



2013–2015

Office of
Maintenance

STATEWIDE
BIENNIAL

Maintenance
Operations
Research Report



Your Destination...Our Priority



DISCLAIMER

Trade names are used on occasions in this report to better identify the type or use of a product or material involved in field research. However, use of these names in no way implies Minnesota Department of Transportation's (MnDOT) endorsement of the product or material discussed unless there is a specific MnDOT recommendation to that effect. No attempt was made to identify which product or material had registered trade mark associated with it.

ACKNOWLEDGMENTS

The Maintenance Operations Research program is able to make a significant impact on the efficiency, safety, and cost of state maintenance operations. Many thanks to the Area Maintenance Engineers and District champions for their enthusiastic involvement. We sincerely appreciate these contributions, as well as the strong support of MnDOT's Office of Maintenance in advancing technology implementation.

Thanks very much to all who contributed content to this biennial report, including writing summaries, submitting photographs and compiling data.

For more information, please visit:

Minnesota Department of Transportation:

<http://www.dot.state.mn.us/>

MnDOT Office of Maintenance Research Unit:

<http://www.dot.state.mn.us/maintenance/research.html>

MnDOT Research Services Section:

<http://www.dot.state.mn.us/research/index.html>

MnDOT Library:

<http://www.dot.state.mn.us/library/>

Office of Maintenance

STATEWIDE BIENNIAL
Maintenance Operations Research Report
2013–2015



Prepared by CTC & Associates LLC and shu shu design
September 2015

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Introduction

The Maintenance Operations Research (MOR) program is a unique statewide collaboration focused on identifying and applying real-world solutions to highway maintenance operations. Managed by the MnDOT Office of Maintenance, the program funds the testing and evaluation of innovative products and practices intended to preserve the existing transportation system and improve the efficiency and safety of MnDOT maintenance operations. This report presents the program and project highlights of the 2013–2015 funding biennium.

The report includes four sections:

- **About the Program** looks at the history of the MOR program, its goals and objectives, and the MnDOT staff throughout the state who make it a success.
- **Project Funding and Selection** describes the funding breakdown for 2013-2015 and the criteria used to evaluate proposed research and implementation projects.
- **2013–2015 Projects** reports on every completed and in-progress research project for FY 2014 and FY 2015. Each project summary includes an overview of the product tested, the expected benefits and any results documented to date.
- **Previous Statewide MOR/NTREC Project Reports** lists all completed research projects since the program began.

About the Program

History

The Minnesota Maintenance Operations Research program began in 1988 with a legislative appropriation for salt research. The department received \$1.5 million for a two-year field study to investigate alternatives to salt for winter maintenance and the effectiveness of additives for reducing salt corrosion.

After this initial investment, MnDOT's interest in maintenance innovations remained strong, and the agency sought an ongoing funding source for maintenance research activities. In 1991, MnDOT's area maintenance engineers set aside 18% of the Road Equipment Budget contingency fund to support the multidisciplinary New Technology, Research and Equipment Committee (NTREC), a subcommittee of the MnDOT Operations Management Group (OMG) focused on identifying practices and technologies to improve MnDOT business. NTREC evolved and grew to encompass four key programs at MnDOT: the MOR program, the Maintenance Operations Implementation Fund, the Maintenance Operations New Equipment Technology Fund, and the Maintenance Operations Strategic Activities Fund. By the mid-1990s, funding across these four programs totaled \$1,346,000, with \$712,500 of this amount dedicated solely to the MOR program. This ongoing investment supported numerous investigations across a range of winter and summer maintenance methods, products, procedures and technologies.

In 2004, department wide budget cuts and layoffs resulted in a reduction in the MOR program to \$470,000. However, MnDOT staff maintained their commitment to bringing innovation to the department, evaluating nearly 175 tools and techniques for enhancing maintenance operations since 2005. In 2013, the Office of Maintenance leveraged additional agency funds to add a technology transfer position to the MOR program. This new position helps the MOR program further encourage and communicate grass roots maintenance innovations throughout the state by collecting and distributing information on devices built in house by MnDOT employees in the field.

Goals and objectives

The MOR program encourages and funds real-world research in maintenance operations to help MnDOT staff improve safety, preserve infrastructure, increase efficiency and ensure fiscal responsibility. The goal is to identify, develop and implement the most effective maintenance procedures, materials and equipment throughout the state.

The MOR program addresses all MnDOT maintenance operations, including winter maintenance, summer maintenance, preservation, road and bridge maintenance, roadside maintenance, work zone safety and traffic control. The program relies on the leadership of the 25 NTREC members who represent a range of specialties and offices within MnDOT, along with involvement of individual district research committee staff who propose research ideas and evaluate new products and technologies.



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Bridge/Structures Office

Rick Shomion
Training

Ted Ulven
*Office of Traffic and Safety
Technology*

Mark Vogel
Environmental Services

District Staff
MOR/SS/MDSS Chairs

Project Funding and Selection

Funding distribution

The annual budget for the Maintenance Operations Research program is \$488,000. The funds are distributed among maintenance research projects, product implementation and staff salaries.

Annual program funding breakdown

Research projects:	\$267,000
Staff salaries:	\$221,000
Total:	\$488,000

The MOR program funds research projects across the state in the categories of Winter Maintenance; Winter Material/Chemicals; Road and Bridge Maintenance; Roadside Maintenance; Equipment and Tools; and Work Zone Safety. See the chart at right for the FY 2014/2015 distribution of funds by research category.

To optimize the return on the research investment, the program typically contributes 25% of the available budget for projects in implementation. Implementation activities that are eligible for partial or full funding include demonstrations, training, technical assistance and distribution of products statewide.

Budgets for FY 2014 and FY 2015 are summarized in Table 1 (by category) and Table 2 (by district). See the location of districts throughout the state in Figure 1.

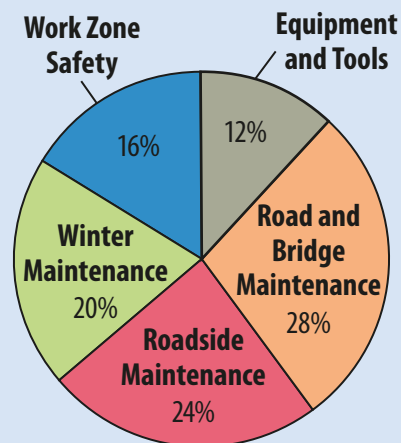
Selection criteria

To ensure that all research projects selected for funding meet the goals and purpose of the Maintenance Operations Research program, the following criteria are used to evaluate each proposed project:

- Availability of funding and matching resources
- Expected benefits or return on investment
- Potential for improving safety in the field
- Opportunity for statewide implementation
- Innovation
- Supports transportation preservation

FY 2014– FY 2015 Funding Distribution by Research Category

Equipment and Tools	\$63,622
Road and Bridge Maintenance	\$145,454
Roadside Maintenance	\$127,655
Winter Maintenance	\$107,165
Work Zone Safety	\$86,322
Total	\$530,218



Research proposals with funding requests of more than \$15,000 require approval from NTREC, which meets twice a year, once to consider proposals and once to act as an update meeting to review previous NTREC projects. Funding requests of less than \$15,000 require approval from the maintenance operations research

committee. See pages 7 to 76 for details about each research in-progress and completed research project for 2013-2015.

Although MnDOT tests numerous products and procedures each year, funding is available to implement only a portion of them. The Maintenance Research Unit, in collaboration with the Research Services & Library, NTREC representatives and a district representative, identifies promising products to implement based on field reports of the research conducted. NTREC then develops a final list of implementation products that are available to the districts. When available, implementation funding is divided up equally among the districts and can be used for implementing any of the approved products from the current year or previous years.

**Table 1. FY 2014 and 2015
MOR/NTREC Budget by Category**

Category	No. of Projects	Funds Assigned	% of Total Funds
Equipment and Tools	12	\$63,622	12%
Road and Bridge Maintenance	13	\$145,454	28%
Roadside Maintenance	19	\$127,655	24%
Winter Maintenance	11	\$107,165	20%
Work Zone Safety	7	\$86,322	16%
Total	62	\$530,218	100%

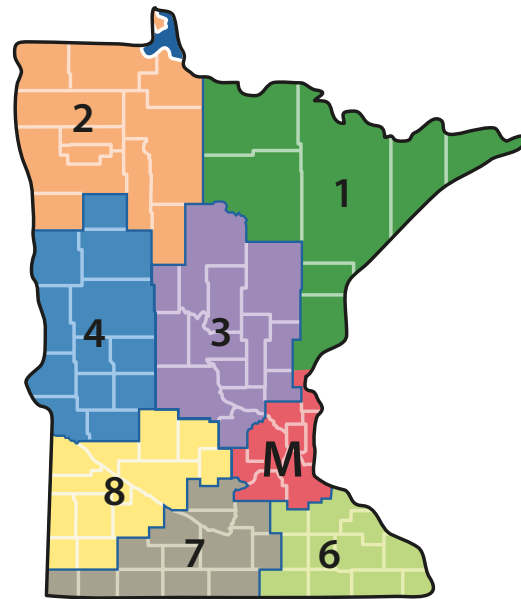


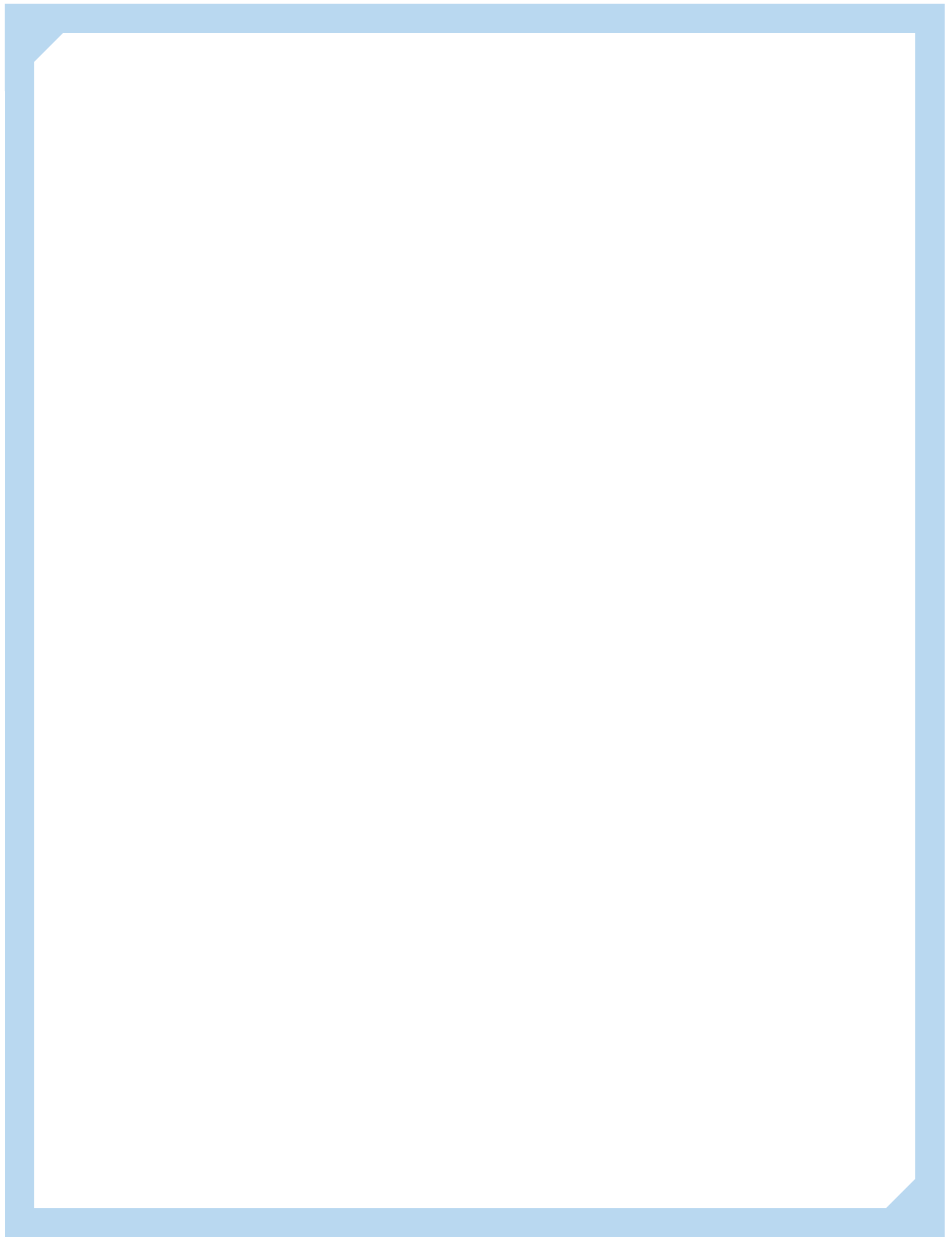
Figure 1. Minnesota Department of Transportation Districts

1 Duluth	6 Rochester
2 Bemidji	7 Mankato
3 Brainerd	8 Wilmar
4 Detroit Lakes	Metro

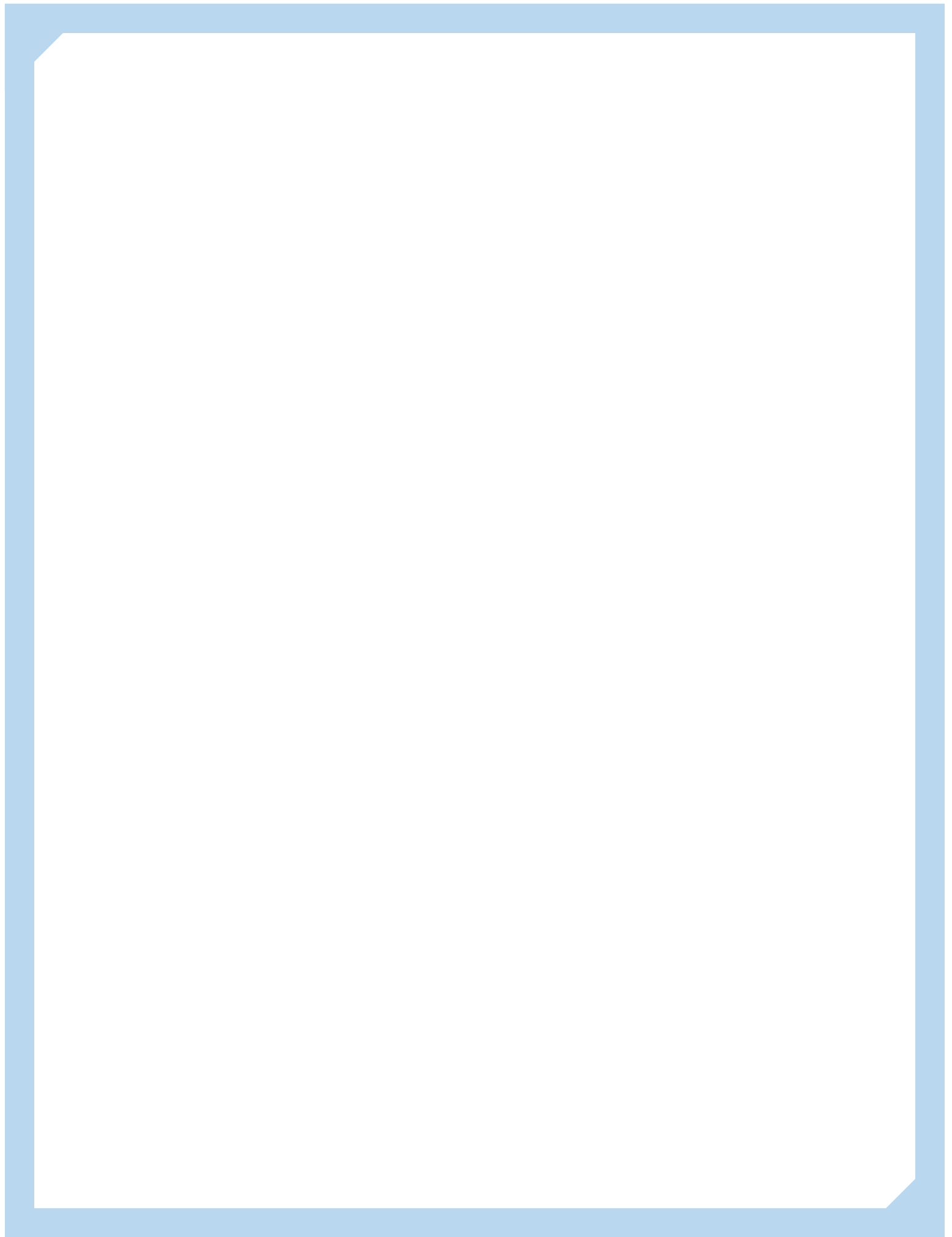
**Table 2. FY 2014 and 2015
MOR/NTREC Budget by District**

District	No. of Projects	Funds Received	% of Total Funds
1	9	\$29,885	6%
2	7	\$44,445	8%
3	4	\$9,700	1%
4	4	\$121,400	23%
6	19	\$220,878	42%
7	8	\$46,000	9%
8	5	\$33,910	6%
Metro	6	\$24,000	5%
Total	62	\$530,218	100%

NOTE: Projects are initiated by MnDOT Central Office and are distributed to the districts.



2013-2015 Completed Projects





Maintenance Research

Equipment and Tools

District/Office:
Metro

Contact:
Patrick O'Brien
651-772-7537

Project Cost:
\$9,900.00

Start Date:
July 2013

Completion Date:
January 2015

Vendor:
primeresins.com

Compact Slab Lifting System *Completed Research*



Project Description: Approach slabs, sidewalks and other areas of sunken concrete can be removed and replaced, or mudjacking (pumping a grout mixture below the slab to raise sunken concrete) can be used to rehabilitate the slab. The district is seeking an alternative to current slab lifting or removal practices that are time-consuming and often require lane closures to accommodate equipment.

Purpose: Providing a faster, cleaner and less labor-intensive alternative to mudjacking, the Precision Lift compact slab lifting system includes the Revolution Pump, which injects Precision Lift Foam, a high-density, structural polymer, into the voids beneath sunken concrete slabs. The foam expands and develops hydraulic lift to level and stabilize slabs without excavation and added weight.

Test Procedure: The district evaluated the slab lifting system's ability to save time, labor and material, reduce environmental impacts, and increase efficiency and safety by eliminating lane closures when additional equipment is needed for mudjacking or slab removal.

Conclusions: The slab lifting system performed beyond the district's expectations, sometimes lifting sunken slabs in less than 10 minutes. Crews did note that the equipment requires extensive cleanup after each use, with cleanup often taking more time than the slab lifting operation.

Recommendations: Given the limited shelf-life of the injectable foam and the complexity of machine usage, the district recommends limiting implementation of the slab lifting system to one unit per district.



Maintenance Research

Equipment and Tools

District/Office:
7E

Contact:
Chris Hanson
507-304-6235

Project Cost:
\$3,500 (12 units)

Start Date:
November 2014

Completion Date:
May 2015

Vendor:
illumagear.com

Halo Light *Completed Research*



Project Description: The district is seeking an alternative to the use of handheld flashlights for staff to see and be seen during nighttime operations. With one hand occupied by holding the flashlight, it can be challenging for staff to complete flagging and other operations at night using only one hand.

Purpose: The Halo Light attaches to any hard hat, producing a ring of light around the wearer that provides visibility in all directions over one-quarter mile away. A rechargeable lithium-ion battery provides up to 12 hours of power. The Halo Light allows staff to keep both hands free to increase the efficiency and safety of nighttime operations.

Test Procedure: The district tested six Halo Lights; an additional six units were distributed to other districts for testing. The districts assessed the effectiveness of the Halo Light in providing visibility during nighttime operations, reducing the possibility for injury and accidents, and reducing the labor and equipment needed to install alternative scene lighting to illuminate a nighttime operation area.

Conclusions: The Halo Light hard hat attachment performed well in lighting the work area and stayed attached to the hard hat, unlike some strap-on headlamps. The battery pack is easily accessed, and the attachment is lightweight.

Recommendations: The district recommends the Halo Light for statewide implementation. District testers noted, however, that the light cannot be used when ear muffs are worn on a hard hat to protect the wearer from noise and cold.



Maintenance Research

Equipment and Tools

District/Office:
6W

Contact:
Gary Wobschall
Jason Schubert
507-446-5509

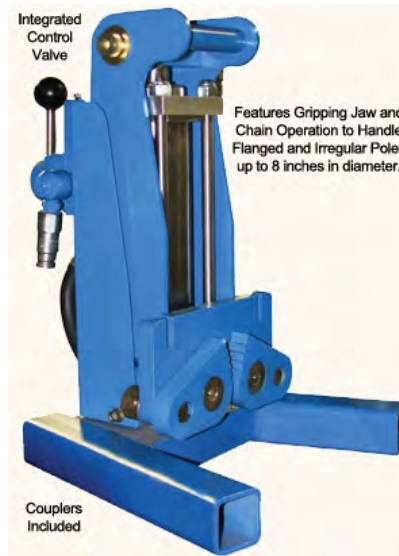
Project Cost:
\$1,862

Start Date:
March 2012

Completion Date:
September 2013

Vendor:
reliable-equip.com

Hydraulic Signpost Puller *Completed Research*



Project Description: The district's current practice of pulling signposts with a crane boom sometimes results in the post breaking, which can be hazardous for the crew, the traveling public, the sign truck and the crane boom itself. The district tested an attachment to the crane boom—the REL-SPP hydraulic signpost puller, which features a gripping jaw and chain operation to handle flange and irregular poles up to 8 inches in diameter.

Purpose: The hydraulic signpost puller is designed to increase safety and limit repair expenses associated with using the crane boom to pull signposts.

Test Procedure: The district assessed the hydraulic post puller's effectiveness at reducing injuries and costs related to pulling signposts.

Conclusions: The hydraulic signpost puller was not as effective or as safe as expected, especially on slopes and when pulling hard posts. In these situations, the jaws often disengaged and the puller bounced off, creating a safety hazard. The puller performed well in the right of way and with smaller posts, but was ineffective with larger signposts.

Recommendations: The district does not recommend this product. The current practice of using the crane boom to pull signposts was deemed faster and safer. The district noted that having an adjustable base would make this equipment more versatile.



Maintenance Research

Equipment and Tools

District/Office:
1/South

Contact:
Jim Kielty
320-245-2324

Project Cost:
\$1,200

Start Date:
May 2014

Completion Date:
September 2015

Vendor:
www.edgewoodmfg.com

Real Clean Hand Soap

Completed Research



Project Description: Real Clean is a 100% biodegradable, all natural and organic hand cleaner and skin conditioner designed to remove grease, grime and strong odors (such as oil, paint and fish).

Purpose: Many industrial hand cleaners have potentially harmful ingredients, including triclosan, which will be banned in Minnesota starting in 2017. MnDOT was interested in alternative cleaners that would safely and effectively remove dirt and odors without increasing operational costs or harming the environment.

Test Procedure: District 1 mechanics and maintenance employees used 10 dispensers of the Real Clean soap over a one-year period, comparing it to their current hand soap for its ability to clean hands and remove odors.

Conclusions: Employees found that Real Clean effectively removed dirt and odors, such as from diesel fuel, oil or propane. They liked that the product is all natural, avoiding the introduction of potentially harmful chemicals into the working environment. In addition, the cost of this soap was similar to other hand soaps used by the district in the past.

Recommendations: The district recommends using this soap for hand cleaning going forward and will also explore the potential use of Real Clean for truck washing.



Maintenance Research

Equipment and Tools

District/Office:

3

Contact:

Kelvin Smith
320-223-6560

Project Cost:

\$2,000

Start Date:

July 2013

Completion Date:

May 2014

Vendor:

msfoster.com

RoadWatch Field Calibration Unit *Completed Research*



Project Description: The district uses RoadWatch sensors, an infrared detection system that provides real-time road and air temperature information, to help snowplow operators monitor road conditions and adjust material application rates during winter maintenance operations. Currently, the RoadWatch sensors must be replaced—at a cost of \$500 per unit—when readings are inaccurate.

Purpose: The RoadWatch Field Calibration Unit is designed to quickly check and recalibrate RoadWatch sensors purchased after 2010. With the calibration unit, the district can validate sensor accuracy and replace units failing to meet specifications before winter operations conclude. The district can also incorporate calibration into its preventive maintenance schedule throughout the summer.

Test Procedure: The district assessed the calibration unit's ability to accurately calibrate newer-model RoadWatch sensors and retain adjustments.

Conclusions: Staff found the calibrator to be very user-friendly. After removing the RoadWatch sensor from the vehicle, the calibration unit quickly showed when a sensor was defective.

Recommendations: The district recommends limited implementation of the RoadWatch Field Calibration unit given its application to only newer-model sensors that can be easily removed from the truck for testing.



Maintenance Research

Equipment and Tools

District/Office:
8/Marshall

Contact:
Craig Gertsema
507-537-2059

Project Cost:
\$8,177

Start Date:
March 2011

Completion Date:
January 2013

Vendor:
truckoffice.com

TruckOffice *Completed Research*



Project Description: The back seats of supervisors' pickups can be packed full of supplies, equipment and paperwork. These unsecured objects can be unsafe in the event of an accident and pose a security issue if valuables are in full view of potential thieves. The TruckOffice storage unit organizes paperwork, files and technical data, provides safe, secure laptop storage, and comes with an optional power inverter that can help with the use of electronics and other instruments in the field.

Purpose: The TruckOffice is designed to organize contents in pickups, improve safety for drivers and occupants, and enhance security by providing secondary locks on valuables.

Test Procedure: Inspectors and maintenance supervisors in the district tested two storage unit models—TruckOffice and CargoDeck—to determine the units' effectiveness in organizing and securing truck contents.

Conclusions: The TruckOffice was very effective in keeping the operator's cab compartment clean and organized. It improved safety by securing loose items. The CargoDeck has more open containers and fewer drawers, which worked well for maintenance staff since they tend to have larger items to transport. However, the units limit the vehicle's versatility somewhat, since the back seat must be permanently removed to install them. Also, the units limit reclining ability in the front seats.

Recommendations: The TruckOffice can be very valuable to the right user, and especially for certain jobs. It is recommended for situations where a pickup is assigned to one specific operator. The limitations placed on the vehicle's versatility should be considered.



Maintenance Research

Equipment and Tools

District/Office:
4A

Contact:
Joe Stegmaier
218-846-7943

Project Cost:
\$14,400

Start Date:
July 2013

Completion Date:
August 2014

Vendor:
edneyco.com

Vicon Front-Mount Mower *Completed Research*



Project Description: The district's current back-mount mowers tend to retain a large amount of noxious weed seeds on the mowing unit, which requires cleaning of the weed seed from mowers after mowing, and also results in the movement of noxious weeds during mowing operations. The addition of a front-mount mower provides the opportunity to reduce noxious weed movement and increase the efficiency of mowing operations.

Purpose: The Vicon front-mount mower features an even number of contrarotating three-bladed discs that provide a wider overlap on each disc compared to other blade configurations. The expected increase in mowing efficiency will free up staff to complete other tasks and leave more tractors available for spraying and shouldering operations.

Test Procedure: The district planned to evaluate the front-mount mower's performance over one year. Operators expected to compare the front-mount mowing system with the district's back-mount Schulte mowers to assess mowing efficiency, savings in labor, equipment and materials, and the amount of noxious weeds carried by each mower.

Conclusions: The mower was damaged beyond repair when it encountered a sign base during operation, cutting short the evaluation period. While operators were satisfied with the performance of the mower in its limited use, the district was unable to gather enough information to evaluate cost savings and mower efficiency.

Recommendations: The district does not recommend the front-mount mower for statewide implementation. Although the mower includes a breakaway feature for avoiding obstructions, it did not effectively prevent damage when encountering objects in the field.



Maintenance Research

Road and Bridge Maintenance

District/Office:
6W/Headquarters

Contact:
Steve Lueken
507-446-5530

Project Cost:
\$1,590

Start Date:
December 2011

Completion Date:
December 2012

Vendor:
amesengineering.com

Ames GPS-DMI *Completed Research*



Project Description: This distance measuring instrument (DMI) uses a GPS receiver to measure pavement distances. The unit is self-calibrating, so it can be moved from vehicle to vehicle; it plugs into the vehicle's 12-volt electrical system.

Purpose: This DMI allows maintenance crews to accurately measure distances along a roadway, such as when setting up traffic control, without the need to hardwire a speed sensor into a vehicle. In the past, some DMIs' speed sensors have affected the vehicle's transmission and have interfered with the vehicle's computer systems. The plug-in units eliminate these issues and require minimal installation time.

Test Procedure: The district evaluated the performance of two GPS-DMI units for one year. The district used its own DMI units; the research project funded the GPS receivers.

Conclusions: The units were very easy to install and use, but operators reported mixed results in terms of accuracy. The units sometimes counted slowly depending on the vehicle's speed, but this was not overly bothersome, and the operators wanted to continue using them. At the time of the district's final report, the vendor was updating this product to integrate a vehicle speed input along with the GPS, which was expected to improve the units' performance. Using these units saved the district about eight hours of installation time (about \$475), and the district was able to use existing DMI control heads at a savings of \$400 each. Since the operators were familiar with the control heads, no learning time was required to use the new units.

Recommendations: The district recommends this product for purchase once it has been updated to incorporate the vehicle speed input.



Maintenance Research

Road and Bridge Maintenance

District/Office:
6E/Rochester

Contact:
Tom Miles
507-286-7623

Project Cost:
\$19,150

Start Date:
March 2010

Completion Date:
June 2014

Vendor:
geophysical.com

Ground Penetrating Radar Bridge Scan System

Completed Research



Project Description: MnDOT staff evaluate concrete bridge decks for delaminations using manual detection techniques, such as chain dragging and core sampling. These manual techniques are labor-intensive and can yield inaccurate results. The Ground Penetrating Radar (GPR) Bridgescan System uses an electromagnetic evaluation technique that could alleviate these problems.

Purpose: The GPR Bridgescan System gathers data about bridge conditions without the need to remove the top layer of pavement. The companion software allows users to accurately see the severity of concrete delaminations and the overall deterioration of the bridge deck.

Test Procedure: Staff evaluated the effectiveness of the system for inspecting bridge decks.

Conclusions: With minimal training, inspectors were able to use the GPR unit to collect data on bridge decks about three to four times faster than using manual methods, reducing their exposure to traffic. However, processing and interpreting data on deck deterioration proved more challenging. Extensive training and experience would be needed to develop the expertise to use the GPR for this purpose, but the tool was not used frequently enough to allow staff to develop this expertise. The GPR can also be used for other applications that do not require extensive data processing and interpretation, such as locating rebar, but this can also be accomplished using cheaper stand-alone devices.

Recommendations: The GPR unit is not used frequently enough for deck deterioration determinations to justify its high cost.



Maintenance Research

Road and Bridge Maintenance

District/Office:
6W/Owatonna

Contact:
Daryl Johnson
507-446-5507

Project Cost:
\$9,178

Start Date:
January 2011

Completion Date:
April 2013

Vendor:
hotpatchheater.com

Hot Patch Heater *Completed Research*



Project Description: This heated truck bed insert uses the truck's engine coolant to heat asphalt patching mix to a workable temperature within half an hour year-round and keep it pliable throughout the day. The system's hydraulic shoveling platform lowers materials from the bed of the truck to a comfortable shoveling height. The system allows leftover hot mix from the previous workday to be reheated to a workable temperature, eliminating the need to chip out hardened mix each morning.

Purpose: This equipment is designed to make patching easier, safer and more cost-effective. The system could improve or replace existing patching units that run off diesel or gas. It is designed to reduce the manpower and time needed to get the patching material hot enough to apply to the roadway, and it is a "green" solution because it uses the engine's own coolant to heat the mix rather than requiring additional fuel. The ergonomic shoveling platform aims to reduce worker injuries.

Test Procedure: The district evaluated one Hot Patch Heater for six months.

Conclusions: The unit was effective at keeping the patching materials at a workable temperature, and the ergonomic shoveling platform made patching easier and safer. The unit produced material savings, since crews were able to reheat and use all of the patching mix rather than having to chip out hardened mix each morning and discard it.

Although each Hot Patch Heater is custom-made to fit the dump truck body, the district had to make its own support brackets so that the unit fit more precisely.

Recommendations: The Hot Patch Heater was cost-effective, and the district recommends it for statewide implementation.



Maintenance Research

Road and Bridge Maintenance

District/Office:
6W/Red Wing

Contact:
Ben Boldt
507-676-2302

Project Cost:
\$2,045

Start Date:
September 2012

Completion Date:
September 2013

Vendor:
vibco.com

Vibratory Roller *Completed Research*



Project Description: The throw-and-go procedure currently used to make hot and cold pothole patches does not involve compaction. Providing an alternative to this procedure is the Vibco GR-1600, a gasoline-operated vibratory roller with an 8-inch diameter and 12-inch-long drum that provides a compaction depth up to 8 inches with a compaction force of over 1,000 pounds at 6,500 vibrations per minute. While requiring only an extra 1 to 2 minutes to compact the patches, the Vibco GR-1600 can provide better water runoff and a tighter pothole patch for traffic to drive over without creating depressions.

Purpose: The vibratory roller is designed to improve cold and hot patching by making a semipermanent pothole patch that lasts longer than a patch made with the throw-and-go procedure.

Test Procedure: The district evaluated the effectiveness of the vibratory roller in reducing costs and material use by creating longer-lasting pothole patches.

Conclusions: The vibratory roller worked well with both cold-mix and hot-mix patches. The patches appear to be lasting longer than throw-and-go patches, and if this continues to be the case, using the roller will allow the district to patch less frequently, which will reduce costs. The district noted that the roller is somewhat heavy, and will be easier to unload and reload at each site once a shelf or rack is added to the patch trailer.

Recommendations: If the patches continue to last longer than conventional patches, the roller is recommended for use statewide.



Maintenance Research

Roadside Maintenance

District/Office:

1

Contacts:

Brian Koczur
Michael Hedlund
218-834-4442

Project Cost:

\$23,135

Start Date:

April 2013

Completion Date:

June 2015

Vendor:

diamondmowers.com

Boom Mower *Completed Research*



Project Description: Brush growing in the right of way can obstruct views of signs and present other sight-line issues, and small trees can blow across driving lanes during storms and require dangerous cleanup. Removing brush in a safe and effective manner can be complicated by the lack of specialty pieces of equipment in the MnDOT fleet. The three-point hitch Diamond boom mower tractor attachment provides an alternative to current brush removal practices.

Purpose: The boom mower tractor attachment is designed to save time by allowing crews to remove trees from the roadside while they are smaller, before they become hazards. The boom mower also makes efficient use of existing equipment and requires a smaller investment than the purchase of a dedicated brush cutter.

Test Procedure: The district assessed the effectiveness of the boom mower attachment in saving staff time and reducing injuries by reducing the amount of manual brush cutting required.

Conclusions: The boom mower tractor attachment performed very well, allowing operators to reach deep into ditches to clear brush that was encroaching on the right of way. The attachment is easy to install, use and remove, and provides much of the capability of a dedicated boom mower. One downside is that because it is mounted on the rear of the tractor, the operator must turn around to watch the mower, which causes neck and back strain. This can be mitigated by switching every hour or two with another operator, perhaps one in a shadow vehicle.

Recommendations: The boom mower tractor attachment can be shared relatively easily between locations, and is recommended as a cost-effective alternative to having multiple areas purchase dedicated mowers.



Maintenance Research

Roadside Maintenance

District/Office:
2/NW

Contact:
Rick Hruby
218-683-8015

Project Cost:
\$8,000

Start Date:
January 2012

Completion Date:
August 2014

Vendor:
tiger-mowers.com

Ditching Wheel *Completed Research*



Project Description: This attachment has a rotary blade that is often used to clear vegetation from roadside ditches during warmer months. The district evaluated the tool's effectiveness during the winter, using it to cut through compacted snow and ice that have accumulated in ditches. The ditching wheel attaches to a Tiger boom mower.

Purpose: The district's goal was to reduce and prevent flooding by using the ditching wheel to create a trench through compacted snow and ice and restore normal drainage. The tool could also be used for temporary or emergency ditching to lower flood waters.

Test Procedure: The district tested one Tiger ditching wheel for about a year and a half, evaluating its effectiveness in this winter maintenance application and its potential to save time and money and to reduce labor hours.

Conclusions: The ditching wheel was very effective for shallow ditch work, especially in small areas with short vegetation. It was effective at cutting troughs in compacted snow caused by snowmobile groomers. The ditching wheel was cost-effective for use in small areas, allowing work to be completed in about half the time and with less equipment compared with using a trackhoe. One advantage of the tool is that it throws the material it removes from the ditch, so there is no material to haul away. The district suggested modifying the tool's paddles for use in compact snow so that the snow is thrown farther. In addition, the district noted that the tool should not be used in areas with taller vegetation, which tends to wrap up on the wheel.

Recommendations: The district recommends this tool for cutting through compacted snow, and for ditch work in dirt in small areas with short vegetation.



Maintenance Research

Roadside Maintenance

District/Office:
8/Marshall

Contact:
Chase Fester
507-537-2083

Project Cost:
\$611

Start Date:
December 2011

Completion Date:
March 2014

Vendor:
microdynamics.com

DOT-Z1 Pro Distance Measuring Instrument

Completed Research



Project Description: Maintenance crews often need to measure distances along a roadway or between roadside features, such as when setting up traffic control. This vehicle-mounted unit measures distance using battery power or by plugging into a vehicle's 12-volt electrical system, so no hardwire connection is needed. The unit has an internal GPS module and stores distance, speed and GPS data for later retrieval.

Purpose: The DOT-Z1 Pro is designed to be more reliable than the distance measuring instruments the department currently uses. It does not require installation, calibration or maintenance by a mechanic, which saves time and money compared with systems that must be hardwired into a vehicle. The unit can also be used outside a vehicle by crews on foot, and can be moved easily from vehicle to vehicle, which means fewer units may need to be purchased.

Test Procedure: The district evaluated the accuracy and reliability of one unit.

Conclusions: The tested unit and others purchased by the district have performed very well. The plug-and-play functionality makes the units very versatile, with no calibration time required when they are moved from one vehicle to another, and they are easy to program and operate. Although they are more expensive than the devices previously used by the district (with each unit costing about \$600 vs. about \$500), the DOT-Z1 Pro units have been much more reliable, saving time and money on repairs. This makes the DOT-Z1 Pro units more cost-effective overall.

Recommendations: The district recommends this device as a more reliable and cost-effective alternative to other distance measuring instruments.



Maintenance Research

Roadside Maintenance

District/Office:
6E/Caledonia

Contact:
Mike Aasum
507-273-8701

Project Cost:
\$1,200

Start Date:
May 2011

Completion Date:
August 2012

Vendor:
autostapler.com

Erosion Blanket Staple Gun *Completed Research*



Project Description: Erosion blankets are used to help control soil erosion in and around roadside ditches, median ditches, slopes and culvert ends before rip-rap is placed. This staple gun is used to secure erosion blankets using 6-inch staples.

Purpose: As the use of erosion blankets increases, this staple gun provides a more efficient method of securing them; it eliminates the need to pound stakes or staples with a hammer or by foot. This tool is especially useful on frozen or hard ground, on steep ravines, and on large landscaping projects. Using the staple gun saves time and reduces back injuries caused by bending over to pound in stakes or staples. It weighs less than 20 pounds and can be easily transported from site to site.

Test Procedure: The district tested one Rifle M100 staple gun for about one year. District 6W owns a similar tool manufactured by a company that has gone out of business, so this test provided performance data on a staple gun from a different manufacturer.

Conclusions: The staple gun was effective and easy to use, and was quicker than pounding staples in by hand. The district estimated at least a 50 percent time savings. On rocky soil, staples sometimes bent and plugged the staple gun; pliers were required to dislodge the bent staple. The unit was a little awkward to use on hillsides. The district also noted that the unit seemed overpriced, but that there are not many similar products offered by other manufacturers.

Recommendations: The district recommends that each subarea have at least one stapler for installing erosion blankets, especially since these projects have become more common with new erosion control guidelines.



Maintenance Research

Roadside Maintenance

District/Office:
6W/Owatonna

Contact:
Dean Homan
507-645-8155

Project Cost:
\$52,127

Start Date:
February 2013

Completion Date:
December 2014

Vendor:
hammellequipment.com

Highline Mower *Completed Research*



Project Description: The district tested the Highline radial contouring hitch (RCH) batwing mower for mowing roadside ditches. A typical hitch mower requires the tractor to leave the roadway to mow ditches and cannot reach the wet areas that the RCH batwing mower can reach by shifting the mower as needed while the tractor stays on dry ground.

Purpose: The RCH batwing mower is designed to improve operator safety and reduce operator fatigue by keeping the tractor on a flat roadway and away from hazards while mowing steep grades. The mower also saves time in mowing wet areas that now require the use of smaller mowers.

Test Procedure: The district evaluated the RCH batwing mower's success in reducing the staff time needed to mow roadside ditches, and its effect on improving the safety of the operator and reducing repairs associated with the tractor encountering hazards.

Conclusions: The district's experience with the RCH batwing mower has been very positive. Crews are able to mow areas that had previously been too difficult or steep, and can mow areas with one pass that had previously taken two passes or two operators on separate mowers. Using the mower reduces operator fatigue by allowing the operator to stay on flat, stable ground. The mower is operator-friendly, easy to maneuver and safer in wet conditions.

Recommendations: The district recommends the RCH batwing mower for use statewide. In areas where the mower will be used, all culverts should be marked.



Maintenance Research

Roadside Maintenance

District/Office:
6E

Contact:
Shannon Wait
507-286-7681

Project Cost:
\$24,695.00

Start Date:
August 2009

Completion Date:
March 2013

Vendor:
trimble.com

Juno Data Collector *Completed Research*



Project Description: Accurate and thorough data collection is an essential part of the job for maintenance staff. The Juno SB handheld is a Global Positioning System data collector that improves and streamlines the inventorying of right of way features and the planning and reporting of field operations. Data are post-processed and can be imported into existing software packages such as Excel, Access and ArcGIS for reporting and work planning.

Purpose: Data are gathered, maintained and stored in an easy-to-access digital format that eliminates the use of written field diaries, allowing for the easy transfer of knowledge that may otherwise be lost. The system also permits the attachment of digital images and coordinates to the file, and gives staff the ability to produce work plans in the field.

Test Procedure: The district purchased 11 units and software to be tested within the district's subareas for collecting project data on a daily or project basis. The project planned to evaluate how well the Juno SB handheld device bridged existing gaps in available data to generate more accurate, thorough and prompt reporting of highway maintenance activities.

Conclusions: This project faced many obstacles, and ultimately could not be executed as planned. A key issue was the staff time required to build the comprehensive data dictionary needed for field collection efforts. As priorities and workloads shifted, the data set could not be completed, and testing could not move forward.

Recommendations: No conclusions could be drawn about the system's performance. To complete project development and testing, the district indicated that additional staff time (such as help from student workers, light-duty personnel or other employees) would be needed, as well as districtwide support for field-testing the units.



Maintenance Research

Roadside Maintenance

District/Office:
3B/St. Cloud

Contact:
Kelvin Smith

Project Cost:
\$25,000

Start Date:
November 2011

Completion Date:
March 2015

Vendor:
roadwidenerllc.com

Road Widener *Completed Research*



Project Description: Small repairs to gravel shoulders are currently made using sander conveyors on the rear of dump trucks. When a load of gravel has been emptied, the truck must leave the repair site to get a new load, which creates downtime if the material is far from the repair site. The district tested a shoulder widening unit that is powered by a skid-steer tractor, which allows crews to use several trucks to feed the unit.

Purpose: The shoulder widener is designed to improve efficiency and reduce traffic hazards to crews and motorists. The unit allows crews to complete large projects without mobilizing several pieces of off-road equipment, and could provide a cost-effective alternative to the grader-mounted units the department currently uses for shoulder work.

Test Procedure: The district used one Road Widener unit to rebuild gravel shoulders for one year. The unit was evaluated for material handling using various grades of gravel mixtures, speed of material application, and durability. Repairs completed in the fall were monitored for longevity and durability over the winter season.

Conclusions: The unit required modifications to reach an acceptable level of performance and dependability. As purchased, it lacked the structural strength to push the district's trucks. It was also difficult to monitor material placement from a skid-steer cab; using a small loader provided a higher sight line. The unit performed best in straight-line applications. Quality results were hard to achieve on curves and uneven shoulders.

Recommendations: Because the unit requires significant modifications to meet MnDOT's needs—D3B spent more than \$1,500 and 130 hours—the district does not recommend it for statewide use.



Maintenance Research

Roadside Maintenance

District/Office:
Metro

Contact:
Jeff Streeter
651-366-5191

Project Cost:
\$58,834

Start Date:
September 2010

Completion Date:
November 2013

Vendor:
cleannsealteam.com

Soda Blaster *Completed Research*



Project Description: Soda blasting is a new paint stripping technology that uses compressed air to propel a bicarbonate of soda-based media onto the surface to be cleaned or stripped.

Purpose: The low-impact, ecofriendly soda blaster can be used to clean and depaint (including graffiti removal) bridges, overpasses, sound walls, pavement, buildings, mechanical equipment and other surfaces for which repainting is not an acceptable option. Although it is similar to traditional sand blasting, soda blasting has the significant advantage of cleaning the surface without causing harm to the substrate or the environment.

Test Procedure: The district evaluated the soda blaster for performance and reliability, assessing the unit for its ability to save time with a one-step cleaning and decoating process, cause minimum impact to surfaces, and reduce labor needs with a mobile, often one-person operation.

Conclusions: The soda blaster was very effective at removing graffiti, especially from historic areas such as the Stone Arch Bridge where graffiti cannot be painted over. This saved money over hiring a contractor for graffiti removal. The district also used the soda blaster to strip paint from trucks and equipment before welding. The soda blaster was easy to use, but the district noted that the paint being removed must be captured and contained to prevent contamination of the surrounding environment.

Recommendations: The district recommends the soda blaster because of its versatility and range of uses, including removing graffiti, stripping paint and removing rust.



Maintenance Research

Safety, Traffic Control
and Work Zone Safety

District/Office:
1/Border

Contact:
Zachary Cheney
218-666-5960

Project Cost:
\$750

Start Date:
May 2013

Completion Date:
May 2014

Vendor:
forestershop.com

High-Visibility Chainsaw Chaps *Completed Research*



Project Description: At night and in other low-visibility situations, MnDOT workers using chainsaws in work zones are required to wear reflective flagging pants on top of their chainsaw chaps. This enhances their visibility in the work zone, but the added layer of clothing can reduce workers' range of motion. Being encumbered by an extra layer could also make workers more likely to trip, and the flagging pants' mesh fabric could snag on branches. Forester high-visibility chainsaw chaps combine leg protection and visibility into one garment.

Purpose: Forester high-visibility chainsaw chaps feature a "safety green" color and two retroreflective bands, while also providing leg protection that meets national standards for chainsaw operators.

Test Procedure: One operator tested a pair of Forester high-visibility chaps, evaluating their performance in comparison with standard chaps overlaid with flagging pants.

Conclusions: The high-visibility chaps exceeded expectations for performance. They have more layers of Kevlar than the operator's standard chaps, and feature a wrap-around design that protects more of the lower leg. The high-visibility chaps were durable, comfortable and eliminated the issues associated with wearing multiple layers.

Recommendations: The high-visibility chainsaw chaps are recommended. They are cost-effective, in some cases costing less than standard chainsaw chaps depending on the vendor, and enhance worker safety and comfort.



Maintenance Research

Winter Maintenance

District/Office:
6W/Albert Lea

Contact:
Larry Anderson
507-446-5535

Wayne Goldberg
507-379-3414

Project Cost:
\$10,000

Start Date:
November 2011

Completion Date:
July 2013

Vendor:
Wind Driven

Aeration System for Snow Drift Control *Completed Research*



Project Description: Blowing snow is a concern on the Interstate 35 bridge over Albert Lea Lake. This project used a wind-driven aeration system to maintain open water on the lake during the winter in an effort to capture a significant amount of the blowing snow.

Purpose: The project's goal was to capture blowing snow on the open water in an effort to significantly reduce the amount of blowing and drifting snow on the bridge. Minimizing this blowing and drifting would improve pavement conditions, reduce deicing chemical use and after-hours call-outs for maintenance crews, and reduce the number of accidents on the bridge.

Test Procedure: The district evaluated one Wind Driven Pond Mill aeration system for six months, assessing its effectiveness at reducing accidents and chemical use compared with previous years.

Conclusions: The aeration system was effective at reducing drifting snow when it was running as intended. However, several issues kept the system from running consistently. Waves and wind blew the support structure into the sand twice, which caused the impeller to become stuck. After several attempts, the district developed a revised anchoring system that successfully held the system in place. In addition, the district concluded that the aeration system is likely to work more effectively in water that is deeper than 5 feet; the water was 3 feet deep at the test site. Deeper water would allow the underwater impeller to more effectively bring up warmer water from the lake bottom.

Recommendations: The district does not recommend this aeration system unless design modifications are made to improve the water flow.



Maintenance Research

Winter Maintenance

District/Office:
Metro/Forest Lake Truck Station

Contact:
Lynn Tschida
651-234-7933

Dave Hagle
651-297-4437

Project Cost:
\$2,280

Start Date:
December 2012

Completion Date:
March 2015

Vendor:
winterequipment.com

BlockBuster Carbide Insert System

Completed Research



Project Description: The BlockBuster carbide plow blade insert system is multipart assembly that includes tungsten carbide insert blades, a steel cover plate, CurbRunner plow guards, and cast steel wear blocks with carbide matrix wear pads. The system is designed to stabilize the blade while plowing, improving performance and reducing blade wear.

Purpose: The BlockBuster system eliminates the cost of buying, installing and inventorying steel cover blades. The product is delivered as a system and all needed hardware and components. It is designed to last up to four times longer than traditional plow setups.

Test Procedure: Initially, one plow truck was outfitted with the BlockBuster Ultimate plow blade insert system for the 2012-2013 winter. The center heavy carbide insert was missing from the installation, causing premature wear. The vendor added the missing blade and installed a new, complete premium blade system on an additional plow. Testing continued through the 2013-2014 winter on the original system and through 2014-2015 on the second set of blades.

Conclusions: The second set of blades did perform well in terms of wear. However, the blades were very heavy to install, and operators reported that this system did not clean the roads as well as Joma blades. The blocks that improved blade wear also caused streaking and prevented the system from scraping the last layer of snow off the roads completely. In addition, installation required the operator to be underneath the plow frame, and to reach under the cutting edge to tighten nuts if needed.

Recommendations: Based on the blades' reduced cleaning ability and their weight, the district does not recommend this system.



Maintenance Research

Winter Maintenance

District/Office:
Statewide

Contact:
Ryan Otte
651-366-3585

Project Cost:
\$2,600 per set

Start Date:
May 2011

Completion Date:
April 2014

Vendor:
kueperblades.com

Küper Cutting Edge *Completed Research*



Project Description: Snowplow operators tested Küper cutting edges to assess the blades' durability, evaluate how well they clean the road surface, and determine whether they allow operators to reduce their salt use. Operators compared the Küper blades with the carbide steel Joma blades that are currently the department's standard cutting edge replacement, and with PolarFlex blades, which were tested separately.

Küper blades consist of a tungsten carbide cutting edge embedded in steel and rubber. Küper's Wave Technology diverts snow across a curved profile for optimal removal, then moves the snow over the mounting elements without resistance. The wave provides efficient movement of snow, and cooling openings control blade heat.

Purpose: MnDOT is interested in finding a durable alternative to Joma blades, which have been increasing in cost. The Küper blades are among the new blade systems and cutting edge technologies that have the potential to reduce costs and improve efficiency for the department.

Test Procedure: Seven trucks statewide were outfitted with the blades and evaluated for one year. The blades were evaluated for their durability and for their ability to remove ice and snow and reduce salt use compared with the Joma and PolarFlex blades.

Conclusions: Two districts reported differing findings. In D1, the Küper blades performed better than the Joma blades; they cleared the pavement evenly, without streaks. D1 found both types of blades to be similar in other areas, including length of wear (both lasted one season and part of a second season). In contrast, D6W (Austin subarea) found that the Küper blades did not clear the pavement as well as Joma blades on uneven surfaces. The Küper blades lasted one season in D6W, while Joma blades typically last two to three seasons.

Recommendations: D6W did not recommend the Küper blades.



Maintenance Research

Winter Material

District/Office:
7/Window, Mankato

Contact:
Randy Glaser
507-304-6234

Project Cost:
\$85,000

Start Date:
October 2010

Completion Date:
September 2014

Vendor:
macqueeneq.com

Liquid Chemical Blending and Dispensing Unit *Completed Research*



Project Description: The district added a state-of-the-art material dispensing unit to its AccuBrine salt brine generators. The unit consists of a series of pumps equipped with flow meters that allow for accurate blending and dispensing of up to five different chemicals into either the tank on a plow truck or into larger tankers for distribution to other sites. Supervisors control the system remotely from a desktop computer or mobile device.

Purpose: This system allows the district to blend and dispense chemicals as needed rather than premixing materials and storing them in tanks. It also allows the district to accurately charge out materials supplied to other agencies.

Test Procedure: The district tested the system's remote monitoring and control capabilities, and its ability to generate reports on the material taken from each site.

Conclusions: By enabling supervisors to change chemical blends at the trucks as conditions change, the unit allows winter maintenance crews to use the right chemical at the right time in the right amount. This generates material savings and reduces environmental impacts. System operators had some initial challenges implementing the system, but it has been easy for truck drivers to use. The district notes that the manufacturer has improved the system and that it now requires fewer pumps.

Recommendations: The district recommends this system as an effective way to control both the blending and dispensing of deicing chemicals.



Maintenance Research

Winter Maintenance

District/Office:
8/Wilmar

Contact:
Denny Marty
320-214-6336

Project Cost:
\$8,000

Start Date:
December 2012

Completion Date:
November 2013

Vendor:
fallsplows.com

Modified Reversible Plow *Completed Research*



Project Description: Clearing snow in windy conditions can be challenging. This modified reversible plow is designed to use wind direction to help cast snow from the road without impeding traffic or the operator's view. This design eliminates the large "ear" on the left (driver) side of a batwing-style plow that sticks out into oncoming traffic during centerline snow removal.

Purpose: This Little Falls Machine plow incorporates two designs into one plow. The plow has a higher opening on the left side to allow operators to clear the oncoming lane with the wind, while a large barrel on the plow's right side facilitates clearing large banks of snow.

Test Procedure: The district evaluated one plow for its effectiveness at clearing snow, especially in windy conditions.

Conclusions: The plow performed very well, particularly in high-wind areas. It was as easy to attach and use as other plows, and operators praised its versatility.

Recommendations: The plow is recommended for implementation, especially in high-wind areas in the western part of the state.



Maintenance Research

Winter Maintenance

District/Office:
3A/Aitkin

Contact:
Jakín Koll
320-241-3631

Project Cost:
\$7,000

Start Date:
January 2012

Completion Date:
April 2013

Vendor:
www.teconer.fi

Road Condition Monitor (RCM) 411 *Completed Research*



Project Description: This mobile road condition sensor is designed to detect the road condition and friction level (how slippery the road is) using an infrared light transmitter and a receiver. As the vehicle travels down the road, this information is sent to a cell phone mounted on the vehicle's dash. The sensor provides continuous information to the operator on real-time road conditions. This project investigated (1) whether the sensor can reliably detect road conditions and (2) whether this information can be transmitted automatically to MnDOT's Maintenance Decision Support System (MDSS), which helps staff select the most appropriate strategies for the conditions.

Purpose: Currently, plow operators and supervisors must manually enter road conditions into a computer or relay them by phone. Using the road condition monitor to automate this process would save operator time and would improve MnDOT's MDSS by providing more timely and accurate road condition and friction information. This would lead to more precise, efficient material application.

Test Procedure: The district tested one RCM 411 unit for one year.

Conclusions: The road condition monitor has been reliable and has provided relatively accurate readings, allowing supervisors to target deicer application where it is needed. Based on the project's initial success, the district installed an Automatic Vehicle Location system in the test pickup and began integrating the road condition monitor data with the MDSS. With a few modifications, the RCM 411 is expected to be a valuable addition to MnDOT's winter maintenance toolbox.

Recommendations: The road condition monitor is an effective tool, but more testing and development is needed prior to statewide use.



Maintenance Research

Winter Maintenance

District/Office:

3/St. Cloud,
Baxter

Contact:

Kelvin Smith
320-223-6560

Project Cost:

\$2,000

Start Date:

February 2012

Completion Date:

March 2014

Vendor:

saltawayproducts.com

Salt-Away *Completed Research*



Project Description: Rust and corrosion take a heavy toll on maintenance and construction vehicles, including snow and ice equipment. Salt-Away rinse produces an invisible barrier that prevents salt from attaching to the equipment's surface, which makes salt removal easier. After large salt debris is manually removed by hand in the salt shed, the truck is then placed indoors in the weigh bay. Salt-Away is mixed with water and applied as a rinse to remove the remaining salt from the surface. District 3A is also investigating using Salt-Away as a final rinse for bridge flushings before and after the snow and ice season to evaluate whether it helps reduce corrosion from salt residue.

Purpose: Salt-Away is designed to reduce the time spent on vehicle and equipment cleaning and upkeep and reduce the amount of water and soap needed. It decreases equipment downtime for cleaning and repairing rusted areas, and increases the life span of equipment and vehicles. It may also help reduce corrosion on bridge structures.

Test Procedure: The district tested Salt-Away for more than a year, evaluating it as a potential best management practice for washing and maintaining its equipment to maximize the equipment's life span. Before being field-tested, the product was tested by MnDOT's chief toxicologist, who recommended that wash water containing Salt-Away be captured and sent to a wastewater treatment facility.

Conclusions: Salt-Away performed well, meeting or exceeding the district's expectations. Compared with other products, it was easy and efficient to apply. Using Salt-Away reduced corrosion-related equipment repairs. It is noncorrosive, did not damage equipment paint or components, and does not require operators to wear extensive protective gear. Salt-Away does not require a separate mixing step, which saves time, and it was relatively inexpensive at 26 cents per wash (using 2 ounces of product). No findings were reported regarding the use of Salt-Away on bridges.

Recommendations: Longer-term evaluation of Salt-Away is needed. The district would also like to examine the results of the Metro District's use of a neutralizing additive in the wash soap. This may be a good alternative because it does not require an additional step.



Maintenance Research

Winter Maintenance

District/Office:
2A/Bemidji

Contact:
Tony Bowe
218-755-6567

Project Cost:
\$24,785

Start Date:
March 2013

Completion Date:
May 2015

Vendor:
hlasnow.com/snowwing.php

SnowWing *Completed Research*



Project Description: The HLA SnowWing is a combination box blade, angle blade, straight blade and reverse box blade controlled hydraulically with a wireless remote control. The blade's design allows the operator to change from a traditional box blade to a straight blade, with the added bonus of extra clearing width. The endplates' 180-degree rotation allows the operator to get closer to buildings and curbs with less chance of damage and better clearing results. The blade can be mounted on a variety of equipment, including tractors, loaders, skid steers and graders.

Purpose: The SnowWing's versatile endplates allow for operation close to buildings and curbs and for dragging the snow away for full clearing even in the tightest of spaces. The blade's versatility makes it effective in clearing snow off parking lots and bridge decks and pulling snow away from curbs and sidewalks.

Test Procedure: The district evaluated the SnowWing's versatility and effectiveness during snow removal and cleanup efforts, especially in the right of way, parking lots and on bridge decks.

Conclusions: The SnowWing was effective at allowing operators to change blades quickly during plowing. Operators were able to capture snow on bridge decks by using the box blade to the end of the bridge and then switching to the angle blade to push the snow off the roadway. The blade also allowed operators to maneuver through parking lots and get closer to curbs, vehicles and buildings more quickly and safely than with other snow removal equipment, saving time, money and labor.

Recommendations: The district has already purchased several additional SnowWings, which has allowed the district to reduce its road grader fleet. The district recommends the SnowWing for statewide use.



Maintenance Research

Winter Maintenance

District/Office:
6E/Winona

Contact:
Don Mehren
507-205-6408

Neil Hjelmeland
507-205-6407

Project Cost:
\$29,978

Start Date:
April 2013

Completion Date:
April 2014

Vendor:
universaltruckequipment.
com

Universal Plow for Loaders

Completed Research



Project Description: The district tested a Universal reversible snowplow and wing assembly for use with its Case 721D front-end loader. The system includes the snowplow, wing and two mounting frames that employ a quick disconnect system on the loader.

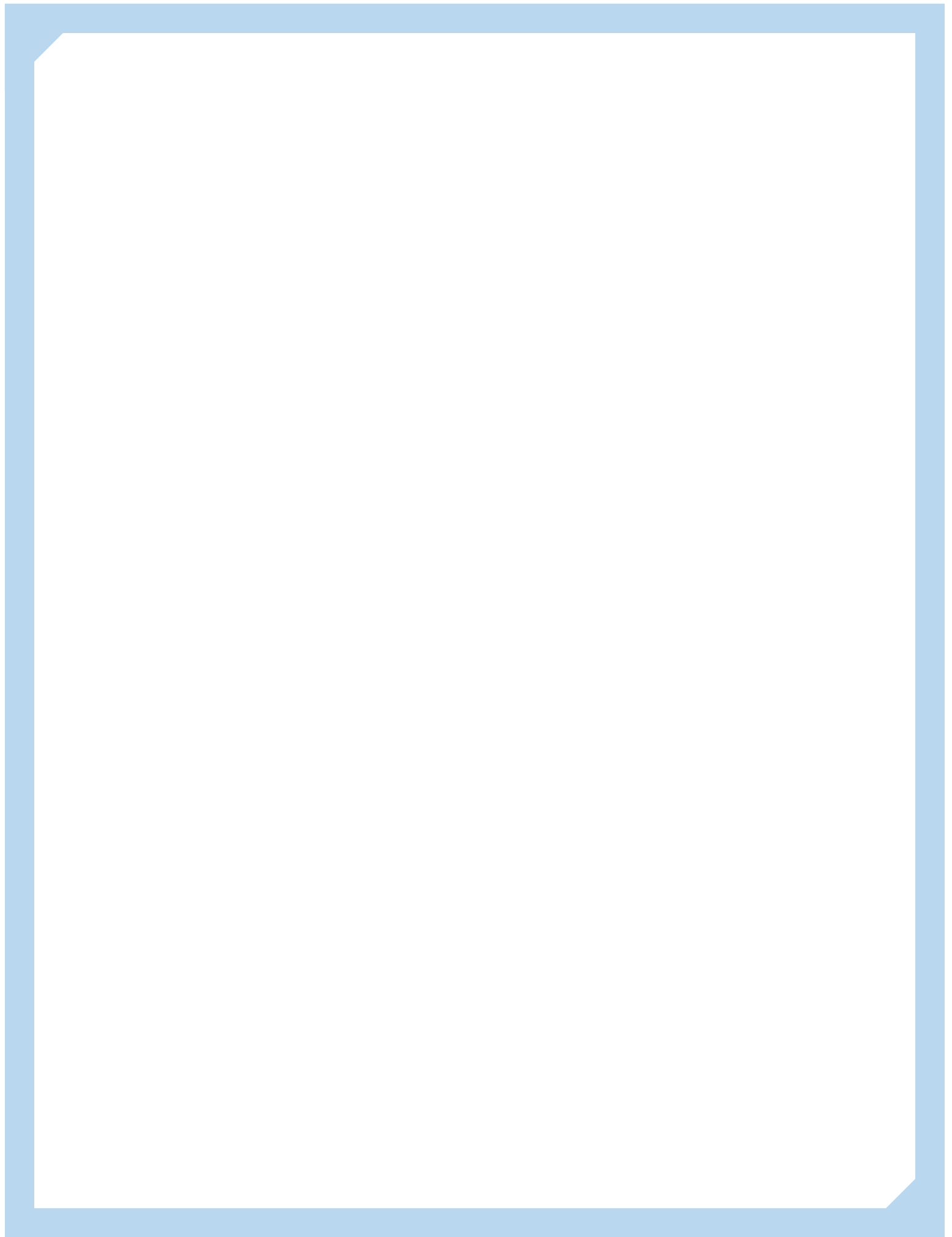
- The first mounting frame is used for winging back operations when both the plow and wing are needed.
- The second mounting frame, used when only the plow is needed, is used to push back sight corners at intersections and piling snow in parking lots.

Purpose: The district used the reversible snowplow and wing attachments to improve the performance of some of its snow and ice cleanup operations. Testing included the maintenance and removal of snow buildup from highway center islands, crossovers and intersection sight corners, as well as the winging operations conducted to push back snow on roadways due to wind and drifting.

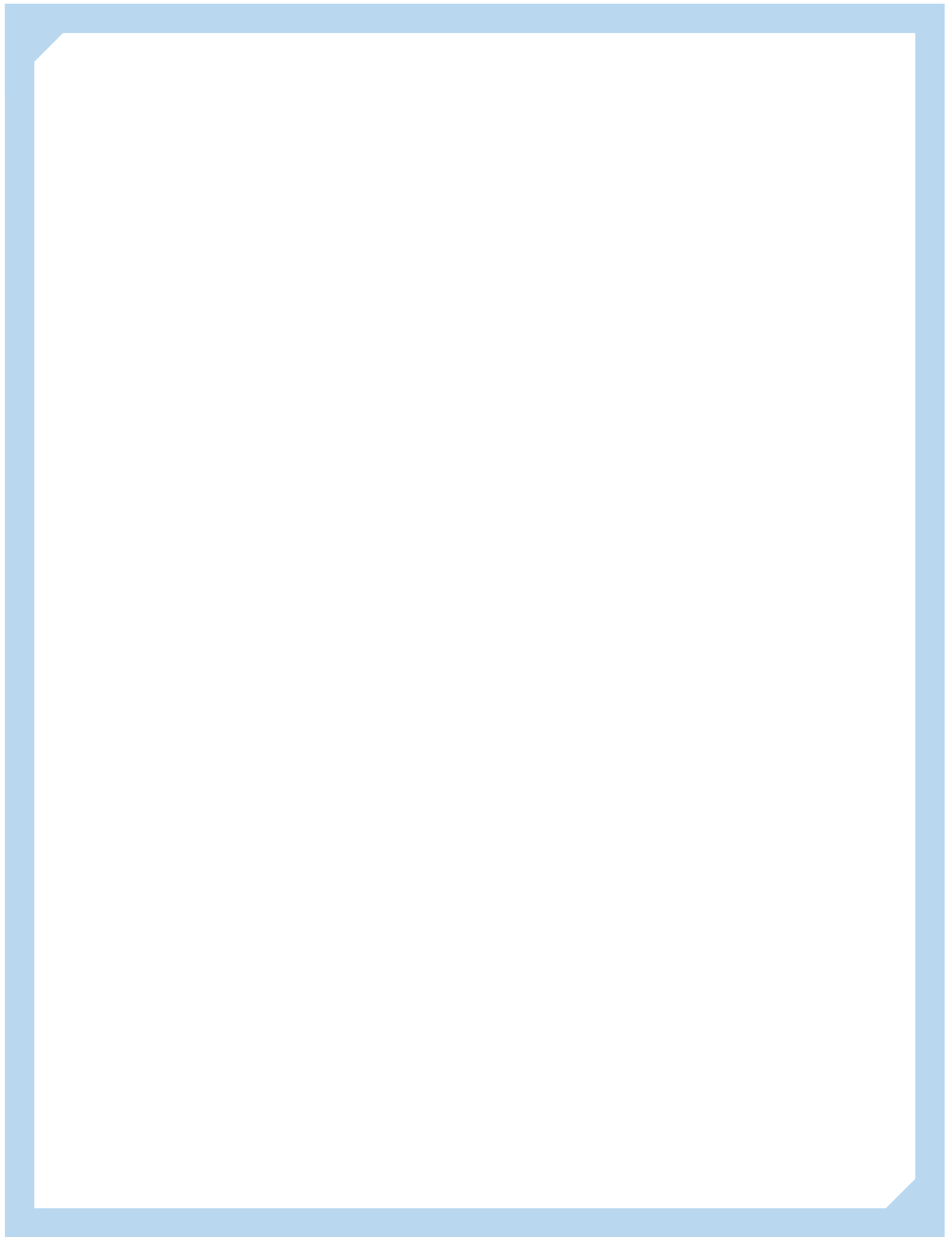
Test Procedure: The district evaluated the reversible snowplow and wing assembly on its ability to provide improved visibility for the operator, improved power and traction, better maneuverability, and less wear and tear on the trucks now used to remove snow from center islands.

Conclusions: Operators using the Universal reversible snowplow and wing assembly noted the plow's excellent maneuverability and its ability to clear snow from center islands quickly and with less equipment as compared to previous methods. The loader climbed easily on the islands, and the reversible snowplow improved visibility for the operator. The equipment was also versatile, with the wing attachment proving to be effective for benching (leveling) snow in high-drift areas.

Recommendations: The district recommends the Universal reversible snowplow and wing assembly for statewide implementation.



2013-2015 Research in Progress





Maintenance Research

Equipment and Tools

District/Office:
7E/Mankato

Contact:
Randy Glaser
507-304-6234

Project Cost:
\$5,000

Start Date:
June 2014

Vendor:
kennedyscales.com

Emulsion Oil Storage Scale

Research in Progress



Project Description: Large, heated emulsion oil storage tanks store emulsion oil used by the Mankato district for paving and patching, and spraying guardrail. The district has agreements with multiple entities to provide oil from their tanks, and keeping track of the amount of oil remaining in the tanks can be challenging. The district will test the Avery Weigh-Tronix bulk electronic weighing system, which uses weight sensors placed under each leg of the storage tank that send data to a digital weight display. The display provides an immediate and accurate inventory of product in the tank.

Purpose: The weight sensor scale system is expected to save downtime by easily identifying the quantity of product on hand, and provide a more accurate consumption record to bill the multiple entities using the district's emulsion oil. Employees will no longer have to use a ladder to inspect the quantity of oil in the tank, reducing the possibility of injury.

Test Procedure: The district will evaluate the effectiveness of the weight sensor scale system over two years in reducing downtime, providing more accurate billing, and reducing the possibility of employee injury.



Maintenance Research

Equipment and Tools

District/Office:
2W

Contact:
Steve Scholand
218-277-7966

Project Cost:
\$1,342

Start Date:
August 2013

Vendor:
gates.com

Hydraulic Hose Cleaning System

Research in Progress



Project Description: The Gates MegaClean hose and tube cleaning system is used to remove dirt from the inside of hoses with the help of pressurized launchers and compatible nozzles. Foam projectiles flow through the inside of the hose, removing with them fine particles of loose dirt and other contaminants.

Purpose: Debris can be left in a hydraulic hose after it has been cut, and hydraulic pumps or motors that fail can leave contamination behind. A hose cleaning system can reduce or eliminate contamination from being introduced into a vehicle's hydraulic system when a new or refurbished hose is installed.

Test Procedure: The district will test two hose cleaning systems to assess the system's ability to reduce downtime, and save time, money and materials associated with equipment repairs.



Maintenance Research

Equipment and Tools

District/Office:
6

Contact:
Ruth Betcher
507-286-7692

Project Cost:
\$6,000

Start Date:
May 2014

Vendor:
frontierprecision.com

Laser Range Finder *Research in Progress*



Project Description: In recent years, District 6 has experienced flood damage by water overtopping the roadways and washing out embankments. For the district to receive federal emergency relief funding, documentation that includes pictures, diagrams, written descriptions and measurements of damaged areas must be submitted to the Federal Highway Administration. Accurate data that describes the flood damage and the cost of repair is essential to receive funds. This project will evaluate equipment that could minimize the time spent by MnDOT staff in documenting flood damage.

Purpose: The TruPulse 360° laser range finder the district will test calculates the geolocation of flooded areas that are either inaccessible or dangerous to access. Field staff can use the range finder to determine the latitude and longitude of damage area points while standing on the roadway shoulder. The area measurements gathered by the unit can be used to estimate material repair quantities. Range finder data is sent automatically to a nearby GPS data collector unit for database storage and linkage with appropriate geolocated photos.

Test Procedure: The district will test three range finder units, assessing the range finder's ability to save time, money and manpower by considering the following factors:

- Speed, ease, safety and accuracy of data collection
- Adaptability of various collection types
- Usability of collected data
- Ease of GIS mapping and usefulness of the maps



Maintenance Research

Equipment and Tools

District/Office:
2

Contact:
Steve Hufnagle
218-683-8016

Project Cost:
\$1,995

Start Date:
June 2014

Vendor:
multiplaz.com

Multiplaz 3500

Research in Progress



Project Description: The Multiplaz 3500 is a compact, portable welding tool that uses tap water for heating materials by turning water into plasma. The tool can weld, solder, braze, harden and cleanse metals including steel, aluminum, copper, cast iron and bronze. Multiplaz 3500 can cut any metal, replicating the functionality of a welding machine, gas torch, plasma cutter and other tools. The unit is efficient and cost-effective to operate, and eliminates the need for gas bottles and additional equipment such as compressors.

Purpose: With the use of a single, portable tool to complete welding-related projects, staff throughout the district can have the right tool available at the right time, eliminating the need to transport a welding project to the district's main shop.

Test Procedure: The district will test the Multiplaz 3500 for one year, evaluating its functionality and ease of use, and its ability to save time and reduce equipment needs.



Maintenance Research

Equipment and Tools

District/Office:
3B

Contact:
Kelvin Smith
320-223-6560

Project Cost:
\$3,600

Start Date:
September 2013

Vendor:
chemsearch.com

Torrent 400 Parts Washer

Research in Progress



Project Description: Currently, the district uses large, hot-water “dishwasher”-type parts cleaners to clean small parts. Waiting for the cleaning cycle can sometimes delay returning units to service. The Torrent 400 parts washer provides an alternative for cleaning small parts.

Purpose: The Torrent 400 parts washer uses a water-based solution that is nonflammable and nonhazardous, and eliminates the need for secondary use of aerosols or other solvents for cleaning. The combination of the special water-based solution, high pressure and heat cleans parts safely and quickly. A special compressed air gun can be used to dry the cleaned parts to allow for immediate use.

Test Procedure: The district will compare the cleaning performance, dependability and efficiency of the new parts washer with the current dishwasher-type parts cleaner.



Maintenance Research

Equipment and Tools

District/Office:
6W

Contact:
Adam Miller
507-446-5508

Project Cost:
\$4,800

Start Date:
January 2015

Vendor:
michelintweel.com

Tweel Skid Loader Tires

Research in Progress



Project Description: A tracked skid loader is preferred over the standard rubber tire unit when doing most jobs because of the track's stability, ride and traction in all types of weather. However, tracks are an expensive option to add to a skid loader and are used on only one machine. The standard rubber tires currently used on skid loaders without tracks are prone to punctures from tree branches and stumps, fence posts and other debris. The current tires produce a rough ride, provide little traction in ditches, and can spin out easily when working on hard road surfaces. The district will replace the standard rubber tires on a skid loader with Michelin Tweel airless radial tires to assess the new tire's impact on the usability of the loader.

Purpose: The Michelin Tweel tires are expected to provide greater flexibility over obstacles and provide greater traction on road surfaces. The airless design should improve impact absorption and limit downtime from penetration, impact damage or flat tires. The tires are one-third the cost of tracks and provide a wear life of two to three times that of a standard tire. The one-piece, airless design means that no tire machine or air compressor is needed. A smoother, more comfortable ride reduces operator fatigue.

Test Procedure: The tires will be mounted on the district's skid loader and evaluated over one year to assess the tires' ability to save time and money, reduce operator fatigue and limit the potential for injury.



Maintenance Research

Equipment and Tools

District/Office:

1

Contact:

Mike Hedlund
218-834-4442

Project Cost:

\$1,100

Start Date:

March 2015

Vendor:

carbideattractionproducts.com

Winter Tire Studs for Skid Steer Loaders

Research in Progress



Project Description: Getting traction in a skid steer loader can be challenging in ice and snow. With chains not an option for the loader's tires, the district will test carbide studs with specially designed threads that provide better grip and reduce chances of pullout. The screw's sharp tip eliminates the need for predrilling and does not leave behind an open hole that can build up with debris after the stud is removed for summer operation.

Purpose: The tire studs are expected to make the skid steer loader safer and easier to control in ice and snow, extending the use of the loader during the winter season.

Test Procedure: The district will evaluate how the tire studs affect the usability of the skid steer loader during the winter season by comparing its usage to the previous year when the skid steer had no traction stabilizers. If the loader's usability is enhanced, the tire studs are expected to save time and money, reduce the equipment and staff needed to clear slippery rights of way, and reduce the potential for injuries.



Maintenance Research

Road and Bridge Maintenance

District/Office:
7E

Contact:
Randy Glaser
(507) 514-1010

Project Cost:
\$4,500

Start Date:
October 2012

Vendor:
kmiinfrared.com

Crack Jet II

Research in Progress



Project Description: Filling roadway cracks with crumb rubber or epoxy requires that the crack be blown clean and dry and heated before filling. This operation now requires a three-person crew with multiple pieces of equipment. To streamline this operation, the district will test the Crack Jet II, a self-contained heat lance, designed for an operator to walk behind, that uses hot air to dry moisture and blow cracks clean.

Purpose: With the Crack Jet II, a single piece of equipment eliminates the need for a separate heat lance, air compressor and blower, and two members of a three-person crew. The equipment can be carried to the job site in a pickup truck and operated by the crew member hauling it. The blow-and-heat operation that prepares a crack for filling can be completed as quickly as the operator can walk.

Test Procedure: The district will assess the impact of the Crack Jet II to save time and money by reducing the number of maintenance staff and the additional pieces of equipment needed to prepare roadway cracks for filling.



Maintenance Research

Road and Bridge Maintenance

District/Office:
1

Contact:
Roger Edstrom
(218) 742-1110

Pat Briski
(218) 742-1108

Project Cost:
\$7,788

Start Date:
December 2012

Vendor:
rjdindustries.com

Fiber Rods for Bridge Rail Replacement

Research in Progress



Project Description: The district uses snap ties to hold forms together when placing concrete for bridge rail replacement. Seeking to reduce or eliminate the additional effort needed to prepare the ties for installation and avoid future rusting when they are placed, the district will test fiber rods as a replacement for the snap ties used when replacing bridge rails. If successful in this application, the use of fiber rods may be expanded to any formed concrete project.

Purpose: Fiber rods provide multiple benefits that speed up the work process, including eliminating the need to backfill the holes left by the cones on the snap ties to eliminate future rusting. Unlike snap ties, which are available in one length and must be cut and welded for custom lengths, fiber rods can be cut to any length needed. The fiber rods are also more adaptable when angled forms are used.

Test Procedure: The district will assess the impact of fiber rods in saving time and money in setting and removing forms for bridge rail replacement.



Maintenance Research

Road and Bridge Maintenance

District/Office:
7E/Mankato

Contact:
Jon Fitch
507-304-6235

Project Cost:
\$2,200

Start Date:
March 2015

Vendor:
brockwhite.com

HP Concrete Cold Patch

Research in Progress



Project Description: HP Concrete Cold Patch is a cold-applied, single-component patching material used to repair potholes, spalls, cracks and other confined voids in portland cement concrete pavement. This patching material can be used in most weather conditions and, unlike other patching materials, requires no mixing, heating or special installation equipment. After the material has been placed in the repair area, leveled and compacted, the patch is ready for traffic. The material's gray color allows the patch to blend in with the concrete.

Purpose: The district is looking for a material that will hold longer in a concrete patched hole to limit the amount of repatching needed. Less repatching will reduce costs and staff time needed for roadway maintenance, and limit the time maintenance crews are exposed to traffic hazards.

Test Procedure: The district will track the HP Concrete Cold Patch test patches over a period of one to two years to assess the effectiveness of the material in holding in the patched hole through freeze-thaw cycles and spring rains.



Maintenance Research

Road and Bridge Maintenance

District/Office:

1

Contact:

Mike Hedlund
218-834-4442

Project Cost:

\$4,500

Start Date:

February 2015

Vendor:

cretexseals.com

Manhole Grade Adjustment Rings

Research in Progress



Project Description: The traditional method of adjusting the elevation of a manhole casting with the use of concrete adjusting rings can be problematic. Concrete rings crack and deteriorate, as can the mortar used to install them. Deteriorated rings allow stormwater to enter sanitary sewer manholes, increasing wastewater treatment costs. And concrete adjustment rings are heavy, increasing the potential for employee injuries. Made from expanded polypropylene, the Cretex PRO-RING manhole grade adjustment system provides an alternative to concrete adjustment rings.

Purpose: The long-term performance of the PRO-RING is expected to reduce or eliminate the need to repair or replace deteriorated concrete adjusting rings every few years. With no need for mortar, maintenance crews will no longer have to mix cement on the job site, and the light weight of the PRO-RING is expected to reduce the possibility for injury during installation.

Test Procedure: The district will make regular inspections of the PRO-RING installations over one year to assess the product's long-term performance. Inspections after rain events will identify whether stormwater leakage has been eliminated or significantly reduced.



Maintenance Research

Road and Bridge Maintenance

District/Office:

4

Contact:

Joe Stegmaier
218-846-7943

Project Cost:

\$86,000

Start Date:

August 2014

Vendor:

rcmspecialties.com

Portable Emulsion Storage Tank *Research in Progress*



Project Description: Stored outside and without insulation, the district's two stationary emulsion tanks can store emulsion only during the summer months. Emulsion needed during the winter months must be obtained in small quantities from other MnDOT truck stations. Crews are not able to efficiently fill newer trucks and trailers with emulsion because of the emulsion tanks' gravity feed dispensing systems, and cleaning the stationary gravity tanks is costly.

Purpose: The portable storage tank the district will test is self-contained. An insulated housing permits year-round outdoor storage, and a heated pump allows for efficient year-round transfer of material. The portable roll-off design allows easy access to crews throughout the district. The cone bottom tank design eliminates sludge buildup and costly cleaning, and the unit's forward and reverse pump eliminates the possibility of sloppy transfers by allowing an operator to draw back material through the hose.

Test Procedure: The district will evaluate the functionality, mobility and efficiency of the portable storage tank for one year, assessing its ability to save time and money and reduce material loss.



Maintenance Research

Road and Bridge Maintenance

District/Office:
7E/Mapleton

Contact:
Don Baker
507-304-6233

Project Cost:
\$3,199

Start Date:
February 2015

Vendor:
concordroadequipment.com

Tailgate Chip Spreader

Research in Progress



Project Description: In the past, the district has filled in wheel ruts on bituminous roadways using a self-propelled chipper to apply a seal coat to the ruts. This equipment must be hauled by a low-boy tractor-trailer, so the operation requires two workers. This project will test a truck-mounted chip spreader that is more mobile and requires only one operator.

Purpose: This one-person operation is expected to save time, be more efficient, and reduce money spent on transporting equipment. The spreader can also be used as a complement to a larger spreader on a bigger project, and may have other applications as well, such as applying material to narrow gravel shoulders.

Test Procedure: The district will test one unit for two years, evaluating how effectively and efficiently the unit applies chips to seal-coat wheel ruts.



Maintenance Research

Road and Bridge Maintenance

District/Office:

7

Contact:

Mark Larson
507-831-8041

Project Cost:

\$15,000

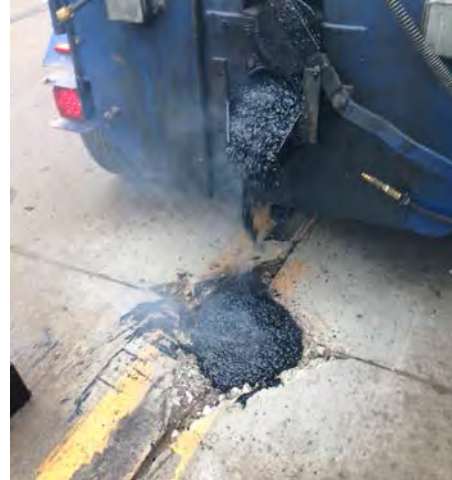
Start Date:

January 2015

Vendor:

midstatesequipment.net

Winter Patching Mix *Research in Progress*



Project Description: The materials currently used to patch roadways during the winter season are either considered temporary patching material or have a very small rock size mixed in with the asphalt material, which gives the material the tendency to “push” when temperatures warm up. For this reason, the patches placed during the winter season are considered temporary patches and must be replaced with permanent patching material as weather conditions permit.

Purpose: Use of a material that creates a durable patch in all weather conditions will allow the district to place permanent patches year-round.

Test Procedure: The district will evaluate the patches made with the new winter patching mix for durability and performance, assessing the potential of the mix to save time, money and material by not requiring the replacement of temporary patches.



Maintenance Research

Roadside Maintenance

District/Office:
6E/St. Charles

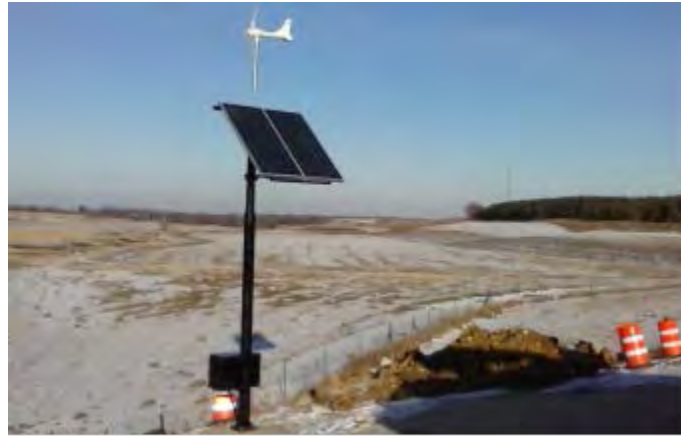
Contact:
Bruce Tanberg
507-251-0149

Project Cost:
\$24,309

Start Date:
August 2014

Vendor Email:
mccabecrane@att.net

Culvert Heat Tape System *Research in Progress*



Project Description: Keeping culverts open by maintaining year-round water flow can be challenging in cold climates. When water in a culvert freezes, water can back up, spill onto roadways and freeze, creating a traffic hazard for motorists. The district will test a solar-powered frost prevention system that heats a tape placed through the center of a culvert to prevent it from freezing and keep water flowing.

Purpose: MnDOT has used a range of tools to keep water flowing through culverts during the winter months—ice chippers, shovels, backhoes, jetters, and bags of salt. Maintaining year-round water drainage with heat tape powered by a solar-powered unit will reduce labor and equipment costs, prevent potential injuries and limit environmental impacts.

Test Procedure: The district will install solar-powered heat tape systems in one horizontal and one vertical culvert. A wind generator will provide a back-up source of power at one of the sites. District crews will monitor these installations to assess the effectiveness of the heat tape in preventing ice formation and maintaining water flow in the culverts.



Maintenance Research

Roadside Maintenance

District/Office:
1

Contact:
Brian Koczur
218-834-4442

Project Cost:
\$12,000

Start Date:
October 2013

Vendor:
envirotac.com

Envirotac II

Research in Progress



Project Description: Repeated efforts to stabilize soils and control erosion in gravel shoulders, washout areas and sensitive materials stockpiles can be costly. Excavating to provide larger-scale erosion control is expensive and not always practical. As an alternative to current soil stabilization efforts, the district will test the use of Envirotac II, an environmentally safe acrylic polymer used to stabilize soil particles. This water-soluble product penetrates into the soil, bonding the soil particles and “cementing” them into place. Any equipment that can spray water can apply the Envirotac II product.

Purpose: Envirotac II is expected to be more effective in keeping more material in place, reducing repeat trips to repair failing areas. Winter maintenance activities will benefit from a more consistent gravel shoulder level, and the product may also be used for dust control.

Test Procedure: Test applications of Envirotac II are expected to include stretches of gravel shoulder, with control sections to compare performance, and uncovered stockpiles susceptible to washing away. A test period of at least one year, preferably to include two spring thaws, will be used to evaluate the effectiveness of the soil stabilizer in saving staff time and material by providing more effective erosion control.



Maintenance Research

Roadside Maintenance

District/Office:
8

Contact:
Dave Miller
507-537-2078

Project Cost:
\$10,000

Start Date:
January 2014

Vendor:
lanoequip.com

Ground Shark Brush Cutter

Research in Progress



Project Description: Clearing out ditches can require the removal of trees that range in size from seedlings to trunks up to 5 inches in diameter. With a 72-inch cutting width, the Ground Shark Extreme Duty brush cutter skid steer attachment is designed to clear tough ground vegetation, brush and hardwoods up to 7 inches in diameter. Once the brush and small trees are removed, the small teeth on the bottom of the retention disc are used to grind the stump down below the surface.

Purpose: Currently, multiple-person crews use chainsaws and hand cutters to remove trees and brush from the district's ditches and right of way. The Ground Shark brush cutter is expected to expedite the clearing of brush, stumps and grass by requiring just one staff person to operate a single piece of equipment.

Test Procedure: The district will evaluate the effectiveness of the Ground Shark brush cutter in saving staff time, reducing equipment needs, and reducing injuries when clearing brush, stumps and unwanted vegetation from MnDOT's right of way.



Maintenance Research

Roadside Maintenance

District/Office:
6W/Owatonna

Contact:
Cam Ihrke
651-385-6416

Project Cost:
\$96,065

Start Date:
April 2014

Vendor:
groundworkexperts.com

Guardrail Post Driver

Research in Progress



Project Description: This self-propelled guardrail post driver will make guardrail repair fast, easy and accurate, enabling crews to install posts in harsh conditions and on uneven terrain. The unit, which can install posts up to 13 feet tall, is designed with a compact footprint to help minimize traffic disruption and lane closures.

Purpose: Currently, maintenance crews use chains and booms to install guardrail posts. The guardrail post driver will save time by automating the post installation and removal processes, and provide a safer environment for both maintenance crews and the traveling public.

Test Procedure: The district will evaluate the post driver's ability to increase productivity and improve workplace safety for maintenance crews and the traveling public, as well as its overall effectiveness in a variety of guardrail post applications.



Maintenance Research

Roadside Maintenance

District/Office:
7E/Mapleton

Contact:
Don Baker
507-304-6233

Project Cost:
\$2,288

Start Date:
March 2015

Vendor:
redidriver.com

REDI Driver *Research in Progress*



Project Description: Currently, district staff use a manual post driver or an air-powered post driver borrowed from another subarea when guardrail posts must be replaced. The air-powered post driver can freeze up in cold weather and may not be readily available when needed to replace guardrail after accidents. This project will test an alternative to current practices—the REDI Driver, a portable, gas-powered post driver designed with a full-size striker to drive larger posts.

Purpose: The portability of the REDI Driver is expected to allow a team of two to respond immediately when guardrail must be replaced. The new replacement procedure will be more reliable, with the gas-powered tool not subject to freeze-up in cold weather.

Test Procedure: Mapleton staff will test one portable post driver for one year, evaluating its effectiveness in driving guardrail posts, and its potential to save time and money and reduce labor hours.



Maintenance Research

Safety, Traffic Control
and Work Zone Safety

District/Office:
6W/Owatonna

Contact:
Adam Miller
507-446-5508

Project Cost:
\$66,600

Start Date:
August 2014

Vendor:
centrevilletrailer.com

AutoCone 500 Cone Setter *Research in Progress*



Project Description: Staying safe when setting cones for a lane closure can be challenging. Current options for setting cones from a vehicle to the pavement include:

- Harnessing staff in the open bed of a moving traffic control vehicle as they individually place cones on the pavement.
- Walking behind the traffic control vehicle to set cones, which exposes staff to road hazards and oncoming traffic.

The AutoCone 500 cone setter provides an alternative to these practices. Mounted to an existing truck chassis, the unit allows for a one-person cone-setting operation that keeps maintenance staff safely away from road and traffic hazards.

Purpose: With the AutoCone 500, the operator is belted in the driver's seat in the cab of the truck chassis while the unit automatically places and picks up cones from either side of the vehicle. A control panel mounted in the truck's cab controls placement of the cones. AutoCone also picks up and stores cones, automatically stacking and sorting cones as they are picked up.

Test Procedure: The district will assess the cone-setting unit's ability to save time, reduce manpower, increase safety, and allow the district to better manage its equipment.



Maintenance Research

Safety, Traffic Control
and Work Zone Safety

District/Office:
7/Window

Contact:
Mark Larson
507-831-8041

Project Cost:
\$8,000

Start Date:
September 2013

Vendor:
minnesotaequipment.com

Barricade Trailer

Research in Progress



Project Description: Handling and transporting the cumbersome barricades used for road and lane closures can be challenging and result in injuries and equipment damage. The district will test a small trailer designed to hold barricades and the other materials needed for barricade placement (legs, sandbags and night flashers) in an effort to improve efficiency and safety.

Purpose: The barricade trailer is expected to save time when barricades must be set quickly in emergency conditions, require fewer employees to transport and set barricades, and eliminate lift hazards when barricades are loaded and unloaded from larger trailers.

Test Procedure: District maintenance crews will assess the effectiveness of the barricade trailer in saving time, reducing the staff needed for barricade placement, and reducing injuries.



Maintenance Research

Safety, Traffic Control
and Work Zone Safety

District/Office:
4A

Contact:
Joe Stegmaier
218-846-7943

Project Cost:
\$4,000

Start Date:
September 2014

Vendor:
actionfabricating.com

Cone Setting Basket *Research in Progress*



Project Description: Placing cones for temporary traffic control is one of the more dangerous activities associated with setting up work zones. Currently, crew members stand or sit on the lift gate of a truck when setting cones on roadways to identify lane closures. Another method is needed that better protects crew members and allows crews to set cones for traffic control safely and quickly.

Purpose: District 4 has developed a front-mounted attachment to a truck from which workers can place cones. The truck can also be fitted with a truck-mounted attenuator, improving the safety of both MnDOT crew members and the traveling public.

Test Procedure: The district will evaluate the functionality of the cone setting basket and its ability to save time and money, reduce injuries, and increase efficiency when setting cones for traffic control.



Maintenance Research

Safety, Traffic Control
and Work Zone Safety

District/Office:
Metro

Contact:
Sheila Johnson
651-234-7935

Project Cost:
\$5,200

Start Date:
June 2014

Vendor:
pivvariables.com

Sequential Traffic Safety Lights *Research in Progress*



Project Description: When MnDOT supervisors are the first responders on the scene of a disabled vehicle or crash, the supervisor's truck and traffic cones may be the only protection or guidance marking the scene. The district will test a battery-powered beacon-style lamp that can be easily attached to a traffic cone to enhance the conspicuity of the incident scene. The lamps offer five "march" patterns and are remotely operated from the safety of the supervisor's vehicle. A similar barricade-style lamp that can be installed on drums offers five flash patterns and can be used for night-only or 24-hour operation.

Purpose: The sequential traffic safety lights are expected to enhance the positive guidance provided by the traffic cones and drums used in temporary traffic control, reinforcing the message to drivers that they must move over.

Test Procedure: The district will test four units—three sets of 10 beacon-style lamps that can be added to traffic cones, and one set of 10 barricade-style lamps that can be installed on drums used to mark the taper of lane closures. The district will use field observations to assess the effectiveness of the sequential traffic safety lights in reducing injuries and accidents.



Maintenance Research

Winter Maintenance

District/Office:
2/Bemidji

Contact:
Tony Bowe
218-755-6567

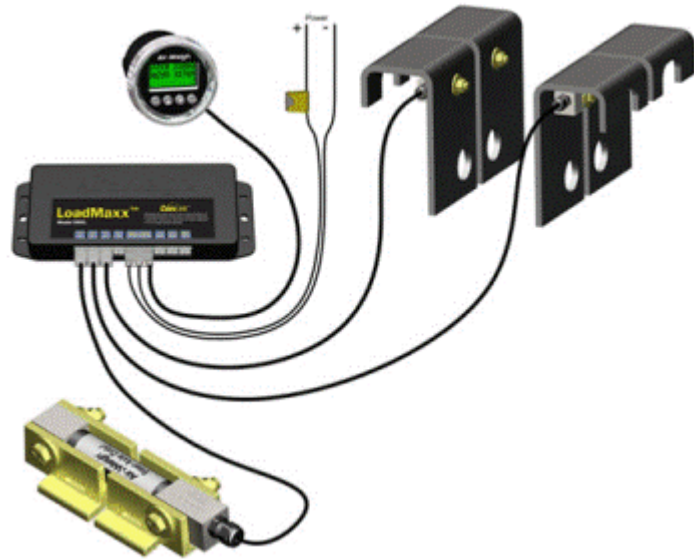
Project Cost:
\$15,000

Start Date:
December 2014

Vendor:
air-weighscales.com

Air-Weigh LoadMaxx Truck Scale

Research in Progress



Project Description: Keeping an accurate count of the salt and other material used to treat Minnesota's winter roadways helps MnDOT make more effective use of its resources. The on-board Air-Weigh LoadMaxx Truck Scale applies state-of-the-art hardware and software technology to accurately measure and display net payload weights. A check of the on-board display before and after loading winter material gives the snowplow operator the initial weight of material before application. After completing a route, the operator checks the on-board display again to identify the change in material weight. The data can be transmitted to the truck's data bus for use by other vehicle applications and wireless transmission to fleet headquarters.

Purpose: The on-board scale will give snowplow operators a more accurate reading of the amount of material applied per mile, allowing operators to identify unexpectedly high usage immediately after a route. The scale is also expected to save time by removing the need to calculate material usage using more manual methods.

Test Procedure: The district will evaluate data generated by four on-board scales installed in district snowplows to determine if the on-board scales save time, provide more accurate data, and make more effective use of winter material.



Maintenance Research

Winter Maintenance

District/Office:
6W/Albert Lea

Contact:
Brad Peterson
507-379-3414

Project Cost:
\$1,280

Start Date:
August 2014

Vendor:
towmaster.com

Combination Snowplow Headlight System

Research in Progress



Project Description: Standard plow lights may not provide sufficient illumination for snowplow operators during nighttime plowing operations, particularly during snow events. Standard plow lights also lack a turn signal. To improve nighttime visibility, MnDOT is testing the use of an auxiliary combination snowplow headlight system. The system, which combines a heavy-duty headlight with integrated park and signal lights, includes the wiring harness and the necessary mounting hardware.

Purpose: Four sets of combination headlights will be tested—one set for use by District 6W and three sets to be shared across the state. The new headlight system is expected to increase road illumination for the plow operator and make the snowplow more visible to the traveling public.

Test Procedure: Snowplow operators will compare the new combination headlight system with plows using only standard plow lights to assess the combination headlight system's ability to improve nighttime visibility and safety.



Maintenance Research

Winter
Maintenance

District/Office:

4

Contact:

Joe Stegmaier
218-846-7943

Project Cost:

\$10,000

Start Date:

May 2014

Vendor:

fallsplows.com

Falls Poly Trip Moldboard Plow *Research in Progress*



Project Description: The Falls poly trip moldboard plow offers an alternative to steel plows. Mounted closer to the truck than a steel plow, the poly plow is expected to push snow further away from the plow, requiring less power to push the plow and reducing the amount of debris that flies onto the plow truck's windshield. Less debris on the windshield means better visibility for the plow operator and less wear on the windshield and wipers.

Purpose: Reducing the amount of snow and debris that comes up over the plow and onto the windshield during snow and ice events will improve the safety and efficiency of plowing operations. Operators will no longer be required to manually clear snow from the truck's hood and wipers, and a poly plow is less likely than a steel plow to frost up between plow shifts.

Test Procedure: The district will evaluate the poly plow's effectiveness in saving fuel, reducing injuries and accidents by improving visibility, reducing wear on a plow truck's windshield and wipers, and increasing cutting edge life as compared to other types of plows on similar surfaces.



Maintenance Research

Winter Maintenance

District/Office:
1

Contact:
Mike Hedlund
218-834-4442

Project Cost:
\$2,100

Start Date:
January 2015

Vendor:
grainger.com

Fluid Film *Research in Progress*



Project Description: Despite frequent washings, exposure to salt on the roadways is rusting the district's expensive plow trucks and loaders, decreasing the life of this equipment. Fluid Film, a solvent- and toxin-free anti-corrosion coating, penetrates metal pores to create an airtight seal that blocks road salts and moisture and slows corrosion. Fluid Film also acts as a release agent for snow and ice and prevents it from sticking to plow trucks.

Purpose: Equipment sprayed with Fluid Film is expected to retain its value and usefulness longer than equipment not treated with a corrosion inhibitor.

Test Procedure: The district will assess the impact of Fluid Film in reducing rust and corrosion, which will reduce the time and costs associated with repair and replacement of corroded parts, and extend the life of equipment.



Maintenance Research

Winter Maintenance

District/Office:
3 and 6

Contact:
Joe Huneke
651-366-3586

Project Cost:
\$10,540

Start Date:
October 2013

Vendor:
highsierraelectronics.com

High Sierra Mobile IceSight *Research in Progress*



Project Description: The High Sierra Model 5435 Mobile IceSight is a vehicle-mounted mobile surface condition sensor that provides real-time surface weather condition of roadways and road friction (how slippery the road is) using infrared technology. The unit is designed to detect hazardous ice, snow or wet conditions without embedding any sensors in the pavement. The sensor's standard data output indicates air temperature, surface temperature and a surface friction coefficient.

Purpose: Currently, plow operators and supervisors manually enter road condition data into an on-board computer or relay the data by phone, a time-consuming process for operators who may not be able to complete it in a timely manner. A surface road condition monitor automates this process, saving operator time and improving the quality of data in MnDOT's Maintenance Decision Support System by providing more accurate and timely road condition and friction information. This would result in more effective application of winter materials, which is expected to reduce material use and reduce accidents by providing a more consistent level of service.

Test Procedure: Districts 3 and 6 will each test one Mobile IceSight unit for one year. The unit's functionality will be examined in conjunction with other road condition monitors being tested throughout the state to determine the usefulness and reliability of the data. MnDOT will also assess the ability of the unit to use the current MDSS/Automatic Vehicle Location interface to transfer data from a mobile unit to MnDOT pavement models.



Maintenance Research

Winter Maintenance

District/Office:
6W/Red Wing

Contact:
Kenneth Peterman
507-732-7112

Project Cost:
\$2,000

Start Date:
September 2013

Vendor:
lightandsiren.com

LED Plow Lights *Research in Progress*



Project Description: This project will test an LED lighting combination that includes spot and flood lights to provide effective illumination of both distance and area. The spot-style LED light projects light over great distances in a concentrated beam. This type of light is designed for use at high speeds or when visibility is needed at great distances. While the flood-type LED light projects light at just over half the distance of the spot light, it provides twice the area coverage.

Purpose: The district will test these lights to determine if they will penetrate adverse weather conditions such as heavy or blowing snow and fog to provide greater visibility than standard fog or white headlights.

Test Procedure: The district will evaluate the effectiveness of these lights installed on four plow trucks in providing better visibility and increasing safety when plowing during heavy snowstorms, fog and other adverse weather conditions.



Maintenance Research

Winter Maintenance

District/Office:
6W

Contact:
Tom Johnson
(507) 456-5350

Project Cost:
\$5,000

Start Date:
March 2010

Vendor:
prairiemoonnursery.com

Native Planting Snow Drift Control *Research in Progress*



Project Description: Keeping snow and ice off of windswept areas of the roadway can be aided by the installation of a traditional snow fence, tree and shrub planting, and by leaving standing corn rows in farm fields. In roadway ditch rights of way where these methods are not an option or have proved to be too expensive to implement, the district will plant a 10-foot-wide swath of tall native grasses and a 5-foot-wide strip of a perennial cone wildflower mix to serve as a windbreak.

Purpose: An effective windbreak can save time and money by requiring fewer passes and less material to clear snow and ice from the roadway. The project plantings have the additional benefit of providing wildlife habitat and an aesthetically pleasing backdrop for the traveling public.

Test Procedure: The district will assess the impact of the planting areas in reducing the time and material required to keep the adjacent roadway free of snow and ice.



Maintenance Research

Winter Maintenance

District/Office:
3

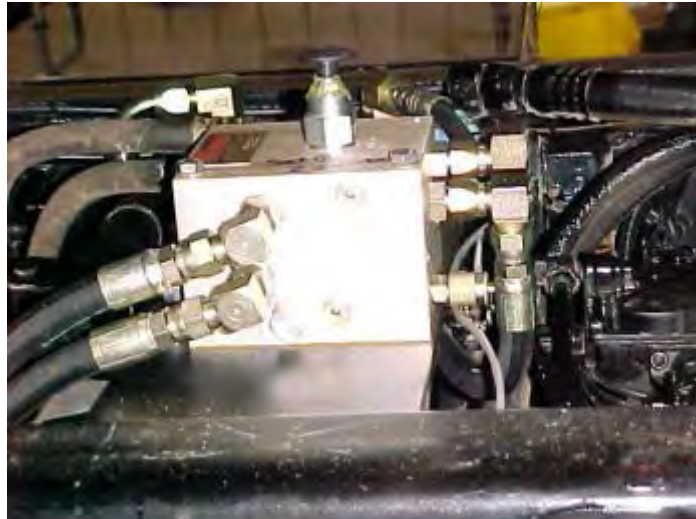
Contact:
Kelvin Smith
320-223-6560

Project Cost:
\$8,000

Start Date:
September 2013

Vendor:
towmastertruck.com

Plow Balance System *Research in Progress*



Project Description: Light snowfalls require less cutting edge friction on the roadway to clear the fallen snow. Using the full plow weight to clear light snowfalls unnecessarily reduces the life of plow cutting edges when less cutting edge pressure is effective in clearing the snow. The PlowGuard plow balance system allows the snowplow operator to control the hydraulically operated plow to reduce the weight the plow's cutting edge applies on the road surface on demand. The system is controlled with a switch inside the truck cab.

Purpose: Controlling the weight the plow's cutting edge applies to the road surface as conditions warrant is expected to extend the life of plow cutting edges, reducing replacement costs and installation time.

Test Procedure: Three snowplows will be outfitted with the plow balance system and evaluated for one year. The average cutting edge life of blades on the test plows will be compared with cutting edges on similar plow trucks in the district to determine if the plow balance system reduces wear on the cutting edge and extends cutting edge life.



Maintenance Research

Winter Maintenance

District/Office:
1

Contact:
Michael Hedlund
218-834-4442

Project Cost:
\$8,000

Start Date:
October 2014

Vendor:
lscenv.com

Posi-Shell *Research in Progress*



Project Description: In support of MnDOT's emphasis on environmental stewardship, the district has been covering salt and sand piles with tarps to reduce leaching of chlorides into the environment. Tarps have proved to be difficult for staff to install and maintain given the large size of the piles, especially with snow cover. The district is testing a less labor-intensive alternative to the use of tarps—a spray-on product that creates an impermeable coating that reduces erosion and infiltration.

Purpose: Posi-Shell is an erosion control formulation that, when mixed with water, produces a spray-applied mortar that dries in the form of a thin layer of durable stucco. The product is applied using vendor-supplied equipment or standard hydroseeding units. This spray-on coating is expected to seal the district's salt and sand piles from rain and limit the leaching of chlorides from the piles, protecting the environment and retaining more of the material for use on winter roadways.

Test Procedure: The district will assess the effectiveness of Posi-Shell in sealing its salt and sand piles, reducing costs associated with the purchase and replacement of tarps, reducing winter material loss, and reducing the risk of injuries to staff.



Maintenance Research

Winter Maintenance

District/Office:
8/Hutchinson

Contacts:
Jerry Eggert
320-583-0844

Christopher Morse
320-864-4417

Project Cost:
\$2,500

Start Date:
April 2015

Vendor:
northcentralintl.com

Power Mirrors for Plow Trucks

Research in Progress



Project Description: Factory mirrors on some of the district's plow trucks vibrate heavily when the truck is idling, and the mirrors go out of adjustment easily. Operators have tried various solutions to lessen the vibrating without success. Replacing the factory mirrors with remote-controlled power mirrors will allow operators to easily adjust the mirrors from inside the truck.

Purpose: These power mirrors are expected to improve safety by restoring the operator's ability to see around the truck. Allowing the operator to adjust the mirror remotely without getting out of the truck repeatedly also saves time and helps limit the operator's exposure to traffic.

Test Procedure: District 8 will install one set of power mirrors on one 2012 International plow truck (Class 33) and compare their performance to the mirrors on similar trucks in the region.



Maintenance Research

Winter Maintenance

District/Office:
8/Marshall

Contact:
Craig Gertsema
(507) 537-2059

Project Cost:
\$16,000

Start Date:
April 2013

Vendor:
[wausau-everest.com/
models/space-patrol.html](http://wausau-everest.com/models/space-patrol.html)

Wausau Space Patrol Wing *Research in Progress*



Project Description: The district's current wing setup for its snowplows employs a light-duty wing that has proved to be less than effective in areas with heavy drifting and high banks. The Wausau Space Patrol Wing is a medium-duty wing with some light benching (leveling) capabilities. The Space Patrol Wing's hydraulic control could eliminate the cable assemblies currently used on the district's wings, and the 10- to 12-foot-long wing (depending on model) is longer than the 9-foot wing now in use.

Purpose: By having a medium-duty wing plow with a wider cutting swath, the district expects to reduce the number of passes needed to clear the roadway. Using a wing that pushes drifts further back off the roadway could also enhance safety for the traveling public.

Test Procedure: The district will assess the effectiveness of the Wausau Space Patrol Wing in reducing the time and manpower needed to clear snow in areas with heavy drifting, as well as its ability to push snow further back off the roadway than the current wing setup permits.



Maintenance Research

Winter
Maintenance

District/Office:
6E

Contact:
Shannon Wait
507-286-7681

Project Cost:
\$12,000

Start Date:
July 2013

Vendor:
wikco.com

Wikco Truck-Mounted Sweeper

Research in Progress



Project Description: A truck-mounted, hydraulically driven sweeper that mounts on a truck's snowplow hitch frame offers an effective solution for cleaning up salt stockpiles and yards after a snow event, controlling the salt residue that presents environmental concerns.

Purpose: A sweeper truck attachment that can be used by remote locations lacking a sweeper eliminates the need for staff to load skid steers onto trailers to transport to outlying truck stations.

Test Procedure: The district will evaluate the sweeper attachment for its ability to contain environmental threats related to salt use, save time, money and manpower, and reduce the potential for injuries and accidents.



Maintenance Research

Winter Maintenance

District/Office:
6

Contact:
Brian Wolfgram
(507) 951-2442

Project Cost:
\$8,520

Start Date:
October 2012

Vendor:
vericomcomputers.com

Winter Roadway Friction Meter

Research in Progress



Project Description: A winter roadway friction meter tests the slipperiness of the roadway in icy conditions. Unlike wheel-type friction testers, the RFM4000X Friction Meter is mounted on the dash of any car, pickup or truck and measures G forces when a driver applies the brakes. This brake action can be done at a safe speed, and it takes only 1 second to get a reading. This measuring device complies with Federal Aviation Administration standards and is used by airports to check runway friction.

Purpose: Snowplow operators change their application rates of winter chemicals as temperatures change during a snow and ice event. The roadway friction meter will enhance the operators' ability to assess the slipperiness of a road and determine the type and amount of chemical to apply.

Test Procedure: The district will evaluate the friction meter's ability to reduce the time, staff and material needed to treat winter roadways by reducing the number of trips required over plow routes to check for and treat slippery roads.

Previous Statewide MOR/NTREC Project Reports

In the infancy stages of the MOR/NTREC Program, the initial research focused on snow and ice field studies and projects were very limited. As the MOR/NTREC Program matured and developed, it expanded into other fields of maintenance including roadside and bridges. Other offices became involved with the quality and evaluation of the projects. As projects were completed and possibly implemented, there was a need to communicate these results to the rest of the state and others.

Following is a list of the project reports that have been published since 1992. Some projects had been carried over from year to year due to improvements made as results are reached. The projects listed below are in the report as it was first introduced to the program and may have conclusions in later reports. If you are interested in any of these projects, you may contact the Maintenance Operations Research Engineer.

1992-1993 Winter Season Report:

- Camden Pre-wetting Field Study
- Lakeville Pre-wetting Field Study
- Plymouth Anti-icing Field Study

1993 Report:

- Corrosion Research
- Road Weather Information System
- Truck Ergonomics Task Force
- Snow Fence Research
- Vehicle Conspicuity Research
- Solar Powered Culvert Deicer
- Quality Control of Premixed Sand/Salt Blender Hopper
- Laserlux Road Striping Management
- Smooth Pavement Task Force
- Remote Driven Vehicle
- Remote Slope Mower
- Zero Velocity Salt/Sand Spreader
- Timesheet Generated Interface
- Short Grass Research Plots
- Extendable Snow Plows
- Portable Interactive Weather Prediction System
- Municipal Waste Salt Water as a Pre-wetting Agent

1994 Report:

- Culvert Rehabilitation
- Thermal Mapping
- Portable Interactive Weather Prediction System
- Temperature Sensors
- Snow Fence Research
- Work Zone Safety Projects
- Circuit Rider Program
- Finnish Emulsion Gravel Pavement
- Automated Call-Out System
- Timesheet Generated Interface & MMS/TIS Interface
- Bar-Coding
- Maintenance Research Project Tracking System
- CB Radios
- Innovative Sprayers
- Band Cleaner
- NIDO Liquid Spreader
- Wash Water Recycling System
- Salt Brine Mixing Systems
- SHRP cutting edges
- Gravel Shoulder Reclaimer

1995 Report:

Winter Maintenance

- Maintenance Concept Vehicle Partnership Project
- System 2000 Stationary Salt Speeder
- Automated Liquid Bridge Deck Deicer
- Brine Applicator
- Power Liquid Spreader Control Unit
- Electronic Pre-wet hang Tanks
- Integrated Tailgates Research
- Improved Snow Plow Design
- Grader End Gates
- Combined Front-Slush Plows
- Ice Buster
- Norsemeter Friction Meter
- Magnetic Pavement Taping Road and Bridge

Maintenance

- Slurry Seal Patching Machine
- MicroSurfacing
- Automated Pothole Patcher
- Cascadia Enduraseal 300 Asphalt Rejuvenator
- Highlift Flatbed
- Earth Penetrating Radar Concrete Delamination Detecting System
- Lightweight Power Screed
- Retrofit Dowel Bars
- Culvert Rehabilitation Project
- Culvert Grapple Extractor (Beaver Dam Grapple)
- Stenciling Unit for Message Painting

Maintenance Management

- Thermal Mapping
- Pavement Condition and Weather Reporting
- Interactive Travel Information Systems (Minnesota Travel Partners)
- Travel Partners Demonstration Project
- Mobile Road Weather Information Systems
- Timesheet Generated Interfaces & PMS/MMS/TIS Interface

- Pavement Marking Management System
- Dial in Server for Operations Management System Pilot
- Bar-coding
- Paperless Field Data Collection
- Maintenance Research Project Tracking System

Roadside Maintenance

- Herbicide Sprayer
- Flexstake Weedmats
- Remote Slope Mower
- Biological Control of Canada Thistle

General Maintenance Management

- All Terrain Crawler Tractor; Posi-Track
- Tracks and Dozer Blade on Skidsteer Loader
- Kentrol Gate Material Control System
- Tire Experiment, Michelin

Technology Transfer

- International Worker Exchange Program
- Finnish Emulsion Gravel Partnership Project

1996 Report:

Winter Maintenance

- Heated Truck Box Using Exhaust System
- Truck Box with a Fiberglass Floor
- Snow Shield Research
- Combined Front Slush Plows
- Anti-icing using Brine from Wash Water Recycling (North Branch)
- Anti-icing using a Herbicide Sprayer Attachment, Spraytroics (Metro)
- MnDOT – Hennepin County Anti-icing Project
- Fiber Optic Lighting Research
- Wing Plow Research (mounted at the rear of the truck)
- National Friction Measurement Study (FHWA)
- Integrated Tailgate Research
- Extendible Hood Snow Plow
- 21-Foot Snow Plow

- Cutting Edge Research
- Multiple Uses for Low-Boy Tractor
- Dual Spinner
- Elkin Spreader
- Salt Brine Mixing Systems
- Oscillating Underbody Scraper

Road and Bridge Maintenance

- Evaluation of Radar for Snowplows
- Automatic Pothole Patcher
- Front mounted Shoulder Retriever
- Bunyan Friction Screed
- Crack Sealing
- Color Flexi Probe Inspection System
- Culvert Rehabilitation Project
- Peel-A-Way Lead Paint Removing Process for Bridges
- Lite Stripe Laser and Camera Pointer Systems

Maintenance Management

- Automatic Low-Visibility Warning System Using Video Cameras
- ARTIC Dispatch Center
- CD Authoring, Writing, and Sharing Project
- Automated Route Planning and Optimizing Software

Roadside Maintenance

- Boom Sprayer Rebuild
- Hooded Ground Sprayer
- Polecat Obstacle Mower

General Maintenance Research

- Reusable Energy Absorbing Crash Terminal
- ProPatch Head Cover, Prototype
- Bioremediation Pilot Project
- Portable Hot Water Pressure Washer
- Multi-purpose Utility Vehicle with Electrical Power tool Package
- Demo Maintenance Truck with Updated Hydraulic System

Work Zone Safety

- Remote Driven Vehicle Unit #3
- Flashing Stop/Slow Paddle Implementation Project

Technology Transfer

- Maintenance Expos – Fall and Spring
- Saving Salt – Simple Solution

1997-1998 Report:

General Maintenance

- Aerosol Alternative
- Drillco Sawblade
- Easy Bend
- Ford Smith Four Post Hydraulics Lift
- Multiple Uses of Hot Water Pressure Washers in Highway Maintenance
- Plasma Cutter
- Remote controller for Boom on Sign Truck
- Vacutec Leak Detector
- Video Image Scope

Maintenance Management

- Blowing and Drifting Snow Control Market Research
- Evaluating Locating and Record Keeping Technology
- Fleet Management System Coordinator
- GIS Project Specialist
- Maintenance Business Planning: Measuring Quality
- From the Customer's Viewpoint
- Pavement Marking Market Research RFP
- Transmap GIS Mapping for Sign Inventory
- Striper Record Keeping/Downloading Using a Laptop Computer
- Maintenance Business Planning: Winter Operations Survey.

Road and Bridge Maintenance

- Epoxy Striper Research Project
- Heated Dump Box-Tapping System
- Laser Level Plane
- Patchrite Self Propelled Pothole Patching Machine
- Silane
- Vibratory Concrete Floats

Roadside Maintenance

- Box Beam Guardrail
- Contour Tree Planter
- E-Z Dig and E-Z Grader
- Funda Flex
- Power Broom/Trimmer for Light Duty Sweeping
- Weld on Wear Pads
- Wheeled Debris Blower
- Wood Chip Blower

Technology Transfer Partnerships

- DNR Tandem Truck
- Truck Driving Simulator

Winter Maintenance

- ALLU Screen Crusher
- Athey Force Feed Loader
- Automated Data Logger for Odin System
- Blending System for Mixing Sand and Salt
- Chemical Storage Building
- Commercial Visibility Instrument
- Continuous Friction Measurement Techniques Research
- Culvert Deicing Resistance System
- Cutting Edge Study
- Dresbach Anti-Deicer System
- Dual Auger Spinner Sander
- Dual Rear Wing Truck
- Elkin Sander
- Enclosed Salt Brine System
- Enhanced Snowplow Visibility Using Radar Technology

- Etnyre Anti-Icing Unit
- Extendable Hood Snowplow
- Heads Up Research Summary
- Henke Heavy Duty Wing
- Hydraulic Snowblower
- I-35 Fixed Bridge Deicer System
- IceBan (Liquid Deicer)
- Large Capacity Integrated Tailgates
- Nokian Tires Part One and Two
- Pick up mounted Anti-icing units
- Rebuilding Frame Work on CL-35 Snowplow
- Road Closure Gates
- Salt Conveyor
- Salt Solutions
- Snake Creek Bridge
- Stainless Steel Integrated Tailgates
- VLB Industrial Snowblower

Work Zone Safety

- Cone Reflective Spinners
- Cone Setter/Retriever Research Trip
- Message/Arrow Brickboard
- Portable Advisory Roll-Up Sign Assemblies
- React 350 Reusable Energy Absorbing Crash Terminal
- Remotely Driven Vehicle
- Speed Control Display Systems
- Striper Crew-Programmable Light Emitting Diode Sign on Shadow Vehicle

1999-2001 Report:

Winter Maintenance

- Cryogenically Treated Cutting Edges
- Non Rotating Carbide Bit System for Underbody Blades
- Hydraulic Driven Snowblower
- Infrared Ice Detector Maintenance Upgrade
- Swenson Precision Placement System
- Expansion and Implementation of Anti-ice Methods

- Adaptable “Slide-in” Anti-ice/Herbicide Spray Unit
- Critical Area Spot Spreaders
- New Component Test Bed Truck

Winter Material

- Ice Ban M-50
- Medium Grade Salt (Nu-Salt)
- Anti-icing Liquid (Caliber)

Road and Bridge Maintenance

- Air Prep System
- Laser Based Clearance measuring System
- For the Birds
- Rubberized Asphalt Melter Applicator
- Aging Optimization Study
- Hot Box
- Spaulding RMV Hot Patcher/Reclaimer

Traffic/Work Zone Safety

- Smart Arrow Messenger Board
- Scorpion Truck Attenuator
- Solar Powered Warning Signals/Flashers

Roadside Maintenance

- Noxious Weed GPS/GIS Mapping
- Posi-Track Soil Compaction Reduction Project
- Harley HST 6 Shoulder Reclaimer
- Geotextile Fabric Laying Machine
- Living Snow Fence
- Dynamic GPS Performance Evaluation
- New Holland Disc Mower
- TRACC System
- ET-2000 Guardrail End Treatment
- (GS-ED-60-50) Side Dozer

Equipment – Tools

- Spray on Box Lining and Irathane Systems
- Wire Feed Welder
- Laxo Quick Lock System
- Brake Watch
- JAGZ Interlocking System

- Retractableflap
- Mud Flap Jack
- Clear View Wiper Mirror
- Lane Scan Mirrors
- Heated Windshield Wiper Blades/Blizzard Blades
- High Intensity Discharge Lighting
- Trailer Safety Lights
- Cordless Impact Drivers
- Mini Skid Loader
- Underbody Grease Banks
- Truck Mounted Roller
- Collision Avoidance Monitors
- Electronic Hearing Protectors
- On-board Truck Scale
- Connect Under Pressure Hydraulic Couplers

Building

- Pre-cast T Panels for Cover-all Storage Buildings
- Wireless for Truck Stations

Technology Transfer

- Truck Weight Education Project
- Field Works
- Snow and Ice Pamphlet
- Snowplow Simulator Phase I
- Electronic Multi-meter
- Electronic Technical Data Collection

2001-2003 Report:

Winter Maintenance

- Critical Area Anti-icing D-8
- Dultmeir Brine Production System
- Hydraulic Driven Snowblower
- LED Wing Lights
- Stainless Steel Hopper
- Precision Placement System
- Plow Guards
- GPS Tire Road Friction
- GPS Gang Plowing
- Expansion of Anti-icing Methods

- D-3A Rear Mount Wings
- Micro-Trac Anti-icing
- Blizzard Plow
- Pre-wetting Liquid Storage Tank
- Anti-icing Equipment
- Wing Wheels
- Crash Attenuator Anti-icing
- Dultmeir Anti-ice Unit
- Liquid Chemical Transfer Pump Station
- Dual Carbide Underbody Edges

Winter Material

- Anti-icing Liquid

Road and Bridge Maintenance

- Hollow Deck Machine
- Over-height Vehicle Detection System
- Silicone Pump
- High Mast Light Pole Inspection
- Night Time Wet Line Recovery
- Air Prep System
- Laser Based Clearance Measuring System
- GL 3000P Laser Guidance System
- Aging Optimization Study
- Wedge Paver
- Bridge Sweeper
- Universal Maintenance Unit

Traffic Control and Work Zone Safety

- Voice Activated Message Sign
- Roo Guard Barriers
- Active Portable Warning System
- Emergency traffic Control Truck
- Scorpion Truck Attenuator
- Stabilization of Aggregate Shoulders
- Safety Light Wand

Roadside Maintenance

- Sprout Guard
- Brown Mower
- Tree Shear
- Erosion Control Equipment

- Noxious Weed GIS/GPS Mapping
- Ditch Hitch
- New Holland Disc Mower
- ATV Swisher Mower

Equipment – Tools

- Lane Scan Mirrors
- Dynamic Performance Evaluation
- Rear Vision Color Monitor
- Backup Safety Cameras
- Ready Welder
- HID Sander Lights
- Clear View Mirror Wiper
- Underhood Air Compressor
- Protective Coated Oil Pans
- Reiter Plastic Truck Body
- Hydraulic Ground Level Trailer
- Laxo Quick Lock System
- Boss Light
- Mud Flap Jack
- Mini Concrete Mixer
- Trailer Safety Lights
- Test Bed Tandem
- Accu Place Spreader
- Ribbon Lift
- Retro Reflective Mud Flaps
- Electro Luminescence Light Signs
- Open Systems Architecture for RWIS
- RWIS RPU Modifications
- Sylvania Silverstar Lights
- Quicksilver Bed Liner

Building

- Wireless for truck Stations

2003-2005 Report:

Winter Maintenance

- Dultmeir Brine Production
- Expansion and Implementation of Anti-icing Methods
- Anti-ice Unit and Geomelt M

- Anti Ice Unit
- Joma 6000 Edges
- Salt Brine Injection
- Pre-wet Tanker
- Dual Carbide Underbody Edges
- Hydraulic Wing Push Arm
- KT-90 Active Adapters
- Transfer Pump Station
- Slap Me Wipers
- Quick Edge Replacement
- Mobile Anti-ice System

Winter Material

- Cargill Clearlane
- Geomelt M
- Geomelt
- LCS 5000
- Andersons Additive

Road and Bridge Maintenance

- Top Down Cracking
- GPS-GIS Edge Drain Mapping
- Bituminous Thermal Crack Repair
- Tailgate Paver
- Ribbon Lift
- Safety Traffic and Work Zone Safety
- Solar Traffic Lights
- Cone Setter
- El Conspicuity Light Signs
- LED Lighting
- Avoiding Collisions With Plows
- Lighted Vests
- Lighted SMV Signs
- El Lighted Mudflaps

Roadside Maintenance

- Beaver Abatement
- Just in Time Sign Replacement
- Bobcat Wolf Disc

Equipment – Tools

- Reiter Plastic Truck Body
- Motorvac MCS245 – 50
- Skidloader Backhoe
- 6 Way Dozer Blade
- Snap-on HD35 Fluid Changer
- Heated Bituminous Box
- 6x9 BDS Mirrors
- Cut Off Saw
- Porta Shear
- Truck Washing Soap

2005-2007 Report:

Winter Maintenance

- Hot Wash Cleaning Unit
- Slap Me Wiper
- Clear Fast/Hot Shot Comparison
- Joma Blades
- Stainless Steel Water Tank
- Boom Mounted Snow Blower
- Brine Maker Injection
- Dye Injection
- Pre-Wet Tanker
- Dual Carbide Underbody Edges
- Hydraulic Wing Push Arm1
- Granular Spreader Epoke Sirous
- Ecco Wing Lights
- El Tail Light Strip

Winter Material

- Geomelt
- Andersons Additive

Road And Bridge Maintenance

- Bypass Scaffold
- Cold Planer
- York Front Mounted Rotary Broom
- Moa Bridge Shark
- Electric Heated Pickup Box
- Epoxy Crack Filling

Safety, Traffic Control And Work Zone Safety

- Litesys Intellect Comms
- Mold Board Lights
- Scorpion Truck Attenuator
- Solar Traffic Lights
- Pack A Cone
- Ecco Rear Vision
- Lighted Slow Moving Vehicle (SMV) Signs
- Flame Proof Vest

Roadside Maintenance

- Shoulder Reclaimer
- Beaver Abatement
- Roo Guard Barrier
- Skid Steer Rubber Tracks
- Stump Grinder
- Wolf Disc
- Loegering Track System
- Auger Bucket
- Skidloader Backhoe
- Rubber Tire Roller
- Rotary Mower

Equipment – Tools

- Pro Press Crimping Tool
- Portable Wheel Stud Remover
- Wireless Mobile Lift
- Gooseneck Lamps
- Safety Work Platform
- Snap-On Hd35 Fluid Changer
- Tree Puller
- GPS Cameras

2007–2009 Report:

Winter Maintenance

- Guidance Laser
- Henderson Zero Velocity Sander
- HID Headlights
- Iowa Snow and Ice Innovative Equipment

- Modified Augers
- Rubber Cutting Edges
- Salt Skirt
- Slurry Auger
- SNO-FLO
- Spray Nozzles
- Tow Plow
- Tuff Tech Bag
- Wiper Shakers.

Road And Bridge Maintenance

- ChemGrout
- Road Shoulder Groomer
- Roll Master 5000
- Wheel Saw

Roadside Maintenance

- Three Point Jetter
- Apache Bullseye 6 Laser
- Compressed Air Bottle
- Forward Looking Sonar
- Guardrail Sprayer
- Herbicide Head/Pump
- Hydraulic Plate Compactor
- Mini Might Patrol
- No Mow Grass
- WeedEnder

Equipment – Tools

- Auto Greasing System
- Headset with Foot Switch
- Mud Cannon
- Nitrogen Tire Inflation System

Safety, Traffic Control And Work Zone Safety

- Horizon Portable Traffic Control Signal
- In Vehicle Video Camera
- Reflective Shirts
- Swift Hitch Wireless Cameras

2009–2011 Report:

Equipment - Tools

- Bevel-Mill Model 8000
- Blue Tork
- Diagnostic Scan Tool
- EnviroTabs

Road and Bridge Maintenance

- Concrete Batch Plant
- Concrete Chuter
- Hitch Mounted Core Drill

Roadside Maintenance

- Concrete Pipe Joint Sealer
- LIMBHOG
- Magnetic Manhole Cover Removal
- Propane Hammer
- Rotary Screener
- Weed Wiper

Safety, Traffic Control and Work Zone Safety

- LED Lights for Stop/Slow Paddles
- LED Solar Barricade Flashers

Winter Maintenance

- Air Foil
- Air Vizion
- Blending Station
- Calibration Scales
- Crystal Fusion
- I.C.E Blades
- LED Sander Lights
- Manhole Protection Ring
- Molded Slurry Tanks
- Rock Salt Moisture Tester

Winter Material

- ArctiClear Gold
- GeoMelt
- IceBan 200

- Thawrox Treated Salt
- Road Guard Plus 8
- MeltDown Apex

2011-2013 Report:

Equipment and Tools

- Conveyor Stand
- Fluke Thermal Imager
- Induction Heating System
- IRISPen
- Jack Jaw Post Extractor
- LED Safety Lights and Flares
- Q-Star FlashCam
- Skid Steer Grout Pump
- Tire Pressure Safety Cap
- Tire-SafeGuard Tire Monitoring System
- TorcUp Wrench
- Valve Extenders

Road and Bridge Maintenance

- Material Control Gate
- Motor Grader, Wedger Attachment
- Pipes for Spray Injection Patcher
- Slip-In Pre-Mix Heater

Roadside Maintenance

- Centri-Pipe
- Cone Setting Cage
- Laser for Sign Height
- Metal Shears
- Rota-JETTER
- Side Shift Mower

Safety, Traffic Control and Work Zone Safety

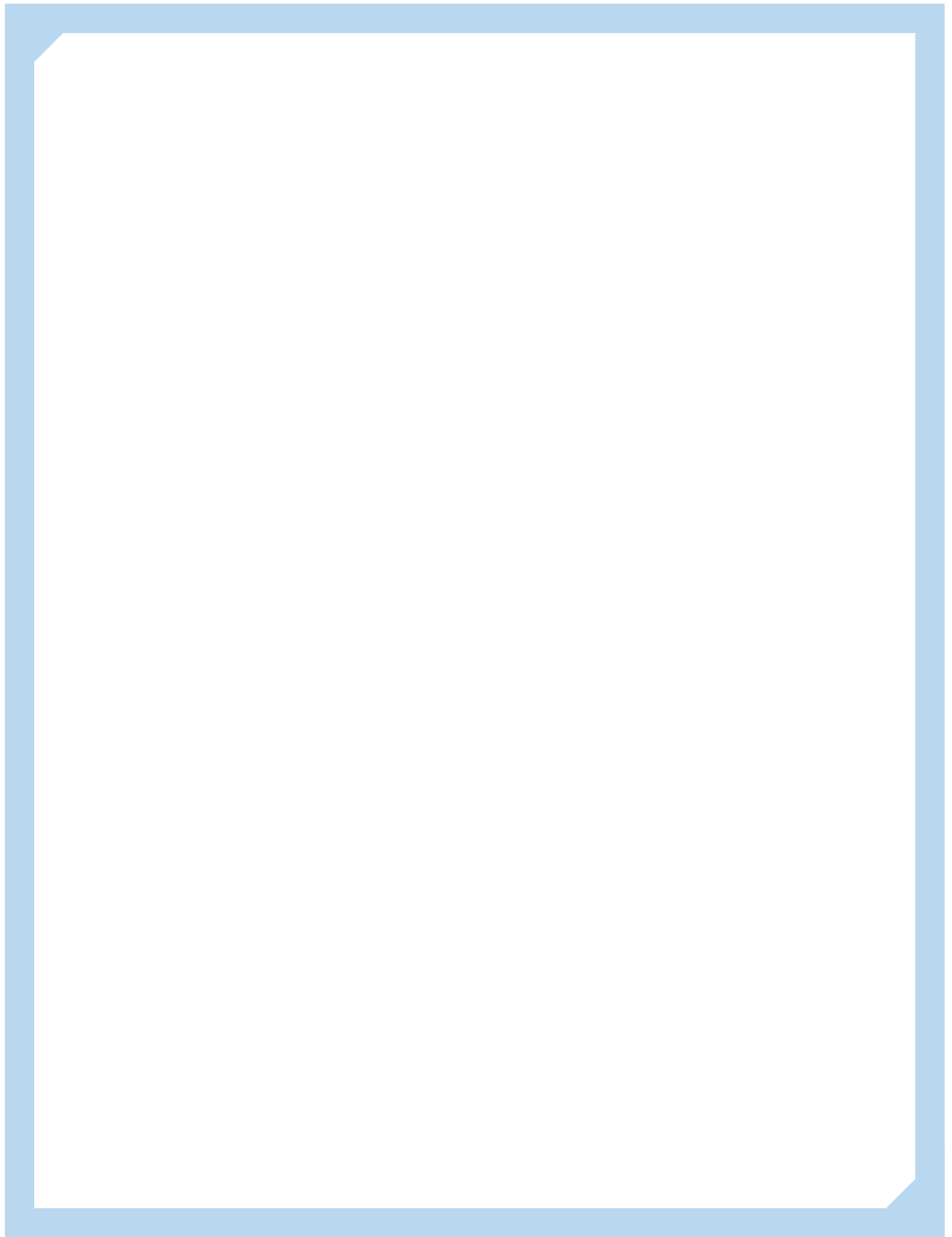
- RoadQuake Rumble Strips

Winter Maintenance

- Bag Reel
- Brine Bags
- LED Headlights
- LED Warning Lights for Plow Trucks
- Monroe Roller Mill
- Mr. Slick
- NEUTRO-WASH
- Salt Brine Flow Meter
- Stainless Steel Hydraulic Couplers
- Tailgate Slurry Sander
- Winter Snowplow Cutting Edges

Winter Material

- SOS Salt Pretreatment





For more information, please visit:

Minnesota Department of Transportation:

<http://www.dot.state.mn.us/>

MnDOT Office of Maintenance Research Unit:

<http://www.dot.state.mn.us/maintenance/research.html>

MnDOT Research Services Section:

<http://www.research.dot.state.mn.us/>

MnDOT Library:

<http://www.dot.state.mn.us/library/>