter/divide loads to meet the restrictions

( ) Seek special permission to traverse restricted area

( ) Choose different routes

( ) Choose a different time

( ) Other

[If “Choose Different Routes” selected] Specify how many total additional miles per season are added for choosing different routes?

( ) 0 - 500 miles
( ) 500 - 1,000 miles
( ) 1,000 - 5,000 miles
( ) 5,000 - 10,000 miles
( ) More than 10,000 miles

[If “Other” selected] Specify Other: _____

Is divisible load permitting available during the spring thaw?

( ) Yes
( ) No

[If “Yes” selected] Do you use it during spring thaw?

( ) Yes
( ) No

What other impacts do the restrictions have on your operation (check all that apply)?

( ) More drivers for hauling the same freight
( ) Longer hours of operation for hauling the same freight
( ) Changes in your equipment (e.g., tractors and trailers)
( ) Other

[If “Changes in your equipment” selected] Specify changes in your equipment:
_____

[If “Other” selected] Specify Other: _____
How do you usually learn about load restriction information (check all that apply)?

( ) Internet (Web site)
( ) DOT (fax or email information)
( ) Signs posted on the roadway
( ) Other truckers
( ) Other

[If “Other” selected] Specify Other: _____

How much advance notice do you usually receive about load restrictions before they are imposed?

( ) 1 - 2 days
( ) 2 - 7 days
( ) 7 - 14 days
( ) More than 2 weeks

Would earlier notice regarding upcoming load restrictions be of value to you?

( ) Yes

( ) No

[If "Yes" selected] Describe how: _____

Would shortening of the duration of load restrictions be of value to your company?

( ) Yes

( ) No

[If "Yes" selected] Describe how: _____

Are there other improvements in restriction policy that need to be made?

( ) Yes

( ) No

[If "Yes" selected] Describe the improvements: _____

Any other comments: _____

Survey responders may be contacted if additional information is needed to better understand the impact of restrictions. If you would be willing to share additional feedback with us, please provide your contact information below. This is OPTIONAL and you may or may not be contacted. The contact information will only be used if it is necessary to contact you for this study and will remain strictly confidential.

Name: _____

Email address: _____

Phone number: _____

Appendix D

Responses to Open-Ended Questions in Motor Carrier Survey

Q5. How does your company usually respond to the seasonal load restrictions?

Response Category: Specify "Other"

- Delay until Spring Thaw is off.
- Stop shipping
- Can't deliver until restrictions are off
- Cancel work until lifted
- Do not work
- We will NOT do business in North Dakota during SLR due to the HIGH permit fees for our crane to mobilize.
- Majority of hauls we leave the product at origin until load restrictions are lifted. This is not always the best economical return to our investment.
- Pay ton-mile fees; Get special permission with fees; modify equipment capacities
- Use additional jeeps and dollies to add axles
- Use more specialized equipment
- Buy non-divisible load permits
- Finish production and move equipment
- Seasonal load restrictions cost our company over $1 M in added costs
- Cost of materials is sometimes recouped by charging full (normal) price for less material. Customers do not like that.

Q7. What other impacts do the restrictions have on your operation?

Response Category: Specify "Changes in your equipment (tractors and trailers)"

- Additional axles on trailers and trucks
- Haulers are required to add additional axels to spread loads out.
- I use my 3 axle trailers only for North Dakota
- More ales to distribute weight to a lower number
- More axles added
- More axles to meet axle weight requirements when applicable.
- Purchasing triple axles trailers instead of tandem axles trailers to haul a little more
- Trailers with more axles
- Using more axles
- We try to use our tractor and trailer that has an extra axle each to help spread out the weight
- Add additional axles
- Additional axles, divide loads

- Extra axles
- Larger trailers with more axles
- Longer trailers with more axles, or use smaller equipment
- Modify and add # of axles on both units that otherwise are not needed
- More axels
- Need to add additional axles
- Putting more axles on equipment
- Using different trailers with more axles
- Had to purchase a trailer with 8 axles to get axle weights legal. Then found out they charge for ton-mile in excess of 130,000 even if you are running legal axle weights.
- Adding more axles to trucks or trailers for smaller loads to be legal axle weights
- Add jeeps/ dollies/ flip axles
- Adding jeeps and boosters
- Adding more axles, changing to lighter trucks when possible
- Adding trailer tenders
- Addition of Flip axles and Stinger Trailers
- Additional axles require different trailers and/or jeeps and boosters
- Use more axles, tires. Use lighter trucks & trailers, turn down business
- More axles & bigger tires
- More axles and take apart equipment for lighter loads
- Need special axle configurations not normally needed
- Trailers with more axles, tag & pusher axles
- Different type of trailers
- Larger units i.e.: tractor trailer to haul straight truck loads
- Need to use smaller equipment, therefore making the job last longer
- Remove all racked equipment to a third party hauler.
- We actually had to buy a different semi trailer this year, and a different tandem truck last year.
- We have heavy equipment that requires extra axle trucks and the cost can be quite expensive
- Spend more breaking equip. Into manageable pieces requiring more loads to move
- Smaller loads, more loads, higher costs
- Trying to find lighter equipment to haul specified freight
- Haul parts of equipment on separate loads
- Have to take apart some pieces of equipment
- More boosters and change configuration of some equipment
- Purchase new smaller machine
- Smaller equipment used takes longer to finish the job
- Utilizing smaller equipment to do the same work resulting in longer hours and additional equipment to do the job.
- Stripping all excess or unneeded equipment/rigging at time of travel, hauling with pickup trucks to the site, reloading and equipping on site and doing the same to return home
- We drive slower to try and help preserve both pavement and gravel roads
- More breakdowns
- More wear and tear
- LTL

Q7. What other impacts do the restrictions have on your operation?

Response Category: Specify "Other"

- Change timeframe
- Loads do not get moved.
- No freight can be shipped
- Postpone the work
- Product not delivered until restrictions are lifted.
- We have to delay shipments until restrictions are lifted
- Do not work
- Don't move some of the equipment because of its size during this time.
- Don't haul the freight
- Waiting for restrictions to come off
- We are shut down and cannot operate
- We are unable to receive or ship product during this time.
- Increase in the cost of our services
- Delays and added costs
- Extra time getting permits and finding alternate routes
- Longer layoffs, we do not bring our drivers back until restrictions are lifted
- Loss of work
- Lost wages, driving for nothing
- Drivers paid extra for smaller loads.
- More fuel expense involved with special permits and cost of extra fuel
- Shorthanded and don't have the manpower to haul more loads
- Smaller loads require us to go to customer more often
- We have to sub-contract another crane operator in the ND area due to high permit fees.
- We take a loss on not always charging full price because we have to haul less in material weight.
- Almost doubles my freight cost because all loads have to be cut back due to weight
- Can't do business with certain customers when restrictions are in effect
- Can't haul overweight/oversize loads
- Huge cost increases for weight permits
- Increased operating cost, loss of revenue do to job cancelations
- Less income, same expense, loss of profit
- Loss of revenue
- Loss of income and loss of hours for the help
- More costs involved with pilot cars and fuel going through MT
- More miles, more fuel, longer time, more cost
- Routes
- Small loads more loads
- Haul lighter loads
- Time
- You can only use certain trucks with more axles for certain heavier loads
- Having to hire outside carriers to assist, having to lose money on loads as we are paid by the ton
- As a house mover, the buildings get torn down or burnt, with the flooding in the Lake Region. This impacts our yearly income as we lose out on jobs.

- We drive on a lot of county and township roads and they are not in the best of shape. It's hard on our trucks and takes more fuel and time to run on them.

Q8. How do you usually learn about load restriction information?

Response Category: Specify "Other"

- Call highway patrol office or call DOT office at state capitol
- Calling local customers or agencies
- County and Township Supervisors (farmers) by telephone.
- Dickinson Highway patrol
- From the person issuing the permit
- Our customers tell us if they are on roads with restrictions.

Q10. Would earlier notice regarding upcoming load restrictions be of value to you?

Response Category: "Describe how"

- Able to move loads easier
- Allow for better planning.
- Allow more time to move heavy loads prior to the placement of restrictions
- Arrange Jobs to reflect the changes to reduce travel and cost
- Be able to plan loads better
- Better planning
- Better planning
- Better able to plan load deliveries
- Better prepare
- Better service planning for meeting our customers' requirements
- Bigger window to place equipment
- Could get the more important loads done first
- Earlier notice can help us inform our customers before we accept a load that cannot be moved
- Email
- For planning route or load
- Enable better planning
- Get equipment moved prior restrictions
- I would be better able to plan my loads
- May be able to move overweight equipment before restrictions go in effect.
- More time to arrange loads before restrictions take place.
- More time to plan vehicle movements
- More time to prepare for a move.
- More time to schedule customers jobs
- More time would allow us to plan to move loads before the restrictions are in place.
- Organize heavy haul trucks to move our equipment while restrictions are low.
- Plan loads accordingly and alter dates
- Planning would be impacted greatly.
- Prepare by getting grain out of areas where restricted roads will be
- We can plan the heavy equipment moves better

- We could get more grain out before they go on.
- We could move more equipment prior to restrictions
- We could plan a head sooner
- What the processes are going to be - earlier notified
- Would be able to plan route & future loads easier.
- Be able to prepare better
- Be ready to change routes
- Batter planning can take place
- Can advise customers and projects
- Could get loads moved before restrictions are implemented
- For better planning
- Get prepared
- Helps scheduling
- In some cases we would haul the equipment before road restrictions
- It would give me extra time to prepare for load restrictions
- More time reroute tuck
- More time to plan loads don't move 2000 miles over night.
- Not get caught with a load overweight
- Plan another route loaded weight
- Planning
- Route planning
- Scheduling around the restrictions
- Some of later restrictions are added the day they come on
- We can plan alternate routes better
- We could get bigger loads hauled sooner
- When the restrictions come without notice need to work longer hours to try to get heavy equip. to the sites before they come on and then can't get some pieces their until after causing a loss of revenue for that site
- Prepare for construction jobs pending in the ND area - either move up the job or have to subcontract out.
- Scheduling moves before they are imposed would save additional equipment expense and labor expense
- I have had to turn trucks around in the middle of the highway because I did not find out about the restrictions until after they were implemented because the email was not sent until midday and the restrictions were put into effect that morning.
- It would help determine how much sooner we need to get a specific load to where it needs to be before the restriction affects our route
- For routing purposes
- Pre-planning and/or scouting of alternate routes
- Let us know a week or two earlier so we can plan alternate routes.
- 2 weeks before & posted signs on road before you turn on too it
- Have a week's notice at least.
- It would help scheduling loads, which generally occur at a minimum 1 week in advance of shipment.
- The ability to know we have a week before restrictions coming on would allow us to finish a job in an area as fast as possible and attempt to get it done before restrictions take place
- I am a county and we put our restrictions on at the same time as the State.

- When planning for a load, we can tell the customer of the additional restrictions, and change the rate to account for the additional equipment
- Mobile Medical equipment that covers hospitals throughout the state, so the longer the notice the more time hospitals can be informed of schedule changes due to road restrictions.

Q11. Would shortening of the duration of load restrictions be of value to your company?

Response Category: "Describe how"

- Decreasing the size of loads for load restrictions cost me revenue.
- Able to put people back to work and extend the construction season
- customers are tired of having to wait to move their equipment or paying outrageous permit costs
- customers would get their freight on time and less expensive
- Decreased cost , less canceled jobs
- In overweight fees
- It would allow us to haul full weight and prevent loss of income
- It would be a value but I don't want roads all torn up like they are now
- It would reduce the cost of conducting business in the spring season
- It would result in lower transportation costs.
- It would save a lot of money
- Less miles, more efficient use of manpower and equipment, lower permit costs
- Less money spent and fewer delays.
- Load restricting directly impact the income of our drivers and customers.
- May not have to let bigger/expensive pieces of equipment sit being unproductive
- More wages
- Move more equipment without higher cost to customers
- Permit fees would be less
- Shorter period of time that drivers are paid extra for smaller loads.
- We could fit more product on our trucks and lower the cost per unit to our customer
- It would minimize the cost of overweight permits
- It would take a lot less to time to get to point a to point b and less expensive
- Less cost for alternate route
- Less imposition and delays and costs
- Lower costs
- More moves could happen on-time saving thousands in lost productivity
- My freight cost would go down
- Smaller window when additional equipment is needed. Lower cost for permits
- The longer the restrictions are in place, the more loss of $$$ incurred
- We would not have to put big jobs off as long & permits costs would not be as much
- Would cut down on cost and man hours
- Load restrictions make our days longer our trucks get more wear and tear on them by taking back roads and it just costs more money to run.
- less time and money spent adjusting for load restrictions, and permitting smaller loads which are legal weight in summer and winter
- Less time and money spent on Validations to move equipment; Takes as long as 3 hours to get the Validations.

- The revenue that our company generates is solely based on our heavy equipment being available to our customers. During the Spring Load Restriction season our revenue declines sharply.
- My revenue per mile would be increased if I did not need to go so many extra miles when restrictions are in place on certain roads.
- It make the rig able to move more , now the Co is putting restrictions on the gravel and making it to where we cannot move so we loss more revenue and the hand loss wages not being able to work
- The load restrictions severely hamper my operation because often cannot afford to move equipment to where it needs to be.
- We operate year round, reduced loads or longer travel distance creates problems. At time if we cannot split a load, we simply cannot move.
- Yes...build roads that can handle our changing business. The load restrictions are the same they were 30 years ago, but ALL of our operations have changed. We pay the taxes, but can NOT do our business a lot of times because of restrictions.
- We wouldn't have to find alternative routes and drive miles out of the way to get to location to do a job
- Would have more profit, shippers do not increase the rate when restrictions are on, just less profit to the truck
- Due to the fact such a high percentage of transportation is done in restricted time, any reduction would have a big impact
- The shorter the duration of load restrictions equals spending less time and money to move the same loads.
- Every day means more extra miles and more fuel used
- Fewer trucks needed to do the job
- Get back to business as normal
- I can work
- I own a seed plant so everything leaves in the spring
- It takes more trucks to deliver product to the oilfields
- Less extra miles and more payload
- My customers need product to sell; if you don't have it you can't sell it....
- While load restrictions are on we cannot operate to our fullest capacity
- Allowing us to move our heavy equipment sooner would increase the income of the company
- Fewer extra miles and less expense
- We would be shut down for a shorter period of time
- Would help to get goods going quicker and minimize expenses
- Would make us more profitable
- Huge benefit - could mobilize our cranes much cheaper in ND (not many major 10-ton roads during SLR).
- Ability to get to jobsites that would otherwise be impossible to get to.
- Ability to move heavy loads sooner
- Ability to provide equipment requested to the customer
- Allow more days to complete our construction projects.
- Allow more freedom to haul equipment in
- Allow us to move heavier loads earlier
- Allow work to go on with delay due to load restrictions.
- Allows more time to move
- Any time road restrictions are in place, they make us less efficient.
- Better planning
- By normalizing the movement of our construction equipment

- Could haul heavy hauls sooner
- Easier to complete the schedules
- Easier to get materials to the site
- Equipment would not be stranded on a project waiting to get from one job to another.
- Getting freight shipped out sooner
- It would shorten the delays for deliveries.
- Larger and more frequent loads
- Less Man hours per season
- Less Paperwork
- Less miles driven
- Less out of route miles
- Less pre-planning and/or scouting of alternate routes and hauling of regular size loads
- Less time spent trying to figure out what route to take. Less extra miles.
- Lesser time frame when adjustments to schedule or smaller loads hauled need to be done.
- More timely delivery of product to customer
- Projects completed more quickly or started
- Reduce the amount of trucks that are needed per job.
- Shorten number of trips, miles and driver hrs to get loads hauled
- Shorter wait time to haul specified load that is restricted during load restrictions
- The sooner the restrictions are lifted the sooner we can move product.
- We could sometimes spread out our deliveries verses rushing to get some things delivered
- Would not have to find alternate routes
- We could get started on road repair sooner
- We could haul more for a longer period of time
- We would be able to accommodate our customers better
- We would be able to start operations earlier.
- We would be able to stat work earlier in the spring and complete more work, increasing work load
- We would be better able to cross the state on other than Interstate Hwys
- We would make less trips and less days on the road
- We would not have to hold up shipment as long
- Would enable us to service our customers when they want as opposed as to when we can
- You would be able to haul a full load sooner
- Ability to complete the same jobs sooner
- Allow jobs to happen on time
- Bigger larger loads means fewer loads to get all product delivered and less trips
- Cannot get to certain areas while restrictions are in place
- Faster deliveries
- Getting commodities to customers better
- I get paid by the gallon, it would get me back to gross weight & gross pay faster
- Less hours
- Less light loads we get paid by gallon hauled
- Less loads
- Less miles
- Less personnel
- Less time that we couldn't work
- Less time with load restriction

- Less travel
- More road access
- Not having to divide loads, less rerouting for less man hours
- Some equipment we haul cannot be moved when restrictions are on
- Some roads are ready before others
- Start jobs earlier to get them done on time in the fall
- We could get more done in the same amount of time
- We could haul our normal loads
- We would be able to plan shipments better around a shorter restriction period.
- We would have to use less trucks for a shorter period of time
- Would free up our normal routes
- Would mean not going so far out of the way for so long but then it would be harder on the roads
- Shortening the route traveled for each load will allow faster travel times and better delivery times
- We are completely unable to ship certain products out of our location during that time, so it would allow us to ship those products more regularly
- When a piece gets moved to a site for restrictions it has to stay there until they come off if the job gets done then that crew may not work again until that equip. can get moved causing that crew to go back on unemployment till restrictions are off
- This is a farming state and these longer load restrictions do not help in getting the product to the farmer or from the farmer to the elevator.
- In the construction business, the season is short enough. It would allow many projects to be started earlier.
- It would enable us to move the buildings to staging areas while foundations are built. Note that it's not our weight, but our width and our wheelbase width. In the Lake Region, all the roads with restrictions are being used to haul dirt and being destroyed by the dirt haulers. Our use is a onetime use with less weight.
- We postpone hauling on many loads until after restrictions. That has a domino effect on other loads that follow.
- Duh??? [I do agree on the need for restrictions!!!] Road damage is tremendous!!!
- It would be a value but I don't want roads all torn up like they are now
- Of course no restrictions would be ideal.
- We short haul into grain Terminals on railroads
- Allowing movement at night while ground is frozen
- Maintain route schedules and patients appointments in effected hospitals throughout the state
- Would save us miles and time. I think reduced speed would help more than reducing the load size.
- The load restriction season is way too long. Usually the ground is more than dried by the time restrictions are finally lifted.
- Sure! More of our gravel roads would be destroyed by idiots driving on them with heavier loads when they are soft roads.
- For instance, now the ground temp is 44, frost is out of the ground down here, but they won't pull them off for a long time yet.

Q12. Are there other improvements in restriction policy that need to be made?

Response Category: “Describe the improvements”

- Always allow permitting of over-weight movements....do not reject permits.

- Are per mile tonnage fee rate sheet and specific highways that may be traveled with an extra fee.
- Being able to buy ton mileage permits over the internet
- Easier way on obtaining a permit 24/7
- Less wait time to receive permission to move on restricted routes
- Make the online maps easier to print out
- Make the restrictions based on scientific facts, not based on an individual's perception.
- Need a more user friendly Superload application process
- Permits can be faster if the system knows Interstate only routes are still able to self issue
- Accessibility to get ton-mile permits
- Allow for round-trip permits as an alternative so we can request one save time
- Get rid of the ton mile fee, and restrict roads to certain ton rates per axle, as S.D. does
- Lower the cost of overweight permits
- Permit all non-devisable loads on roads with restrictions if there is no secondary route
- If the state is going to require us to get permits to drive on certain roads, they need to be available 24 hours a day to get permits since our business and all like ours operates 24 hours a day, 7 days a week. We don't have banker's hours like the state employees who issue the permits.
- We are assessed a 500.00/move for one load and drilling rigs move 30-40 loads that are heavier and also only pay 500.00/move, Very unfair.
- Allowing axle weights to not have such a high ton mile fee when axle weights are legal & the truck trailer has a lot of axles but a larger gross vehicle weight
- There needs to be more ways to get validation numbers so you don't have to be on hold on the phone for 1 or 2 hours
- More advanced communication. Shorter duration for restrictions in place. Cheaper rates for NEEDED moves. a simpler way to calculate a frost law permit
- Highway 20 north should be an 8 ton road instead of a 7 ton road.
- Increase 6 ton max weight over 80,000 if there are enough axles to remain legal on each axle.
- More 10-ton roads available to traverse in the state - only I29 and I94 are free making it SO EXPENSIVE DURING SLR.
- Road starts at 8 ton, reduces to 6 ton, and then goes back to 8 ton, needs to have the road the same from one end to the other
- Need to eliminate short stretches (15 miles or less) of a very restricted road heading more than one direction from an intersection
- Remove fee for gross weight as this defeats adding axles to reduce axle weights. If you want to reduce axle weights for better roads you can't have huge fees for high gross weights with low axle weights.
- Yes they need to quit putting a five or ten mile stretch of 7 or 8 ton road in the middle of a 200 mile stretch of legal weight road and then the dot sit and wait for you there
- In a perfect world all states would use the same system for the permitting and restriction of hauling equipment and materials
- The axle weights are fine but the gross weight should be higher as long as you are good on your axle weights
- Entire areas should not be blocked off by restricted weights. There should be at least one route into every area.
- When load limit season comes on, drilling rigs, workover rigs, frac equipment should not be allowed to move.

- If your axle weights are legal and you have adequate spread why should they still charge you a ton mile fee over 130,000 gross? It makes buying bigger trailers with more axle groups and more total axles not profitable.
- Making the laws more realistic and enforcing the laws. Holding the out of state companies to the same laws and regulations North Dakota companies are required to follow.
- Don't put 6 ton limits in middle of 8 ton limits
- Estimate when restrictions may lift
- Get rid of the short 1-7 mile restrictions that add extra miles
- Ease of determining permissible weight
- Roads that can handle 80,000 semis year around
- Suddenly dropping Load limits from 8 ton to 5 ton is a terrible disservice to the industry
- Look at axle grouping allowances.
- We have 7 axle rigs and they put a max gross wt on why not let us haul so much per axle
- Weight limits
- Early in the season we have to find the county road restrictions as we drive our routes.
- Cooperation between the counties and state
- County roads should be restricted like state roads
- Signage is terrible, you need to put up signs before you turn on to restricted routes
- The biggest problem with toad restrictions is the posted sign is always after you turn on that the restricted road & most of the time you can't r read the sign until your already committed to that road which is entrapment
- Signs need to break down what triples and greater can carry. Right now they only show 6 ton, 7 ton etc. So I person is to assume they have 7 ton per axle which isn't the case for triples or greater.
- Better notification of roads. Some roads are restricted but the sign is not visible until a driver turns on the road. Larger signs stating restrictions and key junctions would be great
- Instead of restricting the weight, slow the speed down on some roads
- Take the restriction off and enforce a slower speed limit of 25 mph
- Increase weight but reduce speed limit.
- Lower speeds on roads and allowing a heaver load to be hauled
- Lower the speed on roads
- Reduce speed on restricted roads
- Reduce speed on restricted roads
- A speed restriction during certain periods rather than a weight restriction may be better in certain situations.
- Build the roads good enough to begin with then we wouldn’t have to deal with restrictions or SURVEYS...what do you think???
- Do away with it.
- Up Grade road building tech
- If the state is going to build a road, engineer it to hold a loaded truck
- Less restrictions
- No restrictions
- The state and counties need to spend the money up-front and make the roads able to withstand "full" loads year round, instead of laying the minimum amount of asphalt and then fixing the breaks every year.
- Road restrictions should be based on actual thaw of season.
- Have definite times to remove restrictions
- Most of our hauling during spring thaw is due to emergency power outages.

- Several roads are included when they may not be affected by the wet spring conditions
- The charges are too high even if we get to move during spring restrictions
- To protect the roads decrease the loads if needed
- Change load restrictions
- Change the restriction limits
- Check trucks that work at night
- Do like MT
- Monitor the oil field trucks as there are probably 25 of them to every farm truck
- More enforcement
- Need to co-ordinate with neighbors in same zones
- To many oil, water and gravel trucks
- I work between state and county to make it so we do not get shut down and cannot move. We only move every couple days and some only once a week. But when state and county tell us we cannot move, then we have customers mad and hands losing hours and wages again.
- Allow special waiver on road restrictions for mobile medical equipment that covers hospitals in remote areas throughout the state.
- Waivers for certain territories would be helpful and flood related use of roads. (Go Green...buildings are being torn down rather than moved because load restrictions are keeping us from moving the buildings which increases building owners costs when having to temporarily stage.)
- Ease off restrictions sooner because roads are dry under and no damage is being done the damage is done within usually one month of frost coming out
- Some areas are just not accessible during road restrictions, have to keep product in the warehouse which then causes us to be full and cannot take on additional product that is on demand from other customers
- The state should require minimum maintenance and construction practices for gravel roads owned by counties and townships. We need more money from somewhere to keep up roads! The Fed. Govt. should chip-in $ if they want our farm products.

Q13. The final question asked respondents for any additional comments.

Response Category: "Any other comments"

- More people processing at the State Permit Authority would help a great deal (the current staff is amazing)
- Longer Permit Office Hours
- North Dakota is the most un organized permitting state
- Website is very helpful and well executed. Advance notification via email is appreciated.
- Make restrictions shorter but I know they need to be implemented in the spring
- They last too long
- During load restrictions we are told to take alternative routes that have light tonnage bridges on those routes or fresh built roads that are very soft and unsafe, resulting in damage to these roads we are told to take and don't dare ask otherwise as I have been hollered at by Highway patrolmen for not taking a route I know was not passable with our equipment and were told that is where he wanted us to go and caused major damage to that road, Just did what he told us because he would not listen what I had to say. Also the time lost waiting for validations is very costly to us and our customers and amounts to thousands of dollars per year.
- Load restrictions are a head ache but most are manageable when there is a place that we need to get to we should be able to permit not just get a NO without exception

- There aren't enough people manning the phones in Bismarck to handle all the permit calls. Wait times for validations are extreme. At times we get messages that there are too many calls and to call back later.
- North Dakota needs to respect their roads and improve them beyond the small country farm trail that they were before the oil industry came to town. They need some major improvements and they need to put some ditches in to accommodate the snow in the wintertime. The State does not appear to understand Snowfall and Ice and what to do with it. The service to the roads in the wintertime is much worse than the surrounding states who also deal with a lot of snow in the wintertime. Minnesota gets out and plows the roads and used enough salt to make a difference. North Dakota is slow and careless on the salt application, using it like they are spreading with a teaspoon. With the poor care the roads are receiving during the rest of the year, it will be more imperative that the road restrictions be in place longer and with harder restrictions than if ND took care of the roads year around.
- Counties do not want you on their roads and state does not want us on the highways so makes it really hard to find a route. With the weights of our workover rigs makes it really hard to move.
- We are a gravel crushing company and make material for road construction, but cannot get to locations to produce the material for the roads, either county, state or federal projects.
- With the current system, we can still get permits for overweight, and pay the additional ton-mile fee. This is a reasonable system, as it allows additional weight to be moved during bans.
- We are a country grain elevator and load limits are so low that we cannot take delivery or ship anything out during the spring thaw.
- Evaluation of certain areas needs to be completed after upgrades to roads are done instead of using same restriction in previous years
- Just cannot stress enough that the state of ND needs more 10-ton roads to utilize like all other states have to avoid horrendous permit costs.
- Roads would be in better shape with proper maintenance. Educate people on what ruins roads... require training class for offenders!
- Road restrictions cost our company several thousands of dollars each year due to downtime.
- Send more oil impact money to the western part of the state so the counties and townships can afford to fix and maintain their current roads that the oilfield traffic is tearing up. They could also purchase newer equipment and pay employees a better wage so they could keep good help and not lose them to higher paying oilfield jobs.
- As time goes on it is getting harder for freight companies to make a profit, with having to run extra miles or proceed with restricted payload as well as the higher fuel costs, everything is noticed right away when margins are tight. But also realize that without restrictions roads would be destroyed!! End of the day this is something that has to be done and we as trucking companies will just have to deal with it!!...lol
- North Dakota has probably the best web site for travel conditions, load restrictions and weather that I use
- We would like to know with all the money we have spent on frost law permits why the roads are in such sorry shape. It looks to us that the money we pay to use the roads is not being put to use in building better roads.
- Currently having to pass up bidding certain projects because of not being able to get permission to move some oversize loads.
- We have several roads that run all the way across the state and they will have 20-30 miles out of 300 that have 7/ton restrictions versus 8/ton or unrestricted so we have to run 100 extra miles. they should fix the few miles or reduce the speed that is a lot of extra fuel and time that I feel should be corrected
- I realize that we need to protect our roads; however, we should be able to build roads that can handle at least 7 ton restrictions AT MOST on all roads.

- You have more trucks running on the roads with less weight, but more trips. So the road gets wear on it anyway.
- Keep an 8 ton restriction on the road in question. and enforce a slower speed of 25 will have less impact on the road base than a lighter truck traveling at highway speeds
- More 10 ton road routes
- The roads I travel are very heavily traveled roads. they need to be rebuilt to handle the traffic
- We understand there has to be road restrictions and people have to work around it
- We understand we need the restrictions to keep the roads in better shape.
- North Dakota is the worst when it comes to restrictions, both in restrictions and length of them
- Roads built for the traffic that they facilitate would help.
- Spring load restrictions are there for a reason, to save the road.
- Take a look at axle loading instead of just gross vehicle weight.
- Improve more roads for fewer restricted miles
- Raise penalties for extreme overweights, many drivers in our area are paid by percentage, hourly pay would discourage a lot of the problems
- Road restrictions should be posted at the junction road sign instead of after you turn on the road. & the internet is great b but not everyone has the countries capabilities to the internet until they get him home for the tour
- We are all interested in reducing the wear on the roads. We would like to make sure that the load restrictions do in fact reduce wear. I also feel that reduction of travel speeds could assist in reducing wear, while allowing heavier loads.
- Eliminate Seasonal Road restrictions, as they don't seem to help the overall road conditions in ND
- I feel that highways are unsafe in areas of Western ND with heavy truck traffic.
- May God bless all North Dakotans! <3
- ND has a budget surplus; why can't we get the roads in shape to handle normal loads?
- The Devils Lake area is in dire need of a waiver for these load restrictions starting TOMORROW!
- What is split load permitting?
- Check more out of state trucks
- Get the government to take the tax from
- It would be nice if all states had a common website to compare restrictions and make it easier to comply
- It is a tough situation. It will take time, resources and patience and planning to work through.
- Although we understand the reason for imposing load restrictions during spring, it has always been a logistical challenge at times, mainly due to the lack of knowledge on the manufactures of equipment.
- I understand the reason for the Spring Load Restriction and it’s a good thing. But these roads are already beat up and with the growing production of the OIL and GAS and all the trucks that have to travel these roads I greatly think it is time that the state of North Dakota need to start improving all of its roads. The revenue that is being generated for the oil & gas boom has to be very good.

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