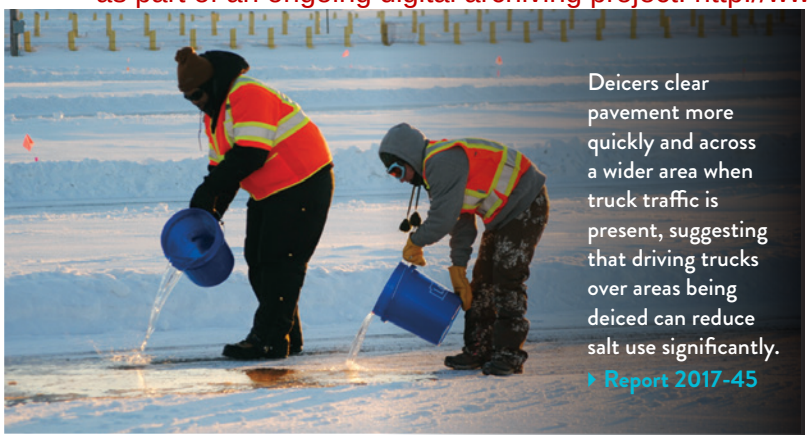


Deicers clear pavement more quickly and across a wider area when truck traffic is present, suggesting that driving trucks over areas being deiced can reduce salt use significantly.
▸ Report 2017-45

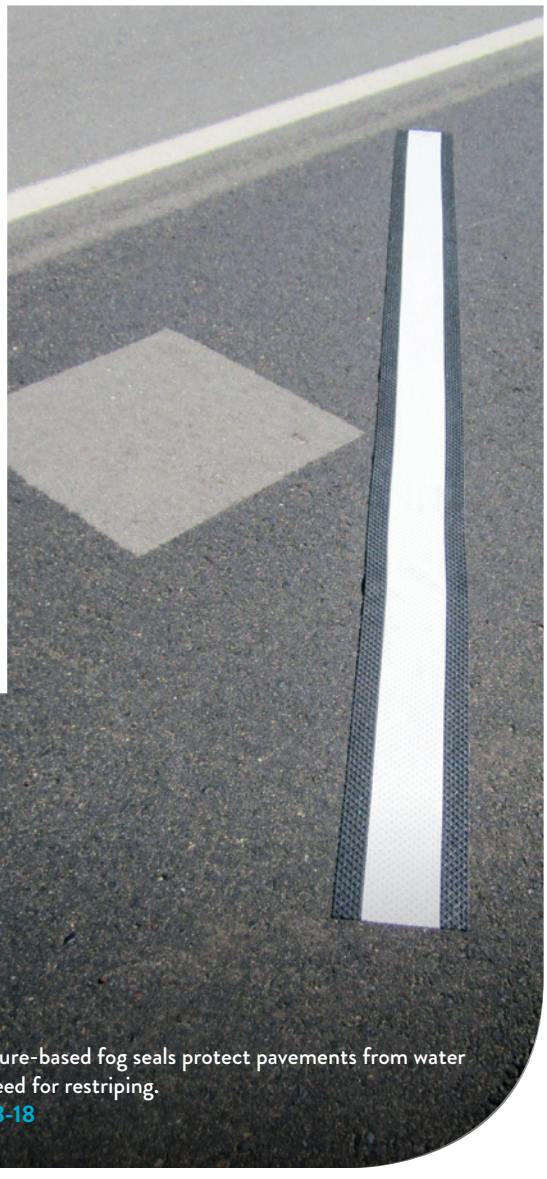
A new drone that flies within a protective cage can safely evaluate areas of bridges that are difficult for inspectors to reach.
▸ Report 2018-26

FY2018: JULY 1, 2017 – JUNE 30, 2018

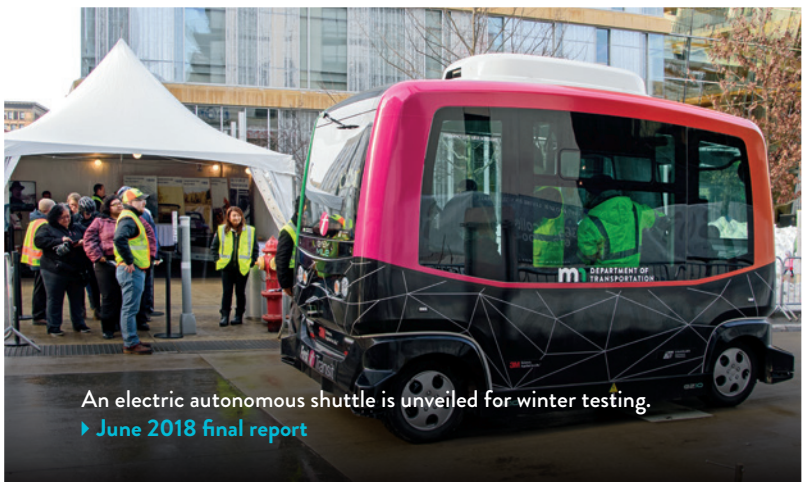
RESEARCH AT-A-GLANCE

Implementing New Practices and Preparing for the Future

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION
mndot.gov/research



Clear, agriculture-based fog seals protect pavements from water without the need for restriping.
▸ Report 2018-18



An electric autonomous shuttle is unveiled for winter testing.
▸ June 2018 final report

OUR MISSION

MnDOT's Office of Research and Innovation, formerly Research Services & Library, supports Minnesota's transportation practitioners by meeting their information and innovation needs.

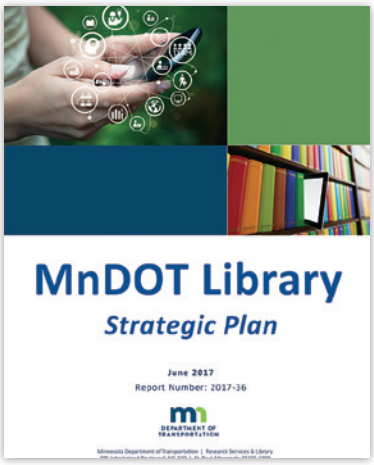
With funding from state, local and federal research programs, our office administers more than 200 research, innovation and technology transfer projects annually. This includes research we manage for the Minnesota Local Road Research Board (LRRB) on behalf of city and county engineers, as well as dozens of multistate initiatives.

In addition, our office has expert librarians who assist transportation professionals with their short-term information needs and keep them up to date in their field of interest.

We welcome your feedback, research requests and involvement on Technical Advisory Panels.

PROGRAM IMPROVEMENTS

Research Program Strategic Plan provides a vision for greater integration of MnDOT priorities into the selection of research projects.



The **Library Strategic Plan** is our blueprint for modernizing library operations to meet future information needs.

KEY ADVANCEMENTS

MnDOT's transportation research initiatives continue to make a difference. Many of these projects captured local media attention and national transportation interest in the past year, including a new approach to repairing concrete bridge beams (pictured below), the integration of live images from snowplows with 511 traveler information and a system that reports available rest area parking spaces to truckers.

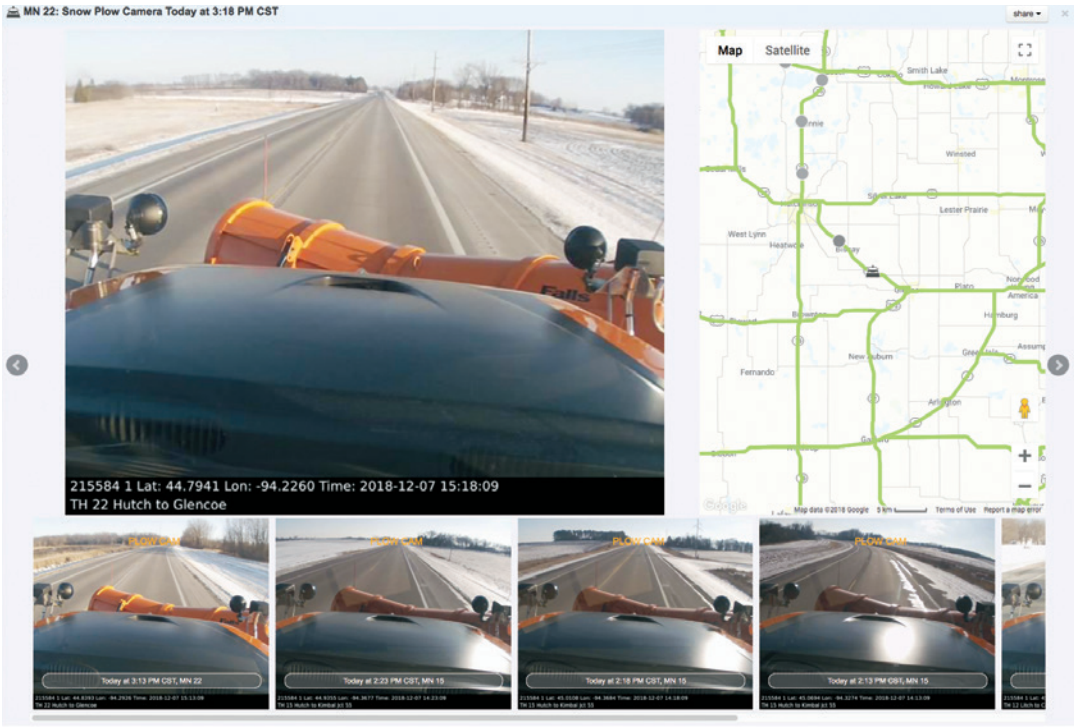
Application of research findings will accelerate with MnDOT's new, five-year comprehensive strategic plan (pictured at left), which strengthens the agency's focus on research implementation. MnDOT will more comprehensively track research expenditures, reporting impacts that extend well past the research period, and prioritize new research based on agencywide strategies.

The role of the Office of Research and Innovation, formerly Research Services & Library, has expanded to take on these new responsibilities and elevate the role of research within the agency. It will continue to communicate the benefits of innovation, like the bridge beam end repair approach (pictured below), which has been replicated on other bridges, restoring beams with severe deterioration while avoiding costly repairs and lengthy traffic closures.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

MnDOT FY2018 RESEARCH IMPLEMENTATION HIGHLIGHTS

Improving Operations



An interactive map shows road conditions at a snowplow's current location and its recent route.

Snowplow Camera Images for MnDOT's Traveler Information System — Dashboard and ceiling cameras on 226 MnDOT snowplows automatically send images to the 511 traveler information system website and mobile app. Up-to-the-minute images help road users safely navigate wintry highways. Articles by **KEYC-TV** and the **Star Tribune** featured the new technology. **Report 2017-41**

Research Implementation Program

In addition to funding and administering research projects, we provide seed funding to put research results and transportation innovation into practice. Funding is available for small-scale deployment, pilots or the development of training materials.

Learn more at mndot.gov/research/implementation.html or contact us at 651-366-3780 or research.dot@state.mn.us about your implementation needs.

Rest Area Signs — In summer 2015, fueled by the results of past research, MnDOT installed new highway signage advertising amenities at 21 rest areas to encourage motorists to take a break. Feedback collected from drivers' mobile devices showed that at least one-third of drivers saw the signs and more than one-quarter took advantage of the amenities because of the signs. This effort, which improves safety on Minnesota roads, was featured in the **Star Tribune** and covered in the **Crossroads** transportation research blog.

Newly Funded Implementation Projects

Eight new projects have been funded for fiscal year (FY) 2019:

- Guidelines for tightening anchor bolts on signs and light masts
- A Metro District drone program for bridge inspection
- Evaluation of corrosion-resistant sealers for reinforced concrete bridges
- New, durable roadside laser sensors to track MnDOT vehicle locations and roadway weather conditions
- Identification of environmental effects of roadway materials
- Testing the structural condition and benefits of full-depth reclaimed asphalt
- Quantifying the flash-flood and climate change vulnerability of bridges and highways
- Weather alerts on overhead highway signs

Better Inspection and Repair

MnDOT Bridge Engineer Paul Pilarski explains new repair method.

Concrete Girder Repair—MnDOT has adopted a Michigan innovation that extends the lives of corroded reinforced concrete beams in bridge systems. After cleaning the area around the beam, crews attach a new reinforcement cage and spray fast-setting concrete to seal the new end. Repaired beams are stronger than the undamaged original beams, and the practice reduces repair costs and shortens traffic closures. **KSTP-TV** reported on the work, which was also featured in **Crossroads**. **Report 2018-07**

Bridge Inspection With Unmanned Aircraft Systems— The Metro District Bridge Office is forming a drone inspection unit to implement MnDOT's **award-winning research** and expertise on the use of unmanned aircraft systems, or drones, in bridge inspections.

- The new unit is creating an inspection plan that identifies situations that best suit drone use. See the implementation project page for the **Metro District bridge inspection program**.
- A new drone inspection coordinator handles requests for drone use in MnDOT rights of way. New drones include one that is encased within a protective cage to inspect areas that are difficult or impossible for inspectors to access.
- Drone video, photo and other data are integrated with data from other inspection tools to create 3-D models and video- and photo-based images for thorough bridge inspections.

Report 2018-26

Guidelines for Tightening Large Anchor Bolts—MnDOT research corrected shortcomings in national guidance and in field practices for tightening the large anchor bolts of support structures for signs, lights and signals throughout Minnesota's transportation system. As part of a new **implementation project**, MnDOT is producing training and demonstration videos to help crews properly measure torque and tighten anchor bolts for different kinds of structures. **Report 2018-27**

Advancing Transportation Technology

Updates to MnPAVE-Rigid allow precise, durable concrete pavement design.

MnPAVE-Rigid 2.0—An upgrade to MnPAVE-Rigid, MnDOT's software for designing concrete pavements, expands design options to better match Minnesota needs. With MnPAVE-Rigid 2.0, designers can select from three kinds of aggregate for concrete mixes and two thicknesses of aggregate base, and can input actual traffic data to generate designs. New concrete pavements will be more precisely designed and potentially less expensive to build. Because MnDOT owns MnPAVE-Rigid, the agency can update the software whenever necessary. **Report 2018-17**

During rush hour, MnPASS lanes are open to fee-paying customers.

Tool for MnPASS Access Spacing —New software for the Regional Transportation Management Center (RTMC) helps traffic engineers predict the traffic and safety effects of closing an open high occupancy toll lane and select optimal closing locations. The software combines models, maps, and historic and real-time traffic data into one tool, offering the RTMC a unique, locally calibrated method for limiting shockwaves that congest traffic and keeping commuters moving safely. **Report 2018-11**

Rolling Density Meter and Mobile Imaging Data Collection—Evaluating pavement and subgrade density during compaction requires measuring density and monitoring roadway alignment and dimensions. Two ongoing studies using the **rolling density meter** and **imaging for data collection** streamlined the intelligent compaction process. Researchers accurately measured compaction and used mobile imaging to monitor road alignment without the need for on-site surveying crews. The rolling density meter was piloted on several projects in 2017. For more information, see **mndot.gov/mnroad**.

Leveraging Our Research Dollars: National Partnerships

For every $1 invested in a pooled fund study with other states, MnDOT leverages $10 worth of research.

The Transportation Pooled Fund (TPF) Program allows federal, state and local agencies and other organizations to combine resources to support research into shared transportation priorities. Minnesota leads nine pooled funds and participates in another 36. Find a summary of all pooled fund activity at **mndot.gov/research/pooled.html**. Some of our notable studies:

Clear Roads The Clear Roads research program brings together transportation professionals and researchers from around the country to drive innovation in winter maintenance. By evaluating materials, equipment and methods in real-world conditions, the program identifies the most effective techniques and technologies to save agencies money, improve safety and mobility, and increase efficiency. **clearroads.org**

Unbonded Concrete Overlays Interest in using less concrete to reduce costs and encourage sustainability drives research about concrete overlays of aging pavements, a durable and popular pavement rehabilitation approach. This study, supported by eight state transportation agencies, will develop a rational design approach that considers every component of existing pavement structures and how they affect new overlays. **pooledfund.org/Details/Solicitation/1309**

National Road Research Alliance The National Road Research Alliance (NRRA) was created by MnDOT to help fund and direct research at the MnROAD cold-weather pavement test track. NRRA finds ways to build roads faster, make them last longer, perform better, cost less to build and maintain, and have less impact on the environment. **mndot.gov/mnroad/nrra**

North/West Passage Minnesota initiated this pooled fund to investigate intelligent transportation systems solutions to traffic management, traveler information and commercial vehicle operations on Interstates 90 and 94 between Washington and Minnesota. **nwpassage.info**

National Accessibility Evaluation This MnDOT-led effort will help states assess their transportation systems and guide planning and research efforts by implementing a uniform measurement of accessibility to jobs across the United States. Annual reports summarize patterns and trends in jobs accessibility. **access.umn.edu/research/pooledfund**

How to Participate in National Research Projects

Pooled Funds If your research idea addresses an issue that affects multiple states, we can help establish a **Transportation Pooled Fund project** to leverage resources and collaborate with other state departments of transportation to solve a problem. Find guidance at **mndot.gov/research/pooled.html**.

NCHRP Research If you are trying to solve a problem of regional or national significance, we can help you develop a problem statement through the National Cooperative Highway Research Program (NCHRP). Contact us at **research.dot@state.mn.us**.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

FY2018 RESEARCH

Search projects at mndot.gov/research.

Each research topic area includes two tables:

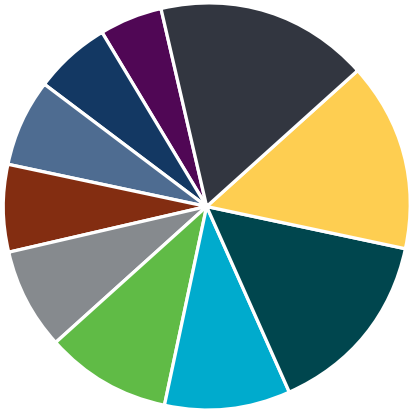
- Research reports completed in FY2018, followed by other research contracts active during FY2018, sorted by contract end date.
- Multi-state pooled funds and American Association of State Highway and Transportation Officials (AASHTO) projects, with MnDOT-led pooled funds listed first.

Prefixes in project titles indicate funding for projects not supported entirely by the MnDOT State Research Program:

- **INV** – Partial or full Local Road Research Board funded
- **MPR/MP** – 80% federally funded/20% state funded
- **TPF** – MnDOT-administered pooled fund (100% federal funds)

For more information about projects, including two-page Technical Summaries for completed reports, search by the title on the "Projects" tab at **mndot.gov/research**. For more information about pooled funds, search at **pooledfund.org**.

EXPENDITURES BY PROGRAM AREA



Total: $10,955,658

- **17%** Dedicated Programs (CTS & LTAP)
- **15%** Traffic & Safety
- **15%** Materials & Construction
- **10%** Maintenance Operations & Security
- **10%** Environmental
- **8%** Federal Program Support
- **7%** Administration
- **7%** Multimodal
- **6%** Bridges & Structures
- **5%** Policy & Planning

BRIDGES & STRUCTURES

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-16	MPR-5(010): Enhanced Culvert Inspections—Best Practices Guidebook	Steven Wolsfeld, CDM Smith, Inc.	Andrea Hendrickson	7/31/17	$118,470
2017-18	MPR-5(015): Unmanned Aircraft System Bridge Inspection Demonstration Project—Phase II	Barritt Lovelace, Collins Engineers, Inc.	Jennifer Wells	10/31/17	$95,898
2017-40	Multi-Beam Sonar Infrastructure Mapping Research	Barritt Lovelace, Collins Engineers, Inc.	Petronella DeWall	9/30/17	$29,993
2017-48	MP-16(003): Implementation of a Refined Shear Rating Methodology for Prestressed Concrete Girder Bridges	Jamison Beisswenger, SRF Consulting Group, Inc.	Yihong Gao	11/30/17	$96,364
2018-07	Experimental Shear Capacity Comparison Between Repaired and Unrepaired Girder Ends	Carol Shield, University of Minnesota	Paul Pilarski	5/31/18	$65,090
2018-24	A Rational Method of Surface Treatment Selections for Concrete Decks	Kevin MacDonald, Beton Consulting	Paul Pilarski, Nathan Schutte	8/31/18	$94,523
2018-26	MP-16(008): Improving the Quality of Bridge Inspections Using Unmanned Aircraft Systems (UAS)	Barritt Lovelace, Collins Engineers, Inc.	Jennifer Wells	9/30/18	$99,980
2018-27	Retightening the Large Anchor Bolts of Support Structures for Signs and Luminaires	An Chen, Iowa State University	Jihshya Lin	8/31/18	$145,238
	Bridge Maintenance Painting Guidance, Training and Test Site	Jeff Johnson, Short Elliott Hendrickson, Inc.	Sarah Sondag	10/31/18	$94,738
	Bridge Construction Time and Costs	Ross Jentink, WSB & Associates, Inc.	Paul Johns	11/30/18	$95,141

cont. ➡

BRIDGES & STRUCTURES [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	Displacement Monitoring of I-35W Bridge With Current Vibration-Based System	Lauren Linderman, University of Minnesota	Benjamin Jilk	2/28/19	$141,114
	MP-17(004): Understanding and Mitigating the Dynamic Behavior of RICWS and DMS Under Wind Loading	Lauren Linderman, University of Minnesota	Jihshya Lin	3/31/19	$173,271
	INV 1035: Anchorage of Epoxy-Coated Rebar Using Chemical Adhesives	Ben Dymond, University of Minnesota Duluth	Joseph Black	4/30/19	$42,210
	INV 1035: Bridge Deck Performance	Ben Dymond, University of Minnesota Duluth	Nickolas Haltvick	4/30/19	$34,400
	INV 1035: Debonded Prestressed Strand in Prestressed Beams	Cathy French, University of Minnesota	Brian Homan	7/31/19	$35,000
	INV 1009: Field Investigation of Bridge Deck Reinforced With GFRP Rebar	Behrouz Shafei, Iowa State University	Paul Rowekamp	8/31/19	$88,000
	INV 976: Development and Integration of Advanced Timber Bridge Inspection Techniques for NBIS—Purchase Equipment and Train Users	Victor Krause, University of Minnesota Duluth	David Conkel, Peter Wilson	1/20/20	$42,794
	10-Year Review of Monitoring System on I-35W St. Anthony Falls Bridge	Lauren Linderman, University of Minnesota	Benjamin Jilk	1/31/20	$70,355
	INV 983: Cost-Competitive Timber Bridge Designs for Long-Term Performance	Don Fosnacht, University of Minnesota Duluth	David Conkel	8/31/20	$212,883
	MP-18(004): Assessment of Bridge Decks With Glass Fiber Reinforced Polymer (GFRP) Reinforcement	Behrouz Shafei, Iowa State University	Paul Kettleson	5/31/21	$100,104

TENTATIVELY FUNDED FOR FY2020: Retightening the Large Anchor Bolts of Support Structures for Signs and Luminaires: Phase II; Steel Reinforcement Section Loss Guidance Tables

Bridges & Structures Pooled Fund Studies and AASHTO Projects

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(174)	Construction of Crack-Free Bridge Decks—Phase II	Paul Kivisto	KS	14	$995,000	$0	$75,000	2011
TPF-5(328)	Strain-Based Fatigue Crack Monitoring of Steel Bridges Using Wireless Elastomeric Skin Sensors	Joe Fishbein	KS	5	$490,000	$25,000	$75,000	2018
TPF-5(336)	Construction of Low-Cracking High-Performance Bridge Decks	Paul Rowekamp	KS	2	$270,000	$45,000	$180,000	2019
TPF-5(356)	Structural Design Methodology for Spray Applied Liners in Gravity Stormwater (SAPL)	Paul Rowekamp	OH	8	$500,000	$25,000	$75,000	2019
TPF-5(381)	Evaluation of Lateral Pile Resistance Near MSE Walls	Nick Haltvick	UT	6	$220,000	$20,000	$40,000	2019
TPF-5(387)	Development of an Integrated Unmanned Aerial Systems (UAS) Validation Center	Kevin Western	IN	8	$600,000	$25,000	$75,000	2020

cont. ➡

ENVIRONMENTAL

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-17, 2017-17G	INV 979: Slope Stabilization Guide for Minnesota Local Government Engineers	David Saftner, University of Minnesota Duluth	Blake Nelson	8/31/17	$78,124
2017-32	MPR-5(003): Tailgate Test Kit for Determining Appropriate Sediment Reducing Chemicals and Dose Rates	Joel Toso, Wenck Associates, Inc.	Dwayne Stenlund	7/31/17	$53,313
2017-44	MPR-4(035): Culvert Length and Interior Lighting Impacts to Topeka Shiner Passage	Jessica Kozarek, University of Minnesota	Scott Morgan	11/30/17	$154,854
2017-50	INV 965: Study of Deicing Salt Accumulation and Transport Through a Watershed	William Herb, University of Minnesota	Wayne Sandberg	12/31/17	$164,043
2018-13	Use of Mussel Spat Rope for Fish Passage in Culverts	Jessica Kozarek, University of Minnesota	Petronella DeWall	3/31/18	$135,625
TRS 1801	Infiltration Basins: Standards and Procedures to Ensure Performance	Patrick Casey, CTC & Associates, LLC	Dwayne Stenlund	7/31/18	$9,998
	INV 1003: NPDES Stormwater Post-Construction Design Guidebook	Randy Neprash, Stantec Consulting, Inc.	Michael Flaagan	1/31/18	$89,745
	MP-17(008): MnDOT BMPs for Potentially Acid-Generating (PAG) Rock	Dean Peterson, University of Minnesota Duluth	Jason Richter	8/31/18	$10,000
	INV 1006: Regional Optimization of Roadside Turfgrass Seed Mixtures	Eric Watkins, University of Minnesota	Dwayne Stenlund	1/31/19	$142,346
	INV 1007, MP-16(005): Minnesota Culvert Manual to Accommodate Aquatic Species Passage	Matt Hernick, University of Minnesota	Petronella DeWall	2/28/19	$164,353
	Assessment of Field Infiltration Performance of Swales in Comparison to Minnesota Swales Calculator Estimates	Joel Toso, Wenck Associates, Inc.	Nicklas Tiedeken	2/28/19	$99,897
	Sediment Control Log (SCL) Performance, Design and Decision Matrix for Field Applications	Bruce Wilson, University of Minnesota	Dwayne Stenlund	3/31/19	$101,814
	Concrete Grinding Residue: Its Effect on Roadside Vegetation and Soil Properties	Halil Ceylan, Iowa State University	David Hanson	4/30/19	$154,996
	INV 984: Expanding the Success of Salt-Tolerant Roadside Turfgrasses Through Innovation and Education	Eric Watkins, University of Minnesota	Dwayne Stenlund	6/30/19	$168,974
	INV 1017: Iron-Enhanced Swale Ditch Checks for Phosphorus Removal	John Gulliver, University of Minnesota	Barbara Loida	8/31/19	$200,036
	INV 1016: Permeable Pavement for Road Salt Reduction	John Gulliver, University of Minnesota	Richard McCoy	8/31/19	$197,835
	Monitoring and Habitat Assessment of Declining Bumble Bees in Twin Cities Metro Roadsides	Daniel Cariveau, University of Minnesota	Christopher Smith	8/31/19	$111,264
	MP-17(008): MnDOT BMPs for Potentially Acid-Generating (PAG) Rock	Ward Swanson, Barr Engineering Company	Jason Richter	10/31/19	$138,949
	TPF-5(346): Regional Roadside Turfgrass Performance Testing Program	Eric Watkins, University of Minnesota	Dwayne Stenlund	10/31/19	$200,000
	MP-17(005): Development and Regionalization of In Situ Bioslopes and Bioswales	David Saftner, University of Minnesota Duluth	Dwayne Stenlund	10/31/19	$199,955
	TPF-5(362): Improvements to the Infrastructure Carbon Estimator (ICE)	Jeffery Ang-Olson, ICF Incorporated, LLC	Timothy Sexton	1/31/20	$310,033
	MPR-5(006): Monitoring Iron-Enhanced Stormwater Infiltration Basin in the Real World	Omid Mohseni, Barr Engineering Company	Barbara Loida	8/31/20	$65,001
	INV 1027: Characterization of Runoff Quality from Paved Low-Volume Roads and Optimization of Treatment Methods	John Gulliver, University of Minnesota	John Welle	11/30/20	$192,527
	INV 1039: Design and Construction of Infiltration Facilities	John Gulliver, University of Minnesota	Dwayne Stenlund	8/31/21	$238,572

cont. ➡

ENVIRONMENTAL [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	INV 1038: Regional Optimization of Roadside Turfgrass Seed Mixtures—Phase II: Regional Field Trials and Economic Analysis	Eric Watkins, University of Minnesota	Dwayne Stenlund	8/31/22	$467,139

TENTATIVELY FUNDED FOR FY2020: Environmental Field Evaluation of Potassium Acetate; Highway Renewable Energy: Harnessing the Sun's Energy Through Noise Barriers and Structural Snow Fencing; Wet Pond Maintenance for Phosphorus Retention

Environmental Pooled Fund Studies

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(346)	Regional Roadside Turfgrass Performance Testing Program	Dwayne Stenlund	MN	6	$260,000	$20,000	$40,000	2019
TPF-5(362)	Improvements to the Infrastructure Carbon Estimator (ICE)	Timothy Sexton	MN	6	$380,000	$10,000	$30,000	2019
TPF-5(352)	Recycled Materials Resource Center—4th Generation (RMRC-4G)	Brian Kamnikar	WI	9	$1,335,000	$40,000	$200,000	2020
TPF-5(358)	Wildlife Collision Reduction and Habitat Connectivity	Chris Smith	NV	10	$945,000	$20,000	$10,000	2021

MAINTENANCE OPERATIONS

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-25, 2017-25A	MPR-4(023): Asphalt Patching Methods Best Practices Guide—How-to Cards	Manik Barman, University of Minnesota Duluth	Susan Lodahl, Perry Collins	8/31/17	$87,106
2017-31	INV 952: Best Management Practices for Establishment of Salt-Tolerant Grasses on Roadsides	Eric Watkins, University of Minnesota	Dwayne Stenlund	9/30/17	$193,677
2017-41	MPR-5(005): Installing Snowplow Cameras and Integrating Images Into MnDOT's Traveler Information System	Patrick Casey, CTC & Associates, LLC	Joseph Huneke	10/31/17	$28,888
2017-42	MPR-5(008): Expanding the Adoption on Private Lands: Blowing and Drifting Snow Control Treatments and the Cost-Effectiveness of Permanent Versus Nonpermanent Treatment Options	Dean Current, University of Minnesota	Daniel Gullickson	10/31/17	$99,988
2017-45, 2017-45B	Appendices to Salt Brine Blending to Optimize Deicing and Anti-Icing Performance and Cost-Effectiveness—Phase III	Stephen Druschel, Minnesota State University, Mankato	Thomas Peters	12/31/17	$168,700
2017RIC01	INV 645: Fleet Management Tools for Local Agencies	Michael Marti, SRF Consulting Group, Inc.	Guy Kohlnhofer	7/31/19	$26,437
2018-01	MPR-5(007): Development of a Road Condition Recovery Time Estimation System for Winter Snow Events	Eil Kwon, University of Minnesota Duluth	John Bieniek	12/31/17	$106,500
2018-14	INV 980: Pothole Prevention and Innovative Repair	Mihai Marasteanu, University of Minnesota	Todd Howard	5/31/18	$129,914
2018-18	INV 974: Nontraditional Fog Seals for Asphalt Pavement: Performance on Shoulder Sections in Minnesota	Eddie Johnson, MnDOT Office of Materials and Road Research	Bruce Hasbargen	6/30/18	$20,000
TRS 1706	INV 1018: Field Usage of Alternative Deicers for Snow and Ice Control	Laura Fay, Montana State University, Western Transportation Institute	Ryan Peterson	11/30/17	$69,285
	TPF-5(218): Clear Roads: Quantifying the Impact That New Capital Projects Will Have on Roadway Snow and Ice Control (RSIC) Operations RFP	James Sullivan, University of Vermont	Thomas Peters	11/30/17	$145,622

cont. ➡

MAINTENANCE OPERATIONS [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	TPF-5(218): Clear Roads: Identification and Recommendations for Correction of Equipment Factors Causing Fatigue in Snowplow Operators RFP	Frank Fitzgerald, Virginia Polytechnic Institute and State University	Thomas Peters	12/31/17	$200,000
	TPF-5(218): Understanding the Chemical and Mechanical Performance of Snow and Ice Control Agents on Porous Permeable Pavements	Michelle Akin, Montana State University, Western Transportation Institute	Thomas Peters	1/27/18	$185,000
	TPF-5(218): Clear Roads: Emergency Operations Methodology for Extreme Winter Storm Events	James Sullivan, University of Vermont	Thomas Peters	6/30/18	$59,030
	TPF-5(218): Clear Roads: Training Video for the Implementation of Liquid-Only Plow Routes	Chad Seaman, Stonebrook Engineering, Inc.	Thomas Peters	6/30/18	$69,285
	TPF-5(218): Clear Roads: Administration and Information Services	Patrick Casey, CTC & Associates, LLC	Thomas Peters	7/7/18	$69,285
	TPF-5(218): Clear Roads: Utilization of AVL/GPS Technology: Case Studies	Ming Shiun Lee, AECOM Technical Services, Inc.	Thomas Peters	9/30/18	$69,285
	TPF-5(218): Clear Roads: Synthesis of Material Application Methodologies for Winter Operations RFP	Xianming Shi, Washington State University	Thomas Peters	9/30/18	$69,285
	TPF-5(218): Clear Roads: Develop a Training Video and Manual for Best Practices and Techniques in Clearing Different Interchange Configurations and Other Geometric Layouts	Yan Qi, Southern Illinois University, Edwardsville	Thomas Peters	10/31/18	$69,285
	INV 645: Personal Protection Equipment Poster and Website	Mindy Carlson, University of Minnesota Center for Transportation Studies	John Brunkhorst	12/31/18	$69,285
	TPF-5(353): Clear Roads: Standard Specifications for Plow Blades With Carbide Inserts—Phase II	Erik Minge, SRF Consulting Group, Inc.	Thomas Peters	1/31/19	$69,285
	INV 1015: Optimized Taconite-Based Pavement Repair Compound and Deployment System	Lawrence Zanko, University of Minnesota Duluth	Perry Collins	2/28/19	$69,285
	TPF-5(353): Clear Roads: AWSSI Enhancements in Support of Winter Road Maintenance—Phase II	Michael Timlin, Midwestern Regional Climate Center, University of Illinois	Thomas Peters	2/28/19	$69,285
	Truck Station Location Optimization	William Holik, Texas A&M Transportation Institute	Christopher Moates	2/28/19	$69,285
	TPF-5(218): Clear Roads: Standards and Guidance for Using Mobile Sensor Technology to Assess Winter Road Conditions	Erik Minge, SRF Consulting Group, Inc.	Thomas Peters	4/30/19	$69,285
	TPF-5(218), TPF5(218), 1001484: Developing Test Bed Software to Qualify Plug-and-Play Technology	Parsons Transportation Group, Inc.	Thomas Peters, Clark Moe	6/30/19	$69,285
	INV 1029: Cost–Benefit Analysis of the Effectiveness of Crack Sealing Techniques	Manik Barman, University of Minnesota Duluth	Daniel Knapek	7/31/19	$69,285
	Investigating Wastewater Reuse at Safety Rest Areas and Truck Stations	Sara Heger, University of Minnesota	Neile Reider	8/31/19	$69,285
	TPF-5(353): Clear Roads: Aftermarket Cameras in Winter Maintenance Vehicles—Phase II	Erik Minge, SRF Consulting Group, Inc.	Thomas Peters	10/31/19	$69,285
	TPF-5(218): Clear Roads Weather Event Reconstruction and Analysis Tool	Chris Albrecht, The Narwhal Group	Thomas Peters	12/31/19	$69,285
	INV 1047: Techno-Economic Analysis of Implementing Hybrid Electric Utility Vehicles in Municipal Fleets	Will Northrop, University of Minnesota	Kevin Schlangen	2/29/20	$69,285
	INV 1034: Adaptive Management to Improve Deicing Operations	Larry Baker, University of Minnesota	Ross Bintner	7/31/20	$69,285
	MP-18(010): Reducing Winter Maintenance Equipment Fuel Consumption Using Advanced Vehicle Data Analytics	Will Northrop, University of Minnesota	Joseph Huneke	1/31/21	$69,285

TENTATIVELY FUNDED FOR FY2020: Hot Shots for Cold Climes—Evaluating Treatment of the Hardest Icy Spots; Implementation of Lane Boundary Guidance System for Snowplow Operations

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Maintenance Operations Pooled Fund Studies and AASHTO Projects

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(353)	Clear Roads II	Thomas Peters	MN	36	$2,975,000	$75,000	$375,000	2021
TPF-5(290)	Aurora	Joe Huneke	IA	18	$1,975,000	$25,000	$125,000	2019
TPF-5(347)	Development of Maintenance Decision Support System	Joe Huneke	SD	13	$1,150,149	$25,000	$100,000	2019

MATERIALS & CONSTRUCTION

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-21	INV 935: Design Considerations for Embankment Protection During Road Overtopping Events	Jeff Marr, University of Minnesota	John Anderson	8/31/17	$194,787
2017-24	MPR-5(004): MnDOT Thin Whitetopping Selection Procedures	Peter Taylor, Iowa State University	Timothy Andersen	8/31/17	$60,000
2017-27	MPR-4(011): Impact of Low Asphalt Binder for Coarse HMA Mixes	Eshan Dave, University of Minnesota Duluth	Gerard Geib	7/31/17	$89,910
2017-35	INV 975: Prevention of Stripping Under Chip Seals	Dave Rettner, American Engineering Testing, Inc.	Klayton Eckles, Tony Kutzke	10/31/17	$18,942
2017-46	Comparing Properties of Water-Absorbing/Filtering Media for Bioslope/Bioswale Design	Kurt Johnson, University of Minnesota Duluth	Dwayne Stenlund	2/28/18	$178,051
2017RIC02	INV 645: Base Stabilization Guidance and Additive Selection for Pavement Design and Rehabilitation	Michael Marti, SRF Consulting Group, Inc.	Benjamin Worel	7/31/19	$29,476
2018-02	A Mechanistic Design Approach for Graphite Nanoplatelet (GNP) Reinforced Asphalt Mixtures for Low-Temperature Applications	Jia-Liang Le, University of Minnesota	Shongtao Dai	2/28/18	$125,963
2018-05	INV 989: Storm-Induced Slope Failure Susceptibility Mapping	Omid Mohseni, Barr Engineering Company	Blake Nelson	1/31/18	$85,000
2018-06	Designing Base and Subbase to Resist Environmental Effects on Pavements	Matthew Oman, Braun Intertec Corporation	Steven Henrichs	1/31/18	$66,504
2018-17	MnPAVE-Rigid 2.0	Derek Tompkins, American Engineering Testing, Inc.	Timothy Andersen	7/31/18	$24,000
2018-19, 2018-20	Mechanical Response of a Composite Steel, Concrete-Filled Pile	Joseph Labuz, University of Minnesota	Derrick Dasenbrock	6/30/18	$198,000
2018-22	Balanced Design of Asphalt Mixtures	Dave Newcomb, Texas A&M Transportation Institute	David Van Deusen	6/30/18	$140,000
2018-23	MP-17(002): Remaining Service Life Asset Measure—Phase I	Mihai Marasteanu, University of Minnesota	Glenn Engstrom	8/31/18	$61,379
2018-29	INV 1013, MP-16(007): Comparison of Performances of Structural Fibers and Development of a Specification for Using Them in Thin Concrete Overlays	Manik Barman, University of Minnesota Duluth	Maria Masten	8/31/18	$153,792
2018-30	Performance Specification for Geogrid-Reinforced Aggregate Base	John Siekmeier, MnDOT Office of Materials and Road Research	Bruce Tanquist	9/30/18	$40,000
2018-32	Cone Penetration Testing (CPT) Design Manual for State Geotechnical Engineers	David Saftner, University of Minnesota Duluth	Derrick Dasenbrock	12/31/18	$100,000
2018-33	INV 981: Evaluation of Stabilized Full Depth Reclamation (SFDR)	Charles Jahren, Iowa State University	Guy Kohlnhofer	1/31/19	$126,991

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MATERIALS & CONSTRUCTION [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
TRS 1804	Ultra-Thin Bonded Wearing Course (UTBWC) Snow, Ice and Wind Effects	Daniel Wegman, Braun Intertec Corporation	Cody Brand	7/31/18	$55,212
	MPR-2(013): Veda Enhancements	George Chang, Transtec Group, Inc.	Rebecca Embacher	7/31/17	$150,924
	MnPAVE-Rigid 2.0	Lev Khazanovich, University of Minnesota	Timothy Andersen	8/31/17	$78,000
	INV 985: Life-Cycle Cost Analysis Tool for Minnesota Pavements	Derek Tompkins, University of Minnesota	John Brunkhorst	2/28/18	$54,682
	INV 885: Research Test Section Tracking—Phase II	Jeffrey Brunner, MnDOT Office of Materials and Road Research	Luane Tasa	6/30/18	$55,000
	Geogrid Specification for Aggregate Base Reinforcement	David Potyondy, Itasca Consulting Group, Inc.	John Siekmeier	6/30/18	$75,000
	TPF-5(341): PCC Sampling/Testing	Derek Tompkins, American Engineering Testing, Inc.	Benjamin Worel	7/18/18	$61,514
	INV 1028: Is Seal Coating Counterproductive or Not?	Brian Arman, American Engineering Testing, Inc.	Steven Bot	8/31/18	$14,923
	TPF-5(269): Development of an Improved Design Procedure for Unbonded Concrete Overlays	Lev Khazanovich, University of Pittsburgh	Thomas Burnham	10/31/18	$118,318
	Disk-Shaped Compact Tension (DCT) Specifications Development for Asphalt Pavement	Andrea Schokker, University of Minnesota Duluth	Shongtao Dai	11/30/18	$172,728
	INV 981: Evaluation of Stabilized Full Depth Reclamation (SFDR)	Charles Jahren, Iowa State University	Guy Kohlnhofer	1/31/19	$126,991
	Investigation of Cracking Resistance of Asphalt Mixtures and Binders	Mihai Marasteanu, University of Minnesota	David Van Deusen	2/28/19	$149,762
	INV 971: Optimal RAP Content for Minnesota Gravel Roads	Charles Jahren, Iowa State University	Joel Ulring	2/28/19	$92,538
	TPF-5(334): Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation—Phase I	George Chang, Transtec Group, Inc.	Rebecca Embacher	2/28/19	$451,190
	TPF-5(341): Short-Term Research	Renae Kuehl, SRF Consulting Group, Inc.	Benjamin Worel	6/30/19	$97,355
	INV 645: Workshop and Materials: Current Practices for Lightly Surfaced Roadway	Michael Marti, SRF Consulting Group, Inc.	Michael Flaagan	7/31/19	$25,029
	INV 645: Gravel Road Management Tools	Michael Marti, SRF Consulting Group, Inc.	Michael Flaagan	7/31/19	$18,021
	Pavement Thickness Evaluation Using 3-D Ground Penetrating Radar	Lev Khazanovich, University of Pittsburgh	Shongtao Dai	8/31/19	$113,852
	INV 1023: Experimental and Computational Investigations of High-Density Asphalt Mixtures	Mihai Marasteanu, University of Minnesota	Eddie Johnson	8/31/19	$150,935
	INV 1045: Life-Cycle Civil Integrated Management (CIM)	Chris Trboyevich, SRF Consulting Group, Inc.	Lyndon Robjent	10/31/19	$98,901
	MP-17(009): Implementation of Recycled Unbound Base Material Properties for MnPAVE	Derek Tompkins, American Engineering Testing, Inc.	David Van Deusen	10/31/19	$74,999
	INV 1028: Is Seal Coating Counterproductive or Not? (Evaluation of Stripping Under Chip Seals—Phase II)	Zhanping You, Michigan Technological University	Steven Bot	12/31/19	$140,508
	INV 1040: Development of Pavement Condition Forecasting for Web-Based Asset Management for County Governments	Bradley Wentz, North Dakota State University	Bruce Hasbargen	4/30/20	$92,831
	INV 986: Performance Monitoring of Olmsted CR 117/104 and Aggregate Base Material Update	Kyle Hoegh, MnDOT Office of Materials and Road Research	Kaye Bieniek	6/30/20	$44,000

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MATERIALS & CONSTRUCTION [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	TPF-5(341): Cold Central Plant Recycling (CCPR)—National Road Research Alliance (NRRA)	Dave Rettner, American Engineering Testing, Inc.	David Van Deusen	8/31/20	$99,997
	INV 1046: Innovative Materials and Advanced Technologies for a Sustainable Pavement Infrastructure	Jia-Liang Le, University of Minnesota	Juan Pinero	8/31/20	$151,514
	TPF-5(341): Determining Pavement Design Criteria for Recycled Aggregate Base and Large Stone Subbase	Bora Cetin, University of Iowa	John Siekmeier	10/31/20	$225,000
	TPF-5(341): Performance Benefits of Fiber-Reinforced Thin Concrete Pavement and Overlays	Manik Barman, University of Minnesota Duluth	Thomas Burnham	12/31/20	$149,999
	TPF-5(341): Evaluation of Long-Term Impacts of Early Opening of Concrete Pavements	Lev Khazanovich, University of Pittsburgh	Bernard Izevbekhai	1/31/21	$149,999
	TPF-5(341): Reduced Cementitious Material in Optimized Concrete Mixtures	Peter Taylor, Iowa State University	Bernard Izevbekhai	2/28/21	$147,627
	TPF-5(341): Effective Long-Lasting Partial Depth Joint Repairs for Challenging Conditions	Justin Lashley, Braun Intertec Corporation	Gerard Geib	4/30/21	$74,978
	TPF-5(341): Developing Best Practices for Rehabilitation of Concrete With Hot-Mix Asphalt (HMA) Overlays Related to Density and Reflective Cracking—National Road Research Alliance (NRRA)	Eshan Dave, University of New Hampshire	Shongtao Dai	4/30/21	$169,970
	Cold In-Place Recycling (CIR) for Bituminous Over Concrete (BOC)	Dave Rettner, American Engineering Testing, Inc.	Terrence Beaudry	8/31/21	$39,995

TENTATIVELY FUNDED FOR FY2020: Assessment of Pavement Segments That Have Remained in Poor Condition for 5+ Years; Best Practices for Preventing Settling/Heaving at Catch Basins/Manholes; Construction Inspection Training/Documentation; Establishing Fresh Properties of Fiber-Reinforced Concrete for Performance Engineered Mixture (PEM); Remaining Service Life Asset Measure, Phase II; Development of Superpave 5 Asphalt Mix Designs for Minnesota Pavements

Materials & Construction Pooled Fund Studies

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(269)	Development of an Improved Design Procedure for Unbonded Concrete Overlays	Thomas Burnham	MN	8	$460,000	$20,000	$60,000	2018
TPF-5(375)	MnROAD/NCAT Joint Study—National Partnership to Determine the Life-Extending Benefit Curves of Pavement Preservation	Benjamin Worel	MN	13	$2,100,000	$50,000	$500,000	2022
TPF-5(297)	Improving Specifications to Resist Frost Damage in Modern Concrete Mixtures	Maria Masten	OK	13	$1,237,500	$17,500	$105,000	2019
TPF-5(313)	Technology Transfer Concrete Consortium (TTCC)	Maria Masten	IA	29	$1,664,000	$12,000	$60,000	2019
TPF-5(334)	Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation	Rebecca Embacher	MN	15	$1,001,500	$50,000	$150,000	2019
TPF-5(341)	National Road Research Alliance (NRRA) (Pooled fund portion; for associate portion, see 2017-010)	Benjamin Worel	MN	6	$2,600,000	$150,000	$450,000	2019
TPF-5(368)	Performance Engineered Concrete Paving Mixtures	Maria Masten	IA	17	$2,020,000	$15,000	$75,000	2022

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Materials & Construction Pooled Fund Studies [cont.]

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(374)	Accelerated Performance Testing on the 2018 NCAT Pavement Test Track With MnROAD Research Partnership	Benjamin Worel	AL	15	$9,650,000	$100,000	$300,000	2020

MULTIMODAL

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-23	INV 964: Traffic Impacts of Bicycle Facilities	Greg Lindsey, University of Minnesota Humphrey School of Public Affairs	James Rosenow	7/31/17	$138,914
2017-26	INV 645: Oversize/Overweight Vehicle Unified Permitting Process—Phase I	Michael Marti, SRF Consulting Group, Inc.	Rich Sanders	8/31/17	$50,176
2017-29	Exploring the Walking Tolerance of Transitway Users	Jason Cao, University of Minnesota	Gina Mitteco	9/30/17	$93,124
2018-15	Measure of Truck Delay and Reliability at the Corridor Level	Chen-Fu Liao, University of Minnesota	Andrew Andrusko	8/31/18	$87,760
TRS 1704	Online Systems for Oversize and Overweight Freight Permitting and Motor Carrier Credentialing	Patrick Casey, CTC & Associates LLC	Shelly Meyer	11/30/17	$14,450
	INV 645: HCV Unified Permitting Process—Phase II	Annette Theroux, Pro-West & Associates, Inc.	Rich Sanders	8/31/17	$17,548
	TPF-5(315): National Accessibility Lab Pool Fund Project	Andrew Owen, University of Minnesota	Deanna Belden	11/30/18	$1,198,500
	Understanding Pedestrian Travel Behavior and Safety in Rural Settings	Greg Lindsey, University of Minnesota	Michael Petesch	12/31/18	$150,000
	Accessibility and Behavior Impacts of Bus-Highway System Interactions	Andrew Owen, University of Minnesota	Jim Henricksen	2/28/19	$152,458
	INV 645: FY2018 ADA Workshops for Local Agencies	Stephanie Malinoff, University of Minnesota Center for Transportation Studies	Kristine Elwood	2/28/19	$125,000
	After Study of the Bus Rapid Transit (BRT) A Line Impacts	Alireza Khani, University of Minnesota	Carl Jensen	2/28/19	$105,687
	MP-17(003): Evaluation of Sustained Enforcement, Education and Engineering Measures on Pedestrian Crossings	Nichole Morris, University of Minnesota	Melissa Barnes	8/31/19	$177,226
	Measuring the Economic Benefits of Rural and Small Urban Transit Service in Greater Minnesota	Jeremy Mattson, Iowa State University	Sara Dunlap	6/30/20	$120,534

TENTATIVELY FUNDED FOR FY2020: Best Management Practices of Bicycle Pedestrian Facilities; Pedestrian Crosswalk Policy; Understanding Pedestrian Travel Behavior and Safety in Rural Settings

Multimodal Pooled Fund Studies

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(315)	National Accessibility Evaluation	Deanna Belden	MN	14	$1,905,000	$40,000	$225,000	2019
TPF-5(293)	Mid-American Freight Coalition—Phase II	Andrew Andrusco	WI	10	$1,075,000	$25,000	$162,000	2019

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POLICY & PLANNING

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-34	Enhanced Capabilities of BullReporter and BullConverter	Taek Kwon, University of Minnesota Duluth	Benjamin Timerson	2/28/18	$42,351
2017-37	Refining Return on Investment Methodology/Tool for MnPASS	Laura Fay, Montana State University, Western Transportation Institute	Bradley Larsen, John Wilson	8/31/17	$147,675
2017-39	INV 963: Stakeholder Attitudes, Knowledge and Engagement in Local Road Systems Planning and Decision-Making	Guillermo Narvaez, University of Minnesota	Bruce Hasbargen	9/30/17	$139,793
2018-03	Weigh-in-Motion Sensor and Controller Operation and Performance Comparison	Diwakar Gupta, University of Minnesota	Benjamin Timerson	2/28/18	$80,000
2018-04	INV 1014: Transportation Investment and Job Creation in Minnesota Counties	Zhirong Jerry Zhao, University of Minnesota	Bruce Hasbargen	3/31/18	$110,350
2018-08	INV 1008: Effective Social Media Engagement Options for Minnesota's Diversifying Population	Ingrid Schneider, University of Minnesota	Renee Raduenz	4/30/18	$163,783
2018-10	Evaluation of Low-Cost, Centimeter-Level Accuracy OEM GNSS Receivers	Demoz Gebre-Egziabher, University of Minnesota	Nathan Anderson	2/28/18	$90,000
2018-31	INV 1031: Investigating Inductive Loop Signature Technology for Statewide Vehicle Classification Counts	Chen-Fu Liao, University of Minnesota	Gene Hicks	2/28/19	$92,820
TRS 1708	Cost Participation Policy for Detours	Patrick Casey, CTC & Associates LLC	Timothy Andersen	12/31/17	$9,984
TRS 1803	Low-Cost Aerial and Spatial Data	Annette Theroux, Pro-West & Associates, Inc.	Benjamin Timerson	3/31/18	$21,412
TRS 1806	INV 1058: Local Agency Fee Policies for Oversize/Overweight Vehicles	Patrick Casey, CTC & Associates LLC	Rich Sanders	1/31/19	$9,896
	One-Year Pilot Test and Evaluation of ASTM DOT Package Compass Portal	Dean Deeter, Athey Creek Consultants, LLC	Marilee Tuite	1/31/18	$21,883
	MnDOT Slope Vulnerability Assessments	Peter Muehlbach, WSB & Associates, Inc.	Andrew Shinnefield	2/28/19	$148,309
	INV 1020: LRRB Strategic Plan Update	Donald Ludlow, CPCS Transcom, Inc.	Lyndon Robjent	7/31/19	$88,821
	INV 645: Consolidated Asset Management Guide for Local Agencies	Michael Marti, SRF Consulting Group, Inc.	Lyndon Robjent	7/31/19	$18,188
	INV 645: Training Workshop: Americans With Disabilities Act (ADA) for Local Agencies	Michael Marti, SRF Consulting Group, Inc.	Ted Schoenecker	7/31/19	$36,289
	INV 1043: Evaluating the Impact of Local Expenditures on State and Regional Transportation Facilities	Zhirong Jerry Zhao, University of Minnesota	Russ Matthys	8/31/20	$121,668

TENTATIVELY FUNDED FOR FY2020: GIS Tools and Apps—Integration with Asset Management; Managing Utility Congestion Within the Right of Way

Policy & Planning Pooled Fund Studies

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(198)	Urban Mobility Study—2009 Continuation	Paul Czech	TX	16	$2,905,000	$25,000	$430,000	2019
TPF-5(326)	Develop and Support Transportation Performance Management (TPM) Capacity Development Needs for State DOTs	Deanna Belden	RI	37	$2,186,000	$10,000	$195,000	2019

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Policy & Planning Pooled Fund Studies [cont.]

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(384)	Exploring Nontraditional Methods to Obtain Vehicle Volume and Class Data	Gene Hicks	FHWA	15	$1,225,000	$25,000	$75,000	2020

TRAFFIC & SAFETY

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-14	INV 1010: Strategies for Effective Roundabout Approach Speed Reduction	Susan Chrysler, Texas A&M Transportation Institute	Joe Gustafson	7/31/17	$74,989
2017-19	INV 978: In-Vehicle Work Zone Messages	Nichole Morris, University of Minnesota	Kenneth Johnson	8/31/17	$105,167
2017-22	MPR-4(030): Safety Impacts of the I-35W Improvements Done Under Minnesota's Urban Partnership Agreement (UPA) Project	Gary Davis, University of Minnesota	Brian Kary	8/31/17	$105,000
2017-30	INV 962: Evaluation of Safety and Mobility of Two-Lane Roundabouts	John Hourdos, University of Minnesota	Joe Gustafson	8/31/17	$124,920
2017-38, 2017-38S	MPR-4(031): Evaluation of Major Street Speeds for Minnesota Intersection Collision Warning Systems	Shauna Hallmark, Iowa State University	Cory Johnson, Michael Kronzer	6/30/18	$278,516
2017-43	INV 972: Minnesota Local Agency Pavement Marking: Mining Existing Data	Omar Smadi, Iowa State University	Kate Miner	10/31/17	$65,000
2017-49	MPR-5(019): Using Mobile Device Samples to Estimate Traffic Volumes	Shawn Turner, Texas A&M Transportation Institute	Gene Hicks	3/31/18	$113,346
2017RIC05	INV 645: Addressing Citizen Requests for Traffic Safety Concerns	Michael Marti, SRF Consulting Group, Inc.	Steven Bot	7/31/19	$25,157
2018-09	INV 1011, MP-16(006): Work Zone Intrusion Report Interface Design	Nichole Morris, University of Minnesota	Todd Haglin	4/30/18	$200,638
2018-11	MPR-5(009): A Tool for Designing MnPASS Access Spacing	John Hourdos, University of Minnesota	Brian Kary	3/31/18	$80,000
2018-12	INV 1005, MP-16(004): In-Vehicle Dynamic Curve-Speed Warnings at High-Risk Rural Curves	Brian Davis, University of Minnesota	Bradley Estochen	4/30/18	$161,803
2018-21	INV 1012: Investigating the Necessity and Prioritizing Pavement Markings on Low-Volume Roads	David Veneziano, Iowa State University	Bruce Hasbargen	6/30/18	$71,475
2018-28	Development of Travel Time Reliability Measurement System	Eil Kwon, University of Minnesota Duluth	Brian Kary	11/30/18	$176,000
2018-34	INV 1004: Development and Demonstration of a Cost-Effective In-Vehicle Lane Departure and Advanced Curve Speed Warning System	Imran Hayee, University of Minnesota Duluth	Victor Lund	2/28/19	$124,704
TRS 1707	Sign Life-Cycle Policies and Practices	Patrick Casey, CTC & Associates, LLC	Josephine Tayse	12/31/17	$9,905
TRS 1802, TRS 1802S	INV 1036: High Friction Surface Treatments Supplement	Patrick Casey, CTC & Associates, LLC	Tracey Von Bargen	8/31/18	$9,988
	INV 1043: Evaluating the Impact of Local Expenditures on State and Regional Transportation Facilities	Zhirong Jerry Zhao, University of Minnesota	Russ Matthys	8/31/20	$121,668
	TPF-5(190), TPF-5(190) 98044, TPF-5(190) 00712, T: North/West Passage Project 10.4 Freight Task Force—Year 2	Donald Ludlow, CPCS Transcom, Inc.	Cory Johnson	7/31/17	$59,866

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TRAFFIC & SAFETY [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	TPF-5(190), TPF-5(190) 98044, TPF-5(190) 93139, T: North/West Passage—Phase III, Project 10.6: Multistate Assessment of Interstate Speed Limit Impacts	Jason Bittner, Applied Research Associates, Inc.	Cory Johnson	7/31/17	$47,982
	TPF-5(190), TPF-5(190) 93139, TPF-5(190) 98044, T: Program Support Services and Technical Writing for the North/West Passage Pooled Fund Research Program—Work Plan 11	Dean Deeter, Athey Creek Consultants, LLC	Cory Johnson	8/31/17	$99,984
	Rest Area Electronic Customer Feedback System	Robert Williams	Robert Williams	6/11/18	$33,072
	Minnesota Autonomous Bus Pilot	Kian Sabeti, WSB & Associates, Inc.	Michael Kronzer	6/30/18	$574,996
	INV 924: Ineffective Specialty Signs Video for Local Agencies	Bryan Nemeth, Bolton & Menk, Inc., Consulting Engineers & Surveyors	Gary Reihl	8/31/18	$28,569
	TPF-5(190): Program Support Services and Technical Writing for the North/West Passage Pooled Fund Research Program—Work Plan 12	Dean Deeter, Athey Creek Consultants, LLC	Cory Johnson	9/30/18	$99,701
	MPR-5(013): Evaluation of the Smart Work Zone Speed Notification System	John Hourdos, University of Minnesota	Brian Kary	1/31/19	$229,576
	Assessing the Impact of Pedestrian-Activated Crossing Systems	John Hourdos, University of Minnesota	Melissa Barnes	1/31/19	$153,962
	TPF-5(190), TPF-5(190) 00712, TPF-5(190) 98689, T: North/West Passage Project 12.2: Freight Task Force—Year 3	Donald Ludlow, CPCS Transcom, Inc.	Cory Johnson	2/28/19	$49,908
	INV 1033: Cloud-Based Dynamic Warning System	Bradley Wentz, North Dakota State University	Richard West	2/28/19	$79,629
	Traffic, Security and Real-Time Integration of Arrow Board Messages Into Traveler Information Systems	Linda Preisen, Athey Creek Consultants, LLC	Daniel Rowe	3/31/19	$44,996
	INV 1030: Examining Optimal Sight Distances at Rural Intersections	Nichole Morris, University of Minnesota	Tracey Von Bargen	3/31/19	$170,549
	MP-17(010): Evaluation of Central Traffic Signal System and Best Practices for Implementation	John Hourdos, University of Minnesota	Kevin Schwartz	4/30/19	$57,486
	INV 1022, MP-17(001): Pavement Markings—Wet Retroreflectivity Standards	Adam Pike, Texas A&M Transportation Institute	Kenneth Johnson	4/30/19	$175,062
	INV 1026: Prepare Local Agencies for Future of V2V/V2I and Connected Vehicle Technologies	Shauna Hallmark, Iowa State University	Douglas Fischer	5/31/19	$51,503
	Traffic, Security and Real-Time Integration of Arrow Board Messages Into Traveler Information Systems	Castle Rock Consultants, Inc.	Daniel Rowe	6/30/19	$130,000
	Improve Traffic Volume Estimates from Regional Transportation Management Center (RTMC)	Taek Kwon, University of Minnesota Duluth	Gene Hicks	8/31/19	$97,484
	INV 1032: Personal Warning Sensor for Road Construction Workers	Gerald Ullman, Texas A&M Transportation Institute	Milford Ulven	8/31/19	$113,693
	INV 1024: Evaluation of the Effectiveness of Stop Lines in Increasing the Safety of Stop-Controlled Intersections	John Hourdos, University of Minnesota	Nick Bauler	9/30/19	$150,330
	INV 1025: How Locals Need to Prepare for the Future of V2V/V2I Connected Vehicles	John Hourdos, University of Minnesota	Deb Heiser	11/30/19	$79,260
	TPF-5(190): North/West Passage Pooled Fund Study Website Maintenance	Bradley Wentz, North Dakota State University	Cory Johnson	1/31/20	$10,570
	Traffic Sign Life-Cycle Evaluation	Gene Hawkins, Texas A&M Transportation Institute	Josephine Tayse	10/31/20	$175,000

cont. ➡

TRAFFIC & SAFETY

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	INV 1051: Development and Demonstration of an In-Vehicle Lane Departure Warning System Using DSRC-Based V2V Communication	Imran Hayee, University of Minnesota Duluth	Victor Lund	2/28/21	$133,656

TENTATIVELY FUNDED FOR FY2020: Establishing a Repeatable Method for Presenting Nontraditional Traffic Treatments to Maximize Stakeholder Support; Evaluation of Metro Freeway System for Reliability and Resilience; Pavement Marking Patterns and Widths—Human Factors Study; Impact of Transitways on Travel on Parallel and Adjacent Roads

Traffic & Safety Pooled Fund Studies

Study Number	Title	Technical Liaison	Lead State or Agency	Number of Participating Agencies	Total Cost	MN 2018 Contribution	Total MN Contribution	Current MN Commitment End Date
TPF-5(376)	North/West Passage—Phase IV	Cory Johnson	MN	6	$460,000	$25,000	$150,000	2022
TPF-5(193)	Midwest States Pooled Fund Crash Test Program	Michael Elle	NE	22	$14,524,211	$66,000	$653,500	2019
TPF-5(316)	Traffic Control Devices Consortium	Janelle Anderson	FHWA	25	$1,490,725	$15,000	$45,000	2019
TPF-5(319)	Transportation Management Center Pooled Fund Study	John McClellan	FHWA	19	$1,970,000	$25,000	$100,000	2019
TPF-5(322)	High Occupancy Vehicle (HOV)/ Managed Use Lane (MUL)	Brian Kary	FHWA	11	$280,000	$25,000	$75,000	2019
TPF-5(340)	Axle and Length Classification Factor Analysis and Effects on Annual Average Daily Traffic	Gene Hicks	WI	13	$262,500	$12,500	$25,000	2018
TPF-5(343)	Roadside Safety Research for MASH Implementation	Mike Elle	WA	24	$2,565,000	$50,000	$200,000	2019
TPF-5(359)	ITS Pooled Fund Program (ENTERPRISE)	Cory Johnson	MI	7	$919,357	$30,000	$30,000	2021
TPF-5(377)	Enhanced Traffic Signal Performance Measures	Steve Misgen	IN	9	$750,000	$30,000	$90,000	2020
TPF-5(380)	Autonomous Maintenance Technology (AMT)	Jay Hietpas	CO	11	$725,000	$25,000	$75,000	2020

ADMINISTRATIVE

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
2017-12	MPR-6(004): MnDOT Research Program Strategic Plan (2017-2022)	Vivek Sakhrani, CPCS Transcom, Inc.	Jean Wallace	7/31/17	$94,569
TRS 1805	Content Management Systems and Website Practices	Patrick Casey, CTC & Associates, LLC	Micheal Foley	10/31/18	$8,569
	INV 936: FY2016 and FY2017 LRRB Focus Groups	Jim Grothaus, University of Minnesota Center for Transportation Studies	Paul Oehme	7/31/17	$29,382
	Research Management Training and Materials	Patrick Casey, CTC & Associates, LLC	Hafiz Munir	7/31/17	$70,480
	INV 645B: LRRB Outreach and Marketing Support	Renae Kuehl, SRF Consulting Group, Inc.	Shannon Fiecke	7/31/17	$20,000

cont. ➡

ADMINISTRATIVE [cont.]

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	MPR-5(011): FY2016 Technology Transfer Material Development (RS AAG and Newsletter)	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	7/31/17	$95,059
	INV 999: FY2016 RSS Report Publication Services	Arlene Mathison, University of Minnesota Center for Transportation Studies	Shannon Fiecke	8/31/17	$73,035
	INV 924, State Aid: Professional Services for Careers in Civil Engineering Video	Renae Kuehl, SRF Consulting Group, Inc.	Mitchell Rasmussen	2/28/18	$82,912
	MnDOT Research Librarian Services (2016-2018)	Arlene Mathison, University of Minnesota Center for Transportation Studies	Sheila Hatchell	6/30/18	$78,280
	MP-16(001): ARTS Technical Support and Maintenance Services	Ryan Anderson, Tech-Pro, Inc.	Deborah Sinclair	6/30/18	$78,570
	INV 936: Research Need Statement Development for Minnesota Local Road Research Board	Renae Kuehl, SRF Consulting Group, Inc.	Mitchell Rasmussen	7/31/18	$51,459
	Research Project Management and Implementation Support	Patrick Casey, CTC & Associates, LLC	Hafiz Munir	7/31/18	$99,023
	INV 916: LRRB 2017 Technology Transfer Material Development	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	7/31/18	$98,942
	MPR-16(012): 2017-2018 Technical Transfer Material Development: Technical Summaries and Project Evaluation Forms	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	7/31/18	$99,816
	INV 645B: LRRB Outreach and Marketing Support (2017-2018)	Renae Kuehl, SRF Consulting Group, Inc.	Shannon Fiecke	8/31/18	$83,812
	MnDOT Research Services Drupal Website Development	Andrea Douglas, Nighthawk Marketing	Shannon Fiecke	12/31/18	$24,750
	MP-16(002): 2017-2019 Technology Transfer Material Development	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	5/31/19	$99,904
	INV 999: Research Services & Library Report Publication Services (FY2018-2019)	Arlene Mathison, University of Minnesota Center for Transportation Studies	Shannon Fiecke	6/30/19	$86,329
	MP-16(002): 2018-2019 Technology Transfer Material Development (RS AAG and Newsletter)	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	7/31/19	$99,773
	INV 645: Research Implementation Committee—RIC Implementation of Research Findings (FY2017-2019)	Michael Marti, SRF Consulting Group, Inc.	Michael Flaagan	7/31/19	$544,925
	INV 645: Implementation Planning by Evaluating or Updating Completed Local, State or FHWA Projects/Products	Michael Marti, SRF Consulting Group, Inc.	Michael Flaagan	7/31/19	$13,217
	INV 645B: LRRB Outreach and Marketing Support	Renae Kuehl, SRF Consulting Group, Inc.	Shannon Fiecke	8/31/19	$99,886
	INV 916: LRRB Technology Transfer Materials Development (FY2018)	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	2/29/20	$99,824
	INV 927: LRRB Website Development and Hosting	Patrick Casey, CTC & Associates, LLC	Shannon Fiecke	7/31/21	$39,462

Federal Program Support

Study Number	Title	Technical Liaison	Total MN Commitment
TPF-5(277)	Transportation Research Board (TRB)	Linda Taylor	$131,331
TPF-5(417)	National Cooperative Highway Research Program (NCHRP)	Linda Taylor	$725,962

cont. ➡

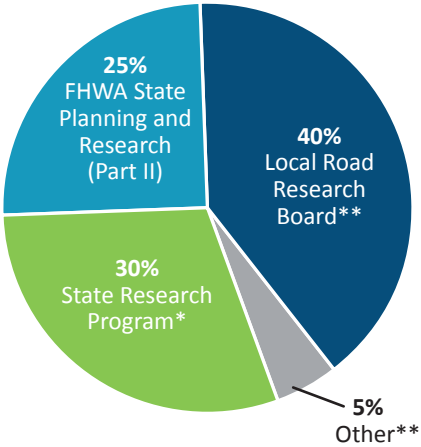
DEDICATED PROGRAMS

Report Number	Title	Investigator	Technical Liaison	End Date	Total Cost
	INV 668: FY2018 Local Technical Assistance Program (LTAP)	Stephanie Malinoff, University of Minnesota Center for Transportation Studies	Mitchell Rasmussen	6/30/18	$450,000
	INV 998: Operational Research Program for Local Transportation Groups (OPERA) (FY2017-2018)	Mindy Carlson, University of Minnesota Center for Transportation Studies	Mitchell Rasmussen	9/30/18	$160,000
	FY2018-2019 CTS Operations	Laurie McGinnis, University of Minnesota Center for Transportation Studies	Linda Taylor	6/30/19	$3,878,742
	MnDOT Research Librarian Services (2019-2020)	Arlene Mathison, University of Minnesota Center for Transportation Studies	Sheila Hatchell	6/30/20	$77,274

FY2018 FINANCIAL ACTIVITY

MnDOT research is funded through the MnDOT State Research Program (SRP) and Federal Highway Administration (FWHA) State Planning and Research (SP&R) Program (Part II). MnDOT's Office of Research and Innovation also manages research for the Local Road Research Board (LRRB), which was created to facilitate transportation research and information sharing among Minnesota city and county engineers.

FY2018 Research Funds by Funding Source



State Research Program*	$ 1,733,183
FHWA State Planning and Research (Part II)	$ 3,882,502
Local Road Research Board**	$ 6,239,327
Other***	$ 738,482
Total	**$ 12,593,494**

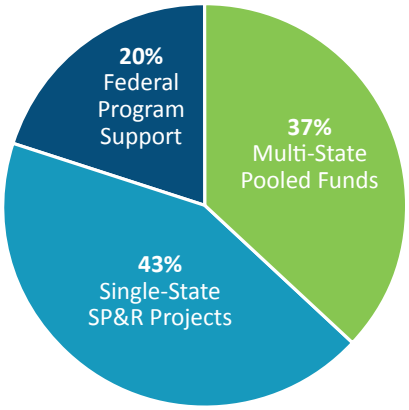
* Includes $505,505 carried over from FY2017.
** Includes $2,595,627 carried forward from FY2017.
*** Includes contributions from other MnDOT funds, partnerships with other agencies, and other federal sources.

FY2018 SP&R (Part II) Funding Distribution*

SP&R (Part II) funds for research are allocated to meet state-specific needs and are distributed as shown below:

Multi-State Pooled Funds	**$ 1,638,000**
a: Participation in Pooled Funds Led by Other States	$ 728,000
b: MnDOT-Led Pooled Funds	$ 910,000
Single-State SP&R Projects	**$ 1,895,813**
Federal Program Support	**$ 877,309**
a: NCHRP	$ 742,940
b: TRB	$ 134,369
Total	**$ 4,411,122**

*Excludes 2018 commitments that were paid in advance with FY2017 funds.



FY2018 By the Numbers

Active research contracts	Research reports and TRSs	Visits to the state research blog	MnDOT-supported active pooled funds	MnDOT-led pooled funds	Active Technical Advisory Panel members	Active Technical Liaisons
230	56	15,583	36	9	788	124

GET HELP: HOW TO ACCESS OUR SERVICES

MnDOT's Office of Research and Innovation delivers information and innovation to transportation practitioners through a variety of programs and services, including those listed below. Contact us at any time if you need assistance at **research.dot@state.mn.us** or 651-366-3780.

AASHTO-RAC Surveys

Have a question or two about other state practices in a particular topic area? We can survey other DOTs using the AASHTO-RAC Listserv.

Track National Trends

Get the latest information on transportation research in your subject area by searching the national database (**trid.trb.org**), watching webinars (**webinar.mytrb.org**) or getting regular alerts through a **trb.org** RSS feed.

MnDOT Library

Our librarians are experts at tracking down hard-to-find information. Request a literature search, interlibrary loan or special publication at 651-366-3791, **library.dot@state.mn.us** or **mndot.gov/library**.

SUBMIT A RESEARCH IDEA

If you need research, we can help you create a proposal and obtain funding. Submit research ideas and vote on those already proposed at **mndot-lrrb.ideascale.com**.

TRANSPORTATION RESEARCH SYNTHESIS

TRS 1802 March 2018

High Friction Surface Treatments

Prepared by CTC & Associates LLC

The Federal Highway Administration's Every Day Counts initiative promotes innovations and technologies that enhance road safety. Among the innovations supported through this effort is the implementation of high friction surface treatment (HFST), a spot pavement surfacing treatment applied in locations with high friction demand, such as curves and other crash-prone areas. This technology is expected to significantly enhance skid resistance and reduce crashes.

MnDOT and local transportation agencies in Minnesota are evaluating the use of HFST as a safety strategy on roadways. To gather information for this evaluation, selected state departments of transportation were surveyed about their practices and experience with HFST applications, including materials specifications, locations that benefit most from HFST, the pavement treatment's durability and the resulting impact on safety. This Transportation Research Synthesis presents the findings of that survey along with the results of a limited literature search. Publications provided by survey respondents that are not publicly available are included in a separate TRS supplement, TRS 18025, available at http://mndot.gov/research/TRS/2018/TRS18025.pdf.

REQUEST A TRS

A TRS is a short-turnaround research report that you can request to answer your research question. TRSs can summarize completed and in-progress research, or report about the state of practice among your peers in Minnesota and other states. For more information or to request a TRS, visit **mndot.gov/research/TRS.html**.

***TRS 1802**, High Friction Surface Treatments, surveyed state transportation agencies and reviewed recent literature on the use of this safety-enhancing approach. The report describes applications for the treatments, epoxies and polish-resistant aggregates used, and durability and safety benefits.*

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Presentations

Schedule a visit to learn how the research program or library can help your office or district.

Crossroads Blog

Check out our recent stories on Minnesota transportation research. mntransportationresearch.org

Find a Project

Find active and completed MnDOT research under the "Projects" tab at mndot.gov/research.

Social Media

Connect with us using your favorite social media channels. See upcoming events on our calendar page.

Webinars

MnDOT offers monthly webinars on innovations in traffic engineering and road research. Sign up for email lists at mndot.gov/trafficeng/topics and mndot.gov/mnroad/researchpaysoff to stay informed.

*In the **Winter Plowing and Deicing webinar**, Professor Stephen Druschel of Minnesota State University, Mankato describes his research and emphasizes how agencies can reduce salt use, optimize plowing time and save money in managing snow on highways.*

Videos

We highlight research projects and provide educational resources for the public. See mndot.gov/research/videos.html or the MnDOT Research YouTube channel.

*The **Shoreview pervious concrete video** describes one city's use of pervious concrete to filter stormwater on neighborhood streets. MnDOT research documented the drainage effectiveness, sound absorption and ride quality over a seven-year period.*

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

Produced by CTC & Associates LLC for:

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Minnesota Local Road Research Board: lrrb.org