Michigan Department of Transportation
RESEARCH Administration

STATE PLANNING & RESEARCH PART II PROGRAM

FISCAL YEAR 2022

ANNUAL REPORT

OCTOBER 1, 2021 — SEPTEMBER 30, 2022

www.michigan.gov/mdotresearch

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Fiscal Year 2022 Annual Report

STATE PLANNING AND RESEARCH, PART II, PROGRAM
2022 ANNUAL REPORT

Introduction

The Michigan Department of Transportation (MDOT) State Planning and Research (SPR), Part II Program is authorized and funded through the Code of Federal Regulations, Title 23, Part 420, Subpart B. This program is administered through the Research Administration Section in the Bureau of Field Services and funds projects that have been initiated to address specific research needs at MDOT. SPR, Part II funding can be used to research and evaluate new technologies that relate to design, construction, maintenance, and operation of all surface transportation modes. Other eligible uses include technology transfer and certain training activities.

Each year, MDOT develops a program consisting of 80 percent federally funded projects and 100 percent federally funded projects. The program also includes funding for various national research initiatives, such as the American Association of State Highway and Transportation Officials (AASHTO) Technical Service Programs (TSPs), Transportation Research Board (TRB), and National Cooperative Highway Research Program (NCHRP). The program must be reviewed and approved by the Federal Highway Administration (FHWA) Michigan Division Office prior to implementation. MDOT received FHWA approval on July 23, 2021. This annual report covers the MDOT SPR Part II Program from Oct. 1, 2021, through Sept. 30, 2022.

Summary

Fiscal Year (FY) 2022 research was conducted in the following focus areas, representing several modes of transportation and MDOT's diverse business functions:

Highways Development
- Environment and Water Sources
- Innovative Contracting
- Project Development
- Real Estate & Permits

Highways Bridges and Structures
- Bridges and Structures
- Geotechnical & Foundation Design
- Surveys and Automated Design

Multi-Modal Transportation & Finance
- Aviation
- Contract Administration
- Freight Rail
- Local Transit
- Travel Demand Forecasting

Planning and Organizational Development
- Non-Motorized Planning & Development

Highways and Delivery Operations
- Construction
- Intelligent Transportation Systems
- Mobility and Traffic Incidents
- Pavements and Materials
- Roadway and Roadside Maintenance
- Transportation Safety

The FY 2022 SPR, Part II, Program consisted of 93 projects; 46 were 80 percent federally funded and 47 were 100 percent federally funded. The FY 2022 approved budget was $6,268,946.18 and expenditures totaled $6,225,843.65.

Table 1 summarizes 80 percent federally funded projects that were funded in FY 2022 while the associated progress reports contain project summaries with projects listed sequentially by job number. Table 2 summarizes 100 percent federally funded projects. For additional information regarding a specific project, please contact Research Administration.

Program and Administrative Milestones

Research Administration staff continued remote work from home during the COVID-19 pandemic, transitioning to a two day remote work hybrid schedule starting in May 2022. The research program was delivered successfully and included the following FY 2022 milestones:

- Michael Townley received the AASHTO President's Award for Research in San Diego, CA on October 29, 2021, for his dedication to transportation research.
- The Michigan State Transportation Innovation Council (MI-STIC) received the National STIC Excellence award along with North Carolina for FY 2021 on October 20, 2021, for expanding its already diverse membership making significant impact toward fostering a strong culture for innovation.
- MDOT received an AASHTO Research Advisory Committee (RAC) recognition for a Supplemental Safety category project titled, *Effectiveness of Crash Fact/Safety Message Signs on Dynamic Message Signs*
- Attended the TRB Annual Meeting in January, presenting information at the poster sessions on the following 2021 HVR award winning research projects:
    - *HVR Award for Develop and Implement a Freeze Thaw Model Based Seasonal Load Restriction Decision Support Tool*
    - *Supplemental Safety recognition for Effectiveness of Green Strobes on Winter Maintenance Vehicles and Equipment.*
- Completed 12 projects that were 80 percent federally funded.
- Initiated contracts for nine new 80 percent federally funded projects in FY 2022, with total budgets equaling approximately $3.1 million.
- Participated in a forum/peer exchange in San Diego, CA, titled *State Innovation Forum.* This event contributed to Research Administration's knowledge and sharing of best practices for a culture of innovation within DOTs. 16 state DOTs were represented along with FHWA, AASHTO, NCHRP and USDOT.
- Published three more MDOT Video Spotlights. The videos summarized the following research projects:
    - *Green Strobes Increase Visibility and Safety for Winter Maintenance*

- *Preparing MDOT's Workforce for Future Transportation Technologies*
- *Restoring Sloped Areas Along Michigan Urban Freeways*

- Published documents to transfer the results of research and innovation to practitioners, including the following Research Spotlights, highlighting the value of individual research projects.
  - *New MDOT design tool predicts how bridge beams will flex and settle over time*
  - *Insights into the Effective Use of Dynamic Message Signs for Traffic Safety*
  - *ITS evaluation tool calculates value and impact of highway technology*
  - *Evaluating safety and traffic improvements along Michigan's first flex route*
  - *Michigan facilities support connected vehicle research*
  - *Risk management tools help MDOT deliver projects on time and on budget*
  - *Benefits of dynamic message signs on driver behavior and traffic flow*
  - *Tools to protect coastal roadways from high water*
  - *MDOT prepares its workforce for emerging transportation technologies*
  - *Innovative contracting provides flexibility to customize project results*
  - *Measuring the effect and value of intermediate diaphragms on bridges*
  - *New standards foster successful roadside plantings*
  - *Dynamic signs along Michigan's freeway ramps improve driver behavior*
  - *Updating best practices to keep pedestrians and bicyclists safe*
  - *Integrating drones into MDOT's day-to-day traffic and asset management*
- Research Administration continued the new research project implementation tracking and planning process in FY 2022 by requesting implementation status reports from implementation managers.
- Completed the FY 2023, 2024, and 2025 research program planning process:
  - Fall 2021, Research Administration requested research ideas addressing MDOT's priorities. All stakeholders were contacted. Research Administration received 106 ideas.
  - February 2022, meetings were held with each MDOT RAC to identify and prioritize the ideas that were recommended and eventually approved by the Research Executive Committee (REC) on March 7, 2022.

- May 9-13, 2022, virtual program development meetings were held to improve these previously approved research ideas. All interested stakeholders participated.
- Thirty three problem statements were developed by project managers and recommended by the RAC members for REC approval on July 11, 2022, to be included as future projects for FYs 2023, 2024, and 2025.
- Approved problem statements for FY 2023 were submitted to FHWA Michigan Division in the FY 2023 SPR Part II program on July 20, 2022.

- Research Administration prepared the FY 2023 SPR II program and received FHWA approval on August 22, 2022. The program for FY 2023 is the largest program to date with 99 total projects planned.
- MDOT's State Innovation Alignment Team along with several subject matter experts continued populating the External Innovation website to have a central location to showcase MDOT innovations.
- The public facing Research Administration website went through a major update and is now more streamlined and user friendly. Additionally, a "Partners in Research" page was developed to highlight the diverse group of MDOT research partners. This page is intended to be a resource for public and private transportation stakeholders interested in our research partners' expertise.
- The first StoryWalk children's book was installed at the Clare Rest Area. The idea came from the Youth Services Coordinator at the Library of Michigan through MDOT's Librarian as another way to support "Read by Grade Three".
- The Engineer of Research presented information about research and STIC to the State Transportation Commission and the House Standing Committee on Transportation
- MDOT continues to partner with the FHWA along with industry, local and state government agencies working together toward innovating our transportation system through STIC, Every Day Counts Initiative (EDC), and the Accelerated Innovation Deployment (AID) Demonstration program.
- During the winter and spring of 2022, MDOT received the NCHRP ballot. The ballot was sent to focus area managers throughout MDOT for review and comment. Research Administration met with executive staff to score each problem statement included in the ballot. The summary ballot was submitted online to TRB's Cooperative Research Programs and final vote submitted by our director.
- Several MDOT staff members have attended AASHTO Research Advisory Committee meetings throughout the year to understand the national research agenda and processes. These meetings have included periodic AASHTO RAC Chats, Region 3 Collaboration and Business meetings, and the national meeting in Massachusetts.

- We topped our fiscal year off with a great Project Manager (PM) Appreciation event held in September 2022. We honored more than 40 research project managers. The following awards were presented, along with an opportunity to walk the “RAd carpet:”
    - **Best Research:** Elise Feldpausch, Jason Firman, Kristi Kirkpatrick, and Ryan Mitchell
    - **People’s Choice:** Jim Gaus and Melissa Longworth
    - **RAd Champion:** Michael Eacker
    - **AASHTO High Value Research in the safety category:** Mark Bott
    - **Lifetime Research Achievement:** Carol Aldrich

TABLE 1 - 80% FEDERALLY FUNDED

Job No.	FY 2022 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
128602	$92,690.93	$622,975.80	$1,169,711.17	Kahl, Steve	LTU	Grace	Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring	12/17/2013	9/30/2025	13
132231	$4,242.11	$443,062.32	$519,732.24	Alton, Nanette	MSU	Cregg	Slope Restoration on Urban Freeways	4/1/2017	12/31/2025	15
201393	$93,237.66	$500,861.96	$534,646.44	Belcher, John	WMU	Attanayake	Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance	7/1/2018	12/31/2022	17
201399	$62,081.20	$200,635.16	$200,704.74	Uzcategui, Alonso	MSU	Gates	Measure the Operational Cost and Benefit of Speed Feedback Signs	7/1/2018	12/31/2021	19
203301	$25,000.00	$125,000.00	$125,000.00	Clover, Andre	TRB	N/A	Sponsorship of the TRB Roundtable on Preparing for Automated Vehicles and Shared Mobility Services	1/1/2020	12/31/2021	21
204644	$42,236.25	$308,882.88	$309,318.50	Liptak, Rick	WMU	Attanayake	Concrete Deterioration of Prestressed Bridge Beams	3/1/2019	7/31/2022	22
204646	$83,844.08	$131,546.45	$206,280.18	Renner Lindsey	MSU	El-Gafy	Training Tools for Effective Advancement of Digital Technologies for Construction Field Operations	2/1/2020	10/31/2022	26
*204648	$0.00	$465,449.94	$473,934.56	Gorman, Joe	Cambridge Systematics	Van Hecke	Development of a Network-level Evaluation Tool for Managing ITS Infrastructure	6/1/2019	6/30/2021	28
*204651	$0.00	$230,161.66	$253,065.27	Feldpausch, Elise	Center for Automotive Research	Dziczek	Recruit and Maintain/Upgrade a High-Tech Workforce for Emerging Technologies	10/15/2019	9/30/2021	29
204653	$228,831.00	$871,003.00	$871,003.00	Cook, Steve	MTU	Brooks	Integration of Unmanned Aerial Systems Data Collection into Day-to-Day Usage for Transportation Infrastructure/Program Asset Management and Systems Operations	6/12/2019	6/11/2022	30
204654	$12,869.92	$206,058.27	$206,101.91	Bott, Mark	MSU	Gates	Synthesis of National Best Practices on Pedestrian and Bicycle Design, Guidance and Technology Innovations	4/1/2019	12/31/2021	32
204655	$52,155.72	$230,104.16	$230,104.19	Bott, Mark	MSU	Savolainen	Evaluating the Impacts of the 2017 Legislative Mandated Speed Limit Increases	3/1/2019	6/30/2022	35
204656	$45,754.52	$184,350.53	$185,074.70	Firman, Jason	MSU	Kassens-Noor	Performance and Safety of the US-23 Flex Route	3/1/2019	11/30/2021	37
208773	$94,978.85	$240,865.25	$366,868.57	Grabarkiewicz, Jeff	MSU	Roloff	Eastern Massasauga (Sisturus catenatus) Road Ecology and Population Dynamics in Michigan	11/25/2019	5/31/2023	39
208774	$25,935.38	$87,890.10	$106,642.26	Johnson, Nikkie	Texas A&M	Das	Safety Enhancements at Short-Storage-Space Railroad Crossings	1/1/2020	12/31/2022	41
208775	$7,927.50	$165,770.76	$172,466.82	Guttierez, Eliseo	WMU	Kwigizile	Quantifying Effectiveness and Impacts of Digital Message Signs on Traffic Flow	11/1/2019	3/31/2022	43
208776	$69,346.50	$389,946.27	$418,912.98	Eacker, Michael	MSU	Kutay	Evaluation of MDOT's Long-Life Pilot Projects	10/25/2019	12/31/2022	45
208777	$190,092.68	$482,054.55	$541,344.29	Schenkel, Justin	MSU	Haider	Characterizing Initial Roughness and Material Properties for Pavement-ME Analysis and Design in Michigan	1/21/2020	6/30/2023	47
208778	$123,306.58	$304,014.75	$304,014.75	Martin, John	MSU	Savolainen	Developing a Consistent Data Driven Methodology to Multimodal, Performance Based, and Context Sensitive Design	10/11/2019	9/30/2022	50
209076	$0.00	$316,409.96	$317,089.20	Mitchell, Ryan	WSP	Chenault	Innovative Contracting Best Practices	2/1/2020	12/15/2021	52

Job No.	FY 2022 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
209437	$76,462.94	$205,944.78	$492,314.72	Hoffmeyer, Mary	CTC & Associates	Casey	Research Administration Section Planning and Communications	10/1/2020	9/30/2025	54
210214	$60,902.83	$331,850.47	$351,631.38	Mitchell, Ryan	RS&H	Keetley	Innovative Contracting Risk Management Best Practices	8/1/2020	12/31/2021	55
210791	$109,568.23	$147,246.35	$180,204.74	Maffeo, Robert	MSU	Zockaie	Assessing System Performance of the Michigan Trunkline Measures and Analytical Procedures for Planning and Operations	8/1/2020	12/31/2022	57
211053	$180,435.37	$184,493.96	$533,305.15	Zwolinski, Andrew	U of M	Kerkez	Electronic Water Level Sensors for Monitoring Scour Critical Structures	4/1/2021	12/31/2023	60
211054	$41,644.95	$105,896.95	$105,898.65	Strzalka, Larry	WMU	Liu, Hexu	Competitive Bidding in Construction Contracting	1/1/2021	9/30/2022	61
211055	$28,636.52	$198,833.95	$198,881.02	Zweng, Hal	Arcadis	Hebebrand	Infrastructure Protection and Rehabilitation Response to High Lake Levels	2/15/2021	3/31/2022	63
211056	$70,119.75	$145,041.50	$464,662.20	Mueller, Michele	Kimley-Horne	Good	Utilizing Video Analytics w/Connected Vehicles for Improved Safety	2/15/2021	1/31/2024	64
211058	$23,943.48	$23,943.48	$355,167.11	Smith, Dave	MSU	Gates	Effective Bridge Deck Weather Warning Technologies	2/15/2021	7/31/2023	65
211059	$116,114.58	$138,401.90	$160,573.35	Shultz, Valerie	MSU	Zockaie	Determining State and Federal Transportation Responsibilities to Residents on Islands	1/15/2021	4/30/2023	66
211061	$213,620.07	$309,885.60	$595,031.80	Eacker, Michael	MSU	Kutay	Evaluation of MDOT's Methodologies for both Quantifying Pavement Distress & Modeling Pavement Performance for LCC and RSL Estimation Purposes	2/2/2021	5/31/2023	68
211062	$130,980.59	$202,547.63	$277,435.40	Schenkel, Justin	MTU	You	Quantifying the Impact of Super Single (Wide Base) Tires on Pavement Damage in Michigan	3/15/2021	12/31/2022	70
211063	$116,067.68	$143,948.04	$269,745.08	Miller, Nathan	WSP	Wendling	Corridor and Systemwide Application of Performance Based Practical Design	2/1/2021	1/31/2024	72
211064	$132,511.15	$190,256.75	$386,927.00	Fitch, Matt	MSU	Bunting	Right of Way Mapping Conversion to GIS	2/1/2021	2/28/2023	73
211065	$124,262.19	$136,806.82	$252,499.99	Ealy, Jason	MSU	Savolainen	Evaluating the Performance & Safety Effectiveness of Roundabouts - An Update	3/1/2021	1/31/2023	74
213122	$65,366.78	$65,366.78	$487,832.56	Kahl, Steve	LTU	Grace	Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subjected to Various Environmental Conditions	10/1/2021	9/30/2024	75
213124	$138,576.36	$138,576.36	$337,141.98	DeBruyn, Josh	U of M	Misra	Leveraging Crowd-sourced Data in Planning, Design, Analysis, and Evaluation of Pedestrian and Bicycle Traffic	10/1/2021	3/31/2023	77
213309	$113,379.41	$113,379.41	$272,812.24	Beatty, Matt	WSU	Menkulasi	Repair of Bridge Deck Fascias	10/1/2021	9/30/2023	78
213313	$51,470.40	$51,470.40	$202,968.38	Eacker, Michael	LTU	Bandara	Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan	10/1/2021	3/31/2023	79
213314	$85,106.86	$85,106.86	$163,913.30	Bott, Mark	WMU	Van Houten	Effective Pedestrian/Non-Motorized Crossing Enhancements along Higher Speed Corridors	10/1/2021	9/30/2023	81
213316	$159,496.92	$159,496.92	$607,935.71	Carlson, Erik	MTU	Watkins	Michigan Hydrologic Calculation Procedures	11/1/2021	12/31/2024	82
213318	$57,819.00	$57,819.00	$517,826.52	Snook, Ryan	U of M	Hryciw	Michigan Cone Penetrometer Test Calibration	1/1/2022	11/30/2024	84
213321	$51,576.71	$51,576.71	$276,587.71	Pakala, Parush	WMU	Attanayake	Operational Baseline for the 2nd Avenue Network Arch Bridge	1/1/2022	5/31/2024	86

Job No.	FY 2022 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
216349	$150,000.00	$150,000.00	$257,424.97	Smith, Linn	Airspace Link	Free	Analysis and Deployment of an Unmanned Traffic Management System in Michigan – Phase 1 Feasibility Analysis	2/1/2022	1/31/2023	88
*217421	$0.00	$0.00	$210,637.52	Bowerman, Glenda	CRAFT	Ketterl	Construction Digital Delivery Technology Scan	12/9/2022	12/31/2023	90
*217455	$0.00	$0.00	$192,465.00	Davis, Kelly	WSU	Eamon	Enhanced Bridge Cost Estimating	10/26/2022	9/30/2023	92
*To Be Determined	$0.00	$0.00	$142,000.00	Douglas, Scott	To Be Determined	To Be Determined	Business Architecting for Digital Delivery	To Be Determined	To Be Determined	93
	$3,552,593.65	**$9,844,934.39**	**$15,805,839.25**	**TOTAL 80% FEDERALLY FUNDED PROJECTS**						

*Project was included in the FY 2022 program assuming a start date that was delayed or an extension that was not necessary.

TABLE 3 - 100% FEDERALLY FUNDED PROJECTS

Project No.	Job No.	FY 2022 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
SPR1801(179)	210931	$165,000.00	$165,000.00	$165,000.00	AASHTO/ FHWA	Clover, Andre	AASHTO Engineering Technical Service Programs	10/1/2021	9/30/2022	95
TPF-5(176)		$0.00	$70,000.00	$70,000.00	FHWA	Firman, Jason	Traffic Analysis and Simulation	6/1/2016	1/31/2023	96
TPF-5(255)		$0.00	$100,000.00	$100,000.00	FHWA	Bott, Mark	Highway Safety Manual Implementation	11/9/2015	12/31/2023	98
TPF-5(281)		$0.00	$125,000.00	$125,000.00	Indiana DOT	Curtis, Beckie	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE	10/1/2017	9/30/2022	101
TPF-5(290)		$0.00	$150,000.00	$150,000.00	Iowa DOT	Droste, Justin	Aurora Program	8/1/2014	7/31/2022	103
TPF-5(305)		$0.00	$20,000.00	$20,000.00	FHWA	Schenkel, Justin	Regional and National Implementation and Coordination of Mechanistic-Empirical (ME) Design	10/1/2016	9/30/2023	108
TPF-5(313)		$0.00	$60,000.00	$60,000.00	Iowa DOT	Kennedy, Kevin	Technolgoy Transfer Concrete Consortium (TCCC)	4/10/2015	5/31/2022	110
TPF-5(317)		$10,000.00	$40,000.00	$40,000.00	Nevada DOT	Bott, Mark	Evaluation of Low-Cost Safety Improvements	10/1/2019	9/30/2023	112
TPF-5(319)		$25,000.00	$200,000.00	$200,000.00	FHWA	Peplinski, Suzette	Transportation Management Center (TMC) Pooled Fund Study	4/17/2015	4/16/2022	114
TPF-5(320)		$0.00	$150,000.00	$150,000.00	Indiana DOT	Kennedy, Kevin	Base Funding for North Central Superpave Center	2/3/2015	9/30/2022	116
TPF-5(341)		$0.00	$750,000.00	$750,000.00	Minnesota DOT	Kennedy, Kevin	National Road Research Alliance	2/22/2016	9/30/2022	119
TPF-5(343)		$50,000.00	$270,000.00	$320,000.00	Washington DOT	Torres, Carlos	Roadside Safety and Research for MASH Implementation	10/1/2016	12/31/2023	122
TPF-5(347)		$30,000.00	$170,000.00	$170,000.00	South Dakota DOT	Roath, James	Development of Maintenance Decision Support System	10/1/2016	9/30/2023	127
TPF-5(351)		$0.00	$60,000.00	$60,000.00	Kansas DOT	Smalley, Erik	Self de-icing LED signals	3/25/2016	6/30/2022	130
TPF-5(353)		$0.00	$125,000.00	$125,000.00	Minnesota DOT	Droste, Justin	Clear Roads Winter Highway Operations Pooled Fund (Phase II)	10/1/2016	6/30/2023	137
TPF-5(358)		$20,000.00	$80,000.00	$80,000.00	Nevada DOT	Novak, Amanda	Wildlife Vehicle Collision Reduction and Habitat Connectivity	10/1/2019	9/30/2022	142
TPF-5(359)	200188 204724 200858	$0.00	$145,000.00	$145,000.00	MDOT	Feldpausch, Elise	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) - Phase II	1/2/2018	2/28/2022	145
TPF-5(363)	201029	$0.00	$266,639.63	$266,639.63	MDOT	Kahl, Steve	Evaluation of 0.7 inch Diameter Carbon Fiber Reinforced Polymer (CFRP) Pretensioning Strands in Prestressed Beams	12/5/2017	3/31/2022	148

Project No.	Job No.	FY 2022 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(368)		$0.00	$75,000.00	$75,000.00	Iowa DOT	Kennedy, Kevin	Performance Engineered Concrete Paving Mixtures	1/1/2017	12/31/2022	151
TPF-5(372)		$20,000.00	$100,000.00	$125,000.00	Iowa DOT	Wagner, Brad	Building Information Modeling (BIM) for Bridges and Structures	10/1/2017	1/31/2024	154
TPF-5(374)		$0.00	$300,000.00	$300,000.00	FHWA	Kennedy, Kevin	Accelerated Performance Testing on the 2018 NCAT Pavement Test Track w/ MnRoad Research Partnership	10/1/2020	11/30/2022	156
TPF-5(375)		$50,000.00	$200,000.00	$250,000.00	Minnesota DOT	Kennedy, Kevin	National Partnership to Determine the Life Extending Benefit Curves of Pavement Techniques (MnROAD/NCAT Joint Study-Phase II)	1/1/2019	12/30/2023	158
TPF-5(385)		$45,000.00	$180,000.00	$225,000.00	Virginia DOT	Shapter, Paul	Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDD's)	3/1/2019	10/31/2023	160
TPF-5(387)		$0.00	$75,000.00	$75,000.00	Indiana DOT	Zakrzewski, Brian	Development of an Integrated Unmanned Aerial Systems (UAS) Validation Center	9/1/2018	12/31/2022	162
TPF-5(389)		$0.00	$100,000.00	$100,000.00	Virginia DOT	Castle, Collin	Connected Vehicle Pooled Fund Study	10/1/2019	9/30/2024	165
TPF-5(396)		$37,000.00	$148,000.00	$148,000.00	Wisconsin DOT	Wulff, Elisha	Mid-America Freight Coalition (MAFC) Phase 3	2/1/2019	3/31/2023	167
TPF-5(422)		$1,434,182.00	$1,434,182.00	$1,434,182.00	FHWA	Clover, Andre	National Cooperative Highway Research Program (NCHRP) for FY 2022	10/1/2021	9/30/2022	169
TPF-5(432)		$0.00	$40,000.00	$40,000.00	Wisconsin DOT	Curtis, Rebecca	Bridge Element Deterioration for Mid-West States	10/1/2019	11/30/2022	170
TPF-5(433)		$0.00	$30,000.00	$30,000.00	Utah DOT	Tichenor, Joel	Behavior of Reinforced and Unreinforced Lightweight Cellular Concrete for Retaining Walls	10/1/2019	9/30/2023	172
TPF-5(435)		$25,000.00	$75,000.00	$125,000.00	Iowa DOT	Roath, James	Aurora Program (FY20-FY24)	10/1/2019	12/31/2024	174
TPF-5(436)		$40,000.00	$120,000.00	$120,000.00	Indiana DOT	Nadjarian, Allie	Development of Criteria to Assess the Effects of Pack-out Corrosion in Built-up Steel Members	10/1/2019	9/30/2024	177
TPF-5(437)		$12,000.00	$36,000.00	$60,000.00	Iowa DOT	Kennedy, Kevin	Technology Transfer Concrete Consortium (FY20-FY24)	10/1/2019	12/31/2025	179
TPF-5(438)		$25,000.00	$75,000.00	$125,000.00	Iowa DOT	Renner, Lindsey	Smart Work Zone Deployment Initiative	10/1/2019	12/31/2025	181
TPF-5(441)		$10,000.00	$30,000.00	$50,000.00	Colorado DOT	Rowley, Todd	No Boundaries Transportation Maintenance Innovations	10/1/2019	9/30/2024	183
TPF-5(444)		$10,000.00	$30,000.00	$50,000.00	Montana DOT	Bott, Mark	Traffic Safety Culture - Phase 2	10/1/2019	9/30/2024	185
TPF-5(447)		$20,000.00	$40,000.00	$100,000.00	FHWA	Bott, Mark	Traffic Control Device (TCD) Consortium (3)	1/1/2021	2/28/2025	187

Project No.	Job No.	FY 2022 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(453)		$50,000.00	$100,000.00	$250,000.00	Ohio DOT	Castle, Collin	Automated Vehicle Pooled Fund Study	10/1/2020	9/30/2025	189
TPF-5(460)		$55,600.00	$55,600.00	$166,800.00	South Dakota DOT	Carlson, Erik	Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records	10/1/2021	9/30/2024	190
TPF-5(466)		$150,000.00	$300,000.00	$750,000.00	Minnesota DOT	Kennedy, Kevin	National Road Research Alliance - NRRA (Phase-II)	10/1/2020	1/31/2026	191
TPF-5(468)		$10,000.00	$30,000.00	$50,000.00	FHWA	Wagner, Brad	Structural Behavior of Ultra- High-Performance Concrete	2/1/2021	9/30/2025	193
TPF-5(479)		$25,000.00	$25,000.00	$50,000.00	Minnesota DOT	Droste, Justin	Clear Roads Winter Highway Operations Pooled Fund (Phase III)	5/1/2022	9/30/2024	194
TPF-5(480)		$30,000.00	$60,000.00	$150,000.00	Iowa DOT	Arnold, Luke	Building Information Modeling (BIM) for Infrastructure	7/1/2021	9/30/2025	199
TPF-5(486)		$30,000.00	$30,000.00	$60,000.00	Indiana DOT	Curtis, Beckie	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)	10/1/2021	9/30/2026	201
TPF-5(489)		$25,000.00	$25,000.00	$100,000.00	FHWA	Gill, Sarah	Safety Service Patrol Standardization and Management Practices	10/1/2021	9/30/2025	203
TPF-5(490)		$35,000.00	$35,000.00	$175,000.00	MDOT	Feldpausch, Elise	ITS Pooled Fund Program (ENTERPRISE) Phase III	10/15/2022	9/30/2027	205
TPF-5(495)		$12,000.00	$12,000.00	$108,000.00	Iowa DOT	Leix, Tracie	2023 Technology Exchange on Low Volume Road Design, Construction and Maintenance	9/1/2021	9/30/2023	206
TPF-5(496)		$222,468.00	$222,468.00	$222,468.00	AASHTO/ FHWA	Clover, Andre	TRB Core Program Activities FFY 2022 (TRB FY 2023)	10/1/2021	9/30/2022	208
		$2,673,250.00	**$6,929,889.63**	**$8,511,089.63**	**TOTAL 100% FEDERALLY FUNDED PROJECTS**					

80% FEDERALLY FUNDED PROJECTS

Sequentially Listed by Job Number

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Steve Kahl

CONTRACT/AUTHORIZATION NO.	2014-0043	PROJECT START DATE	12/17/2013
PROJECT NO.	128602	COMPLETION DATE (Original)	9/30/2020
OR NO.	OR14-039	COMPLETION DATE (Revised)	9/30/2025
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Nabil Grace		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$119,740.00	Total Vendor Budget	$1,166,711.17
MDOT Budget FY 2022	$1,000.00	Total MDOT Budget	$3,000.00
Vendor FY 2022 Expenditures	$92,690.93	Total Budget	$1,169,711.17
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$622,975.80
		Total Amount Available	$546,735.37

PURPOSE AND SCOPE

Carbon Fiber Composite Cable (CFCC), and other Carbon Fiber Reinforced Polymer (CFRP) materials are being used for prestressing applications in Michigan bridge rehabilitation and replacement projects. As this is still considered an innovative material, understanding and quantification of the long-term behavior based on stress/strain gage readings of previous field deployments is essential for future design and construction considerations. Continued monitoring of the CFCC elements in already constructed bridges will provide information on the long-term behavior and allow for recommendations to be made for future designs, taking into account the behavior of current field deployments.

FISCAL YEAR 2014 ACCOMPLISHMENTS

Completed the setup of the monitoring website and data are now available for review and download. The research team at Lawrence Technological University (LTU) was successful at downloading data from the website and recordings from Bridge Street bridge, M-50 bridge, and M-39 bridge have been checked. Readings from M-50 and M-39 bridges had minor issues that were corrected later. The system was then working properly in both bridges and the readings conformed to the theoretical calculations. At the close of the Fiscal Year (FY), work was continuing connecting M-102 bridge to the website and making the data available. As part of the nearly completed construction project, a power system is to be installed on-site. Scheduled maintenance visits to Bridge Street bridge and M-50 bridge were postponed until the necessary power system for M-102 is available.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Data from each bridge has been used for a separate research project, 2013-0065 - Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer prestressing and post tensioning strands. There have been pieces of data collection equipment and sensors that have been noted as not functioning properly, and a meeting with the supplier will take place in early 2016. In the meantime, data received is being used to corroborate analytical calculations and responses.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Monitoring of bridges containing CFRP elements continued throughout FY 2016. Several locations had equipment upgrades, along with assessments of the adequacy of the data collection equipment. Reports were provided of the trends in strains, loads, and deflections at different locations, and the data has been continued to be used in conjunction of research project 2013-0065 - Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer prestressing and post tensioning strands. The data analysis and trends from this monitoring continue to validate numerical simulation of bridge behavior being done as part of that research.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Monitoring of the current inventory of bridges will continue. The I-75 SB over Sexton Kilfoil Drain construction is complete and load test was performed. This bridge was added to the overall monitoring contract, and monitoring activities will continue until project completion in 2020.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Continued monitoring, and regular data reporting on all six (6) wired bridges will keep correlating actual experimental data with theoretical calculated values.

Reporting of data to the Research Advisory Panel (RAP) was done with meetings for the OR14-024 project, and this data was used to calibrate several equations and constants used in the proposed guide specifications.

The subcontractor visited the M-50 and Bridge Street bridges for annual maintenance. Defective equipment was noted, which resulted in abnormal readings. The subcontractor was able to replace the defective hardware and bring the system back to functioning properly. The Bridge Street bridge is also suffering from possible defective hardware but the troubleshooting and repair of the system is beyond the scope of annual maintenance.

In addition, the wireless carrier has issued a firmware upgrade to their phones as a fix from universal hacking and introducing malware into these systems. This fix can be done remotely on newer phones. Older phones such as those supplied in the bridge monitoring systems need to be upgraded manually. While the subcontractor was able to upgrade the firmware manually on the phones, the wireless carrier will stop supporting 3G networks in the next year and all phones will require the ability to utilize a 4G network. Therefore, an estimate for the repair of the hardware at Bridge Street and an upgrade for the phones in all bridge locations has been submitted to MDOT for review and approval of this amendment.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Monitoring continues for the M-39, M-50, M-102, Bridge Street and I-75 bridges. The research team at LTU was successful at downloading data from all bridges with some concerns in the Bridge Street Bridge. The subcontractor visited all bridge sites, checked hardware as well as the accuracy of the collected data, and provided a report on the conditions of all bridge monitoring systems. The systems on M-50, M-102, and I-75 bridges were all in good working condition and provided accurate readings. There were some sensors on M-39 bridge that were not giving accurate readings (even when collected manually) and they were assumed defective. In Bridge Street Bridge, it appears that a recent power surge caused some hardware issues and caused some sensors to stop reading properly. Defective sensors were removed from the site and a plan to address the conditions of the monitoring system of Bridge Street Bridge is currently underway and being discussed with MDOT Engineers.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Continued monitoring of the bridges in the contract, and analysis of long-term material behavior is expected. This analysis is being used to adjust material resistance factors and long-term durability considerations in the current design guidelines that MDOT has implemented as part of a separate research project. There were several data collection and communication components that were replaced and/or upgraded.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Continued monitoring of the instrumented bridges on M-39, M-50, M-102, Bridge Street and I-75, along with generation of data points for long-term material performance and refinement of the creep-rupture factors for the 0.6” diameter CFRP strands. The MDOT Project Manager (PM) held quarterly meetings throughout the year.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Monitoring continued for the M-39, M-50, M-102, Bridge Street and I-75 bridges. Overall, there seem to be no new issues with the monitoring system or the readings from the sensors. Monitoring on M-39 was interrupted due to software issues, which were resolved by the subcontractor. The research team analyzed the recorded data, shared the results with MDOT Engineers, and continues to download and analyze data while watching for any faulty readings. The team is working closely with the subcontractor to assess the readings from the sensors and address any maintenance issues. They team also performed in-depth calculations and finite element simulation to assess the effect of temperature change on the readings from different sensors.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The next progress meeting will be held in January 2023. Continue monitoring of the instrumented bridges on M-39, M-50, M-102, Bridge Street and I-75, along with generation of data points for long-term material performance and refinement of the creep-rupture factors for the 0.6” diameter CFRP strands. The MDOT Project Manager will plan and schedule progress meetings throughout FY 2023.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Project cost was increased in FY 2017 to include the addition of the I-75 SB over Sexton-Kilfoil Drain, which is the longest CFCC prestressed bridge built to date. The contract was also modified early 2019 to add five years of data collection and increase the budget to cover unexpected repairs that caused failures in bridge monitoring. There was also a change in MDOT project manager in FY 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Slope Restoration on Urban Freeways

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Nanette Alton

CONTRACT/AUTHORIZATION NO.	2013-0066 Z10	PROJECT START DATE	4/1/2017
PROJECT NO.	132231	COMPLETION DATE (Original)	7/31/2019
OR NO.	OR16-008	COMPLETION DATE (Revised)	12/31/2025
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Bert Cregg		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$476,941.06
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$42,791.18
Vendor FY 2022 Expenditures	$4,217.24	Total Budget	$519,732.24
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$443,062.32
		Total Amount Available	$76,669.92

PURPOSE AND SCOPE

The purpose of this project is to research and subsequently develop best practices and viable alternatives to turf as a solution for slope stabilization, especially steep slopes. Current methods and practices necessary to specify correct soils, plant species, cultural practices, planting standards, maintenance plans, benefits, and costs will be analyzed. The result will be best practice recommendations for slope restoration and continued maintenance. The scope of work includes the following tasks:

1. Analyze existing research regarding erosion control, restoration, and maintenance on steep slopes adjacent to freeways.
2. Identify field research plot location(s) in the I-696 corridor.
3. Provide MDOT with research work plan.
4. Partner with MDOT and vendor installation contractor to provide oversight on installation.
5. Perform subsequent maintenance of research plots.
6. Collect data.
7. Review and analyze data collected to determine best practices and cost-benefit ratios.
8. identity best practices for site preparation.
9. Identify native and non-native trees, shrubs, herbaceous perennials, and grasses suitable for Michigan roadside plantings. Compile research from the current project as well as a review of literature of similar studies and relevant guides from other DOTs to develop a new MDOT Plant Selection Guide
10. Present research results with final recommendations.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Hired Research Technician for the project (Deborah Trelstad), finalized plot site selection, and marked research plot boundaries. Collected mulch, compost, and soil samples from study area. Also identified comparative areas along I-696 (outside of study blocks) and initiated sampling and assessment, of areas where establishment was successful. Hired a designer to complete plot design drawings for bid specs and a graduate student (Liza Christopher) initiated literature review of related roadside planting protocols from DOTs in other states. MDOT did not completed the planting in fiscal year 2017 as originally planned.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Plot designs and plant lists were completed by MSU. MSU reviewed literature of related roadside planting protocols from DOTs in other states as well as roadside salts. The contractor for plot installation was selected (WH Canon) and installation started June 15, 2018. Plot installation and planting completed for blocks 4-6 and 4a-6a. Over 50 percent of plant installations were completed in 2018 in coordination with major construct of I-696 and despite operators strike. MDOT facilitated watering operations between local municipalities, MDOT, researchers and contractors. MDOT region provided additional funding for plant replacement due to mortality from I-696 construction damage and 2018 summer drought. MSU measured leaf chlorophyll index on Cornus, Physocarpus, Forsythia and Dierivilla plants in blocks 4-6. Collected leaf tissue for nitrogen (N) analysis. They also installed rain gauges data loggers/ temperature sensors on the plots and collected data. Periodic growth measurements taken for blocks 4-6 and 4a-6a.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Contractor completed installation of study treatments and plants in Blocks 1-3 in October 2018 on North side of I-696 West and East of the Nieman St. overpass. Sites for Blocks 1-3 were moved from their original planned locations to avoid additional lane closures during I-696 construction in Summer-Fall 2018. MSU researchers installed soil moisture sensors, soil temperature sensors and automatic data loggers in each plot. Data collection continued the site throughout the 2019 growing season and included plant growth, plant moisture stress, plant nutrient status, and photosynthetic rate. MSU Personnel conducted periodic

maintenance on the plots including hand- weeding and application of pre- and post-emergent herbicides. Project was amended to allow for longer-term (5 years) evaluation of the test plantings. In conjunction with project amendment, MSU Researchers developed a proposal for additional funding through MSU project GREEEN, which was funded at $35,000 per year for two years ($70,000 total). The grant funding will provide continuing support for an M.S. graduate student at MSU. Preliminary results of the project indicate the addition of compost greatly improved plant establishment and growth. The response of plants to compost appears to be primarily related to improve plant nutrient availability. To date, tillage appears to provide relatively little benefit for plant establishment and growth.

FISCAL YEAR 2020 ACCOMPLISHMENTS

MSU graduate student Maddy Dubelko, Drs, Cregg and Schutzki provided research results to date on the project at the Michigan Nursery and Landscape Association Great Lakes Trade Expo in January 2020. Covid-19 shutdown protocols affected early season site visits. When the MSU Research Team was cleared for travel, data collection and maintenance operations resumed, and the researchers were able to track plant growth, plant physiology, and soil testing throughout the remainder of the growing season. MSU researchers continued progress on the plant selection guide, which includes species from plant research and species based on an exhaustive literature search. Researchers installed two automated weather stations, one on the south side of I-696 and one on the north side of I-696. These stations will provide detailed micro-climate information that highlight conditions which affect plants by their respective locations. MSU used equipment currently on hand for one weather station and secured funding from the Michigan Department of Agriculture and Rural Development Horticulture fund to purchase equipment for the second weather station. It is expected that field operations will conclude late fall season 2020 and resume when weather and Covid-19 restrictions permit.

FISCAL YEAR 2021 ACCOMPLISHMENTS

MSU personnel completed intensive plant-based measurements on I-696 field plots in fall 2020. Data analysis and summary of data were completed in spring 2021. MSU Graduate student (Maddy Dubelko) completed an MS thesis documenting field study finding, which were also summarized in a project report submitted to MDOT. Key findings of the initial phase of the field research include Initial plant establishment was improved by addition of compost but was not affected by tillage. This indicates that top-dressing with compost is adequate, saving the cost of tilling sites before planting. The improvement of plant establishment with compost was related to improved soil and plant nutrition. Plant establishment varied with plant type as shrubs, particularly Diervilla, Physocarpus, and Cephalanthus selections had greater survival, growth and plant cover than most of the herbaceous and grass selections. MSU personnel (Dubelko and Schutzki) completed and submitted a plant selection guide for roadside plantings for Michigan including plant selection for various regions of the state and planting specifications. MSU personnel presented key findings and recommendations from the project to MDOT Metro region personnel via virtual meeting on May 25, 2021. MSU personnel developed a request and plan of work for an extension of the project through 2025. The project extension will allow continued monitoring of the site to determine longer-term impacts of site preparation on soil properties and plant performance as well as evaluation of freeway microclimates. MSU personnel continued site visits in 2021 to maintain the field plots, including pre- and post-emergent herbicide applications, maintain the weather stations, and collect data on plant coverage.

FISCAL YEAR 2022 Accomplishments

MSU personnel re-assessed plant coverage on all plots in September 2022. They maintained automated on-site weather stations and conducted periodic data downloads, conducted on-site plot maintenance, and applied pre- and post-emergent herbicides to control competing vegetation. MSU published a peer-reviewed article (Dubelko, M., Schutzki, R., Andresen, J., & Cregg, B. (2022). Compost addition, but not tillage, affects establishment of urban highway plantings. Urban Forestry & Urban Greening, 75, 127688) based on plant growth and soils data collected through the first three years of the project.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Complete data analyses from 2022 field data collection and data downloads from automated weather stations. Continue plot maintenance (pre- and post-emergent weed control) as needed on I-696 plots. Collect soil samples for soil pH and soil bulk density determination. Conduct foliar nutrient analyses. Prepare a manuscript for peer-reviewed publication on assessment of all plant selections (main plots and plant evaluation plots) – target journal Ecological Engineering. Prepare a summary of project findings to date suitable for professional publication such as the Michigan Landscape.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A Project Manager (PM) change was approved on 3/13/2018 due to staff changes at MDOT. Another contract revision was approved 7/15/2019 that added scope and budget as well as extending the end date to 4/30/2021. The scope addition was a deliverable for documenting plant recommendations to replace outdated MDOT guidance. One additional year was needed because of delays associated with the planting phase. Another extension was granted to 12/31/2025 to support long-term evaluation of roadside plantings and refine plant selection and long-term maintenance recommendations.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion in FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: John Belcher

CONTRACT/AUTHORIZATION NO.	2016-0069 Z6	PROJECT START DATE	7/1/2018
PROJECT NO.	201393	COMPLETION DATE (Original)	12/31/2019
OR NO.	OR17-201	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Upul Attanayake		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$33,680.17	Total Vendor Budget	$534,646.44
MDOT Budget FY 2022	$8,200.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$93,237.66	Total Budget	$534,646.44
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$500,861.96
		Total Amount Available	$33,784.48

PURPOSE AND SCOPE

MDOT currently waits 28 days after the placement of all concrete decks, rigid overlays, and patches on bridge decks before placing epoxy overlays and sealants. Often this extended period conflicts with traffic and weather limitations. With more information on the crack development and moisture release characteristics of MDOT standard concrete materials (Grade D, DM, SFMC, LMC, etc.) and special/patching mixtures, MDOT could potentially reduce the time required between placements.

The objectives of this project include the following:

1. Research criteria and benefits of epoxy overlay and sealant placement timing with regards to standard materials and special/patching material.
2. Develop a testing plan that encompasses the material used by MDOT.
3. Prepare specimens and conduct QAQC testing.
4. Evaluate overlay/sealant performance vs crack development and curing.
5. Analyze results and quantify the cost savings.
6. Recommend a procedure for determining overlay/sealant placement timing based on material/mix design.

The scope of work for this project includes the following tasks:

Task 1. Review state-of-the-art and state-of-the-practice.
Task 2. Develop a testing plan that encompasses the material used by MDOT.
Task 3. Prepare specimens and conduct QAQC testing.
Task 4. Evaluate overlay/sealant performance vs crack development and curing.
Task 5. Evaluate long-term bond strength and concrete durability properties of epoxy overlay.
Task 6. Analyze results and quantify the cost savings.
Task 7. Produce final research report.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The team was able to establish which testing protocols and mix designs will be included in the research.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Tasks 1 through the initial intent of 4 are complete. Work was added to task 4 for FY 2020.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Completion of tasks 4-6. A final report was submitted for review but will need to be updated when extended testing is complete.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Extended testing was completed, and the draft final report was updated accordingly.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Epoxy overlay bond strength was evaluated in August 2022 using more than 50 large concrete slab specimens exposed to Michigan outdoor conditions since summer 2019. The evaluation parameters included two concrete mix designs, two overlay types, three concrete ages at the time of overlay application, impact of silane pretreatment, exposure conditions (summer and winter) and duration, and concrete temperature at the time of bond strength evaluation.

The North and southbound bridges on the US-131 business route over Ravine Road were selected to evaluate thin epoxy overlay performance over patches and repairs. Grade DM concrete, latex modified concrete, and MasterEmaco T 1060 were the three patching/repair materials selected for this study. Our team documented all the patched areas and the material used in each patch. Also, two slab specimens were fabricated using each mix. E-bond 526 Lo-Mod thin epoxy overlay was applied over the bridge decks and the slab specimens. Bond strength was evaluated over the patches and the parent concrete.

The Sixth Street bridge over I -94 in the Southwest Region was selected. Initially, the deck was repaired by injecting epoxy into delaminated areas. Following healer sealer application, 8 cores were removed to evaluate the depth of penetration and the bond performance. These cores were photographed and prepared to pond with a mix of water and a blue dye to evaluate the water tightness of the sealed cracks.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

All bond strength data collected in 2022 from over 50 slab specimens will be analyzed and presented with the data collected since 2019 to compare overlay performance variation with respect to evaluation parameters. Bond strength was evaluated over the patches and the parent concrete in two bridge decks; results will be summarized and compared to identify the performance differences. The water tightness of the sealed cracks will be evaluated using the cores taken out from the Sixth Street bridge deck following the healer sealer application and results will be summarized and presented. A summary of activities will be developed and presented with implementation recommendations for thin epoxy overlays and healer sealers.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

On 6/6/2019, funds were shifted within the existing budget to cover the purchase of new equipment to manage the work schedule and case a set of new slabs to collect additional data for clarifying observation results. A contract revision was also approved on 9/30/2019 to add scope and costs for additional studies to evaluate material outside of the laboratory for a longer period, which also extended the project end date. Additional testing was added to the scope with additional costs to evaluate the performance of full-scale bridge application and to study longer term performance of materials. FY 2022 saw the project extended to include work on a summer project and a shift in the budget to include the purchase of a pendulum skid tester kit.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project completion expected FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Research on the Operational Costs and Benefits of Speed Feedback Signs

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Alonso Uzcategui

CONTRACT/AUTHORIZATION NO.	2018-0045	PROJECT START DATE	7/1/2018
PROJECT NO.	201399	COMPLETION DATE (Original)	6/30/2020
OR NO.	OR17-204	COMPLETION DATE (Revised)	12/31/2021
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Timothy Gates		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0	Total Vendor Budget	$200,704.74
MDOT Budget FY 2022	$12,000.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$62,081.20	Total Budget	$200,704.74
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$200,635.16
		Total Amount Available	$69.58

PURPOSE AND SCOPE

From 2011-2015, interchange ramps averaged over 40 fatal and severe injury crashes annually. Operationally, these crashes often result in long periods of closure with rerouted traffic impacting the transportation network and several secondary crashes. Interchange ramp Dynamic Speed Feedback Signing (DSFS) offers the potential to reduce crashes. This installation alerts drivers exceeding the recommended speed with a flashing speed value. There is potential to enhance communications with operations centers, vehicle to infrastructure intelligent transportation systems (ITS), and vehicle to vehicle ITS. Existing research on dynamic speed feedback signs many provide information on how to approach these efforts.

The goal of this research is to evaluate the effectiveness of sign technologies equipped with feedback systems versus traditional warning signs. The major task needed to achieve this goal include the following:

- Literature review and state of the practice survey of other states
- Site selection
- Identifying components
- Recommending equipment for purchase
- Procuring equipment for MDOT ownership.
- Installing equipment
- Testing and connecting equipment in lab setting
- Field installation
- Data Collection
- Analysis of data
- Recommendations and reporting

FISCAL YEAR 2018 ACCOMPLISHMENTS

The following tasks were completed:

- Literature Review
- State Agency Survey

FISCAL YEAR 2019 ACCOMPLISHMENTS

The following tasks were initiated:

- Site Selection
- Field Evaluation
- Data Analysis

FISCAL YEAR 2020 ACCOMPLISHMENTS

Additional field evaluations were conducted. Draft guidance has been developed for using DSFS on interchange ramps.

FISCAL YEAR 2021 ACCOMPLISHMENTS

New technology for detecting vehicle speed and displaying speeds was tested in 2021. The final report with recommendations and the guidelines is in progress and will be complete by the project end date.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The final report was approved, and the project was complete in December 2021.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
The end date was extended in March 2020 to allow field testing beyond summer 2020 and the budget was shifted to remove the subcontractor and transfer that work to staff at MSU. Another extension was granted to allow additional time to complete remaining field studies, perform a full analysis of the data, and complete the final project report.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)
The field evaluations consistently showed the dynamic speed feedback signs successfully lowered speeds as vehicles approached and entered the curves at freeway exit ramps. With data collected from the test sites, researchers identified a variety of optimization strategies that resulted in average speeds that were up to 4 mph lower than when the signs were not present. To help MDOT's traffic engineers replicate the signs' success statewide, the researchers developed a series of best practices for designing, operating, and installing effective dynamic speed feedback signs at freeway interchanges.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Sponsorship of the TRB Roundtable on Preparing for Automated Vehicles and Shared Mobility Services

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Andre Clover

CONTRACT/AUTHORIZATION NO.	N/A	PROJECT START DATE	01/01/2020
PROJECT NO.	203301	COMPLETION DATE (Original)	12/31/2022
OR NO.	OR18-016	COMPLETION DATE (Revised)	
RESEARCH AGENCY	National Academy of Sciences		
PRINCIPAL INVESTIGATOR	Director Paul Ajegba		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$25,000.00	Vendor Total Budget	$100,000.00
MDOT Budget FY 2022	$0.00	MDOT Total Budget	$0.00
PAID FY 2022	$25,000.00	Total Expenditures	$100,000.00
MDOT FY 2022 Expenditures	$0.00	**Total Amount Available**	$0.00

PURPOSE AND SCOPE

The objective of this Forum is to bring public, private and research organizational partners together to discuss, identify, and facilitate fact-based research needed to deploy automated vehicles and shared mobility services in a manner and timeframe that informs policy to best meet long-term goals. These long-term goals include increasing safety, reducing congestion, enhancing accessibility, increasing sustainability, and encouraging economic development and equity. National Academies' Forums are supported by financial contributions from sponsoring organizations with a two-year commitment preferred.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Research needs have been generated from convening activities and subsequent formation and implementation of Forum Annual Sessions:
TRB Symposium "Partners in Research – Transformational Technologies" was held in 2016.
Forum- Scoping Meeting was held in 2017.
February 2018 kick-off meeting of the Forum.
Forum approved to continue in FY 2020 and FY 2021.

Forum shared information of ongoing and recently completed research that will assist in meeting long-term policy goals.

Commissioned authored papers to inform the Forum and/or to provide perspectives on Forum current/future discussions.

Sponsored sessions at the annual TRB Automated Vehicle Symposium (AUVSI) and other appropriate venues to keep Forum sponsors and others up to date.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Continued annual meetings with state sponsors.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Continued annual meetings with state sponsors. (Paid in full during FY 2021.) TRB invoice payment for TRB AVS/SMS project was processed under to cover MDOT's participation for the period July 1, 2021 – December 31, 2022.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT's financial support is based on the Director's authorized approval to use SPR Part B federal and state funds. The job was extended to include a total of four years participation.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

None.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Concrete Deterioration of Prestressed Bridge Beams

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Rick Liptak

CONTRACT/AUTHORIZATION NO.	2016-0069 Z9	PROJECT START DATE	3/1/2019
PROJECT NO.	204644	COMPLETION DATE (Original)	2/28/2021
OR NO.	OR19-017	COMPLETION DATE (Revised)	7/31/2022
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Upul Attanayake		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$309,318.50
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$42,236.25	Total Budget	$309,318.50
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$308,882.88
		Total Amount Available	$435.62

PURPOSE AND SCOPE

Many prestressed concrete beam bridges in Michigan constructed in the 1970's and 1980's exhibit mild to significant concrete deterioration due to Alkali Aggregate Reactivity (AAR). The primary material compatibility issue lies with Alkali Silica Reactivity (ASR), though Alkali Carbonate Reactivity (ACR) is also of concern. Deterioration due to AAR has necessitated premature repairs on a number of bridges – including, in some cases, full superstructure replacements. It is currently unknown how widespread this problem is in Michigan bridges and whether bridges built in the 1990's and beyond are also susceptible to deterioration due to AAR. As part of this research project, WMU will investigate the following six (6) tasks:

(1) The status of MDOTs bridge inventory and condition with respect to AAR
(2) Effects of AAR on the capacity of prestressed concrete beams
(3) Guidelines for load rating given the presence of AAR
(4) Options for field testing for AAR
(5) Rehabilitation options for prestressed concrete beams with AAR
(6) Guidelines for bridge inspectors for both National Bridge Inventory (NBI) component ratings and AASHTO National Bridge Element ratings in alignment with the Michigan Structure Inspection Manual (MiSIM) and Michigan Bridge Element Inspection Manual

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task 1 Accomplishments:

- Developed and administered a survey of Region Bridge Engineers to help determine the extent of cracking on MDOT-owned prestressed concrete (PC) beam bridges
- Prepared a list of NBI/SIA and Element data needed for inventory analysis.
  - Analyzed this list as well as inspector comments
  - Distress charts were developed based on analysis of inspector comments on SIA reports to identify clusters of bridges with distress types that indicate specific concrete deterioration mechanisms
- Survey of PC girder fabrication inspectors and precast plant staff was administered.
- Two precast plants were visited to document girder end distress types and plant experience
- Inspection templates developed for field review of bridges with suspected ASR in PC girders
- Field reviews performed on multiple University Region bridges with PC girders

Task 4 Accomplishments:

- Uranyl acetate testing method was used to benchmark assessment procedures
- Data collected using Raman Spectroscopy testing method to evaluate the possibility of using such advanced technologies for detecting ASR

Task 5 Accomplishments:

- Literature review of guidelines and best practices of various agencies
- Products from MDOT's Qualified Products List (QPL) were reviewed
- Application methods, effectiveness, and challenges of such methods were documented

FISCAL YEAR 2020 ACCOMPLISHMENTS

Task 1 Accomplishments:

- Entire PCI beam database was analyzed to develop a list of state-owned bridges with longitudinal cracking potentially due to materials-related deficiencies such as alkali-silica reaction.
- This task is 100% complete.

Task 2 Accomplishments:

- Developed finite element models to evaluate the effects of longitudinal cracks due to ASR on the stress-strain distribution and subsequent load capacity of PC girders.
- This task is 30% complete.

Task 3 Accomplishments:

- Rating guidelines, MDOT policies and practices, practices by other agency guidelines and literature were documented.

Task 4 Accomplishments:

- Further evaluation of field methods for testing for ASR.
- Several options were investigated and tested, such as Uranyl Acetate testing.
- This task is 45% complete.

Task 5 Accomplishments:

- Review the performance and advantages/drawbacks of using typical products as well as proprietary innovative products available in the market to slow progression of ASR in PC girders.
- Develop an experimental program for assessing such products for mitigating/controlling ASR.
- A two-phase plan was developed and shared with the Research Advisory Panel (RAP). RAP comments were incorporated into plan.
- This task is 50% complete.

Task 6 Accomplishments:

- Develop rating guidelines for bridge inspectors for NBI component and AASHTO element rating systems.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 2 Activities:

- Developed a comprehensive procedure and a Math CAD calculation sheet to estimate the capacity of prestressed concrete beams.
- This task is 95% complete.

Task 3 Activities:

- Girder capacities were assessed with respect to the documented deterioration and the LFR/LRFR methodologies. A MathCAD calculation sheet was developed to assess the load capacity of girders with different distress types.
- This task is 95% complete.

Task 4 Activities:

- Evaluated uranyl acetate and ASR Detect ® methods using several different aggregate types subjected to various exposure conditions. Also, several concrete and mortar specimens with ASR were evaluated using the same methods.
- This task is 100% complete.

Task 5 Activities:

- Phase II specimens were fabricated. A control room was built to maintain high temperature on the specimens to accelerate alkali-silica reaction. Selected sealants and coatings were applied on one set of specimens. Specimens with coatings and sealants were exposed to about 120°F to evaluate breathability performance.
- This task is 90% complete.

Task 6 Activities:

- Procedures were developed.
- This task is 95% complete.

Task 7 Activities (NEW):

- Crack depth of laboratory specimens and two prestressed I-beams was evaluated to determine impacts to prestressing strands in load rating analysis.
- Task is 100% complete.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 2 Activities:

- Submitted draft procedures for RAP review and response. Finalized the procedures based on RAP input.

Task 3 Activities:

- Submitted draft guidelines for RAP review and response. Finalized the guidelines based on RAP input.

Task 5 Activities:

- Completed testing to evaluate coating and sealant performance with a special focus on crack-bridging ability of coatings.

Task 6 Activities:

- Submitted draft guidelines for RAP review and response. Finalized the guidelines based on RAP input.

Task 8 Activities:

- Developed draft deliverables.
- Final Report developed and accepted
- Submitted all deliverables

Research project is complete and final report accepted. Developing implementation plan and getting that kicked off will be the activities for FY23. The team to do this will be internal MDOT staff.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The contract was revised 11/17/2020 to increase the budget and expand the scope. Additional studies were authorized to evaluate the material outside the laboratory. There was also a change in MDOT Project Manager and end date extensions to allow for more thorough and complete project report.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The following is from the Recommendation of the Final Report and will be the basis for the upcoming implementation plan:

1. About 12% of the MDOT I-beam bridge inventory has map and/or longitudinal cracking on fascia beams, which is an indication of concrete deterioration. The location of these bridges is provided in the ArcGIS file submitted with this report. The fascia beams need to be inspected to identify the type of maintenance and repair actions needed to extend the service life.
2. The inspection guidelines presented in this report can be seamlessly integrated into the current practice. An implementation example demonstrating the updated procedures is provided in the report. It is recommended to upgrade the current procedures using an image-based inspection template to collect consistent and quality data that can be used for the causal evaluation of deteriorations and distresses of bridge elements to develop appropriate maintenance and repair strategies.
3. Uranyl acetate is the most reliable method available to screen for ASR under field conditions. A major challenge of implementing this method in the field is the interference from the Concrete Deterioration of Prestressed Bridge Beams ambient light while observing the unique florescence signatures using ultraviolet (UV) light. It is recommended to develop a remote-controlled digital imaging system to alleviate the field implementation challenges.
4. It is necessary to identify the effective number of prestressing strands in deteriorated PSC Ibeam sections for flexural load rating. It is recommended to follow the procedure demonstrated in this report to develop crack depth vs. crack width relationships to identify the possibly damaged strands in a beam cross-section. Until then, it is recommended to assume a 2.5 in. depth for longitudinal cracks that are narrower than 0.016 in.
5. It is recommended to use the Mathcad calculation sheet provided with this report to calculate necessary input parameters for AASHTOWare BrR for load rating of box-beams. The sheet can also be used as a stand-alone load rating tool for box-beams. The report provides the necessary guidelines to identify the ineffective strands in a distressed box-beam section.
6. A suitable concrete protection method needs to be selected based on the degree of concrete deterioration, life-cycle performance, and the cost. Considering the available guidelines, 100% silane sealants can be applied to protect components with surface crack widths less than 0.002 in. However, when a surface is exposed directly to a source of moisture, such as the outside and bottom surfaces of a fascia beam, it is recommended to use a concrete protective system consisting of a breathable coating and a penetrating sealant as the primer. Based on the crack bridging ability of the breathable coatings evaluated in this study, concrete surfaces with cracks as wide as 0.004 in. can be protected.
7. The MDOT product qualification process requires evaluating penetrating sealant performance using a Grade D structural concrete mix with a 0.45 water-cementitious material ratio (w/c). The product evaluation methods listed in the current MDOT specifications need to be revised to reflect the concrete mixes used in PSC bridge beams, curing methods, and the concrete age at the time of sealant application. It is recommended to review and evaluate the Alberta Transportation specifications for Type 1c sealers, which are recommended for precast concrete, to develop MDOT specifications for the selection of sealers for PSC bridge beams.
8. Considering the cost and breathability performance, Si-Rex 03 with Si-Primer is recommended over the Ultra Spec® Masonry Elastomeric Waterproofing Coating Flat 0359 with SIL-ACT® ATS-200 as the primer. It will improve protection to the surface if there are no active cracks that are wider than the crack bridging limits specified in the manufacturer technical data sheets. As of 09/2021, Si-Rex 03 with Si-Primer costs $542 per 1000 ft2, whereas the Ultra Spec® Masonry Elastomeric Waterproofing Coating Flat 0359 with SIL-ACT® ATS-200 costs $1058 to cover the same area.
9. It is recommended to use the above-stated coating systems at the fabrication yard on new fascia beams to protect all the surfaces, except the top. Available guidelines support the application of coatings at the 4th day from fabrication. For the fascia beams on in-service bridges, all the exposed surfaces are recommended to be protected using any of the above coating systems since the moisture is drawn towards the outside surface as it warms up when exposed to sunlight, while the moisture enters through other surfaces.
10. It is recommended to evaluate the crack bridging ability and long-term performance of SiRex 03 with Si-Primer and the Ultra Spec® Masonry Elastomeric Waterproofing Coating Flat 0359 with SIL-ACT® ATS-200 as the primer to define the service life of such systems/products.

11. It is recommended to adopt the sealant and coating evaluation method implemented in this study to evaluate the system performance since it considers the substrate, substrate preparation, application, curing, and the type of sealants and coatings as system parameters.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Training Tools for Effective Advancement of Digital Technologies for Construction Field Operations

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Lindsey Renner

CONTRACT/AUTHORIZATION NO.	2020-0159	PROJECT START DATE	2/1/2020
PROJECT NO.	204646	COMPLETION DATE (Original)	4/30/2022
OR NO.	OR19-133	COMPLETION DATE (Revised)	10/31/2022
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Mohamed El-Gafy, Ph.D., P.E.		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$21,603.76	Total Vendor Budget	$205,881.39
MDOT Budget FY 2022	$3,160.00	Total MDOT Budget	$398.79
Vendor FY 2022 Expenditures	$83,844.08	Total Budget	$206,280.18
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$131,546.45
		Total Amount Available	$74,733.73

PURPOSE AND SCOPE

Simple and effective training tools are needed to increase the knowledge base of construction field staff to support sustainable construction field operation practices. Core competency development with software and hardware technologies is necessary to realize the benefits of digital technology. Engineer and technical field staff skillsets vary widely in preparation for use of these technologies and practices. Training opportunities are often restricted to on-the-job learning and growth potential through exposure and learning with consultant staff field support, thus bridging knowledge gaps. Construction field staff training typically lags in comparison to the contracting and consultant industries. Training in the field or on-the-job has not been sustainable as opportunities to use knowledge gained year to year creates a population of construction field staff with varying levels of proficiency which in turn yields limited project management consistency and alignment within the Michigan Department of Transportation. Staff should have exposure to digital technologies as the standard for construction field operations through education and training.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Contract authorization was delayed until Fiscal Year 2020. This Fiscal Year, proposals received were scored and the selected research organization was announced.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The first year of the project has focused on data collection and analysis. COVID-19 interfered with this first phase task as MSU was not able to perform this work for several months between March and July. Work resumed in August of 2020. Each Transportation Service Center (TSC) and Region office was contacted and those that responded (~95%) were interviewed on the state of the practice using digital technology in construction including the areas of 3D modeling, project PDFs and digital survey equipment used for payment. Assets management was not included as there are other ongoing efforts in the department regarding this topic. Subject matter experts within central office were also interviewed in the later part of 2020 for their perspective in support and policy roles.

FISCAL YEAR 2021 ACCOMPLISHMENTS

A brief overview presentation of the project was provided by the PI at the Statewide Construction Alignment Conference. COVID-19 continued to hinder progress regarding student assistance for the project until the August/September timeframe when traditional college schedules resumed including student availability.

Task 1: Performed an assessment of knowledge and experience in 3D technology, project PDF's, and asset management of construction field operation staff in all seven regions. (Progress 85%)

- As noted in the 2020 annual report asset management was not pursued to assist in focusing project efforts.
- Task 1 was expanded to include assessments of other leading states in training for digital technologies.
- All assessments within the state of Michigan have been complete. Other state assessments are ongoing. FHWA resource expert for digital as-builts, David Unkefer, is anticipated to provide more direct focus to the assessment effort as David also has been following states progression in this area.
- A document report is anticipated before calendar year end 2021.

Task 2: Developing a performance measurement tool for advancing the training solution and to test the solution effectiveness to ensure training is effective and sustainable. (Progress 75%)

- Work has begun on a simplified version of the Kirkpatrick business partnership model to evaluate the training program. This task was delayed for the reasons noted above and is anticipated to complete in November of 2021.

- Additional meeting with MDOT training personnel is needed to identify the MDOT specifications and requirements for implementing performance measurement tools. These meeting should begin early FY 2022.

Task 3: Working with subject matter experts at MDOT to further develop BIM for transportation processes by improving the integration of e-reference guides and developed training curriculum for use through MDOT. (Progress 10%)

- Only two subject matter experts (SME) have been identified with content that could be incorporated in the training: Glenda Bowerman (Central Office – Design Survey Support) and Dale Johnson (Metro Region). Additional SME (internal to MDOT or out of state SMEs) will need to be identified and their work artifacts need to be collected and analyzed.
- The PI started working with Glenda Bowerman and collected her training materials. The vendor's research team is currently working on analyzing the materials and provide some recommendations.
- Work on this task began earlier than originally planned. Work began in September of 2021 and is expected to be completed in March of 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 1 is complete. Virtual Interviews were conducted to review and assess the knowledge and experience in 3D technology and project PDFs of construction field operation staff in all seven regions. The team could not find any substantial work on asset management due to the loss of personal championing this area to the industry. Per agreement with the formal project manager, this area excluded from the project scope.

Task 2 is 75% complete. The original target completion date was June 30, 2022, and the revised target completion date is November 30, 2022. The research team has developed a proposed performance measurement protocol based on the Kirkpatrick Business Model and the application of Kern's 6-Step approach in curriculum development. The proposed protocol will be implemented during development of the MDOT Subject Matter Expert (SME) training.

Task 3 is 50% complete. The original target completion date was June 30, 2022, and the revised target completion date is December 29, 2022. The current e-reference guides and available training curricula have been collected and evaluated against the current best practices of curriculum development. Few isolated training materials were found, and the team is currently working on identifying additional resources. The research team worked closely with the project manager to identify current pilot projects and means for other material/artifact collection.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

A project time extension is planned to allow the study of the I-696 Project that will be utilizing the state's first Bridge Model as part of the contract.

The contract will now include the following tasks:

- Working with SMEs at MDOT to further develop Building Information Modeling (BIM) for transportation processes by improving the integration of e-reference guides and developed training curriculum for use throughout MDOT.
- Developing multiple educational schemes/mechanism for training.
- Revising and submitting a final report.

Task 4 will be completed by the newly revised target completion date.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

An extension as a renew and amend is in process to extend project time to April 30, 2023, with no charges allowed between November 1, 2022, and the final amendment approval date.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project completion expected in FY 2023.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Development of a Network-level Evaluation Tool for Managing ITS Infrastructure

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Joseph Gorman

CONTRACT/AUTHORIZATION NO.	2019-0377	PROJECT START DATE	5/1/2019
PROJECT NO.	204648	COMPLETION DATE (Original)	6/30/2021
OR NO.	OR19-052	PROJECT COMPLETION FY 2021	
RESEARCH AGENCY	Cambridge Systematics, Inc.		
PRINCIPAL INVESTIGATOR	Samuel C. Van Hecke		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$473,934.56
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$0.00	Total Budget	$473,934.56
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$465,449.94
		Total Amount Available	$8,484.62

PURPOSE AND SCOPE

The purpose of this project is to evaluate Intelligent Transportation Systems (ITS) network performance and develop and deliver a user-friendly performance evaluation tool for use on existing or proposed ITS programs. The project includes Development of a vision for the tool; compilation of the existing ITS inventory and relevant roadway performance data; defining the limits of the network; evaluating current ITS performance; identifying gaps in ITS coverage and density; development of the performance evaluation tool; development of a tool implementation and training strategy; and documentation of research in a final report.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Held project kickoff meeting with the Research Advisory Panel (RAP). Also held a project visioning session where a draft and final vision were created. Began compilation of existing ITS inventory and relevant roadway performance data and defining the limits of the network.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Continued regular progress meetings with the RAP. Completed compilation of existing ITS inventory, relevant roadway performance data and defining the limits of the network. Completed evaluation of current ITS performance and started identifying gaps in ITS coverage and density. Began development of the performance evaluation tool.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Began MDOT testing of beta version of evaluation tool in first quarter 2021. Internal tests and evaluations were performed to provide feedback to the project team prior to delivery of the tool's final version. Project was successfully completed on schedule.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project was included in MDOT's FY 2022 program expecting a request for a time extension that was not necessary.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A change in project manager from Brandan Maurer to Joseph Gorman was approved on 9/15/2019.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

MDOT ITS Program Office will continue to explore the expansion of the methodology developed under this project as part of a larger framework for ITS project selection and performance evaluation.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Recruit and Maintain/Upgrade a High-Tech Workforce for Emerging Technologies

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Elise Feldpausch

CONTRACT/AUTHORIZATION NO.	2019-1038	PROJECT START DATE	10/15/2019
PROJECT NO.	204651	COMPLETION DATE (Original)	6/30/2021
OR NO.	OR19-129	COMPLETION DATE (Revised)	9/30/2021
RESEARCH AGENCY	Center for Automotive Research		
PRINCIPAL INVESTIGATOR	Kristin Dziczek		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$253,065.27
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$0.00	Total Budget	$253,065.27
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$230,161.66
		Total Amount Available	$22,903.61

PURPOSE AND SCOPE

The construction and operations of transportation-related infrastructure is poised to undergo a dramatic shift due to rapidly emerging technologies in the next ten years. This shift will expose work force to these emerging technologies that are either already filtering in or will rapidly impact the industry soon. Upgraded training is necessary to ensure the work force is ready for the technological shift. It will be critical to identify the attributes and impacts of emerging technologies that will require a differently trained work force for construction and operations of transportation-related infrastructure.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The contract was delayed from Fiscal Year 2019 to Fiscal Year 2020. Proposals received were scored, the selected research organization was announced, and the contracting process was started.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The contract was authorized and a state of practice review for transformative technologies was completed. A recommendation for ideal core competencies and organization structure was also created. Research was conducted on best practices by like organizations with recruitment strategies. Areas of the organization most impacted by transformation technologies were also identified. The Principal Investigator (PI) holds monthly check in calls with the MDOT Project Manager (PM) and work is approximately 35 percent complete.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Contract was completed in Q3 2021. All deliverables have been finalized and submitted for MDOT approval. These include the work force development strategies to train and recruit a new generation of workforce as well as maintain and upgrade the current staff to reflect the impacts of transformational technologies. This included the delivery of the final report and the RAP debrief of the results.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project was extended during FY 2021 for three additional months due to problems with subcontractors. It was included in MDOT's FY 2022 program expecting a request for another time extension that was not necessary.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date of the project was extended to ensure time for obtaining and addressing committee comments on the final report as contract authorization was delayed.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Based on the results of this research MDOT would work to establish a potential realignment of structure to support MDOT's goals of delivering cutting edge systems and services. This will help to position staff in a way to sooner adapt to emerging technologies and be better suited to effectively deliver a better product for our customers.

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5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Integration of Unmanned Aerial Systems Data Collection in Day-to-Day Usage for Transportation Infrastructure

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Steve Cook

CONTRACT/AUTHORIZATION NO.	2019-0311 Z1	PROJECT START DATE	6/12/2019
PROJECT NO.	204653	COMPLETION DATE (Original)	6/11/2022
OR NO.	OR19-064	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	Colin Brooks		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$100,505.89	Total Vendor Budget	$871,003.00
MDOT Budget FY 2022	$8,888.89	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$228,831.00	Total Budget	$871,003.00
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$871,003.00
		Total Amount Available	$0.00

PURPOSE AND SCOPE

Based on Unmanned Aerial Systems (UAS) data collection, develop workflows to implement applications into regular use that will meet the Department's needs for timely, high-resolution, safely collected, repeatable, and objective data. Make these data, applications, and workflows part of day-to-day usage for management and operations (planning, design, construction, operations, maintenance, asset management, etc.), especially under new federal rules that are increasing the practical deployment of UAS. Enable leveraging these rapidly advancing technologies to meet operational data needs for connected vehicle corridor surveillance, construction site monitoring, asset management, traffic monitoring, geophysical evaluations, incident management, infrastructure inspection (e.g., bridges, roads, railways, etc.), confined space safety assessment, and pro-active monitoring of roadways and bridges, among other applications.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Fieldwork was conducted along I-96 Eastbound in Lansing to collect bridge inspection, traffic monitoring, and construction inspection data and work with MDOT Subject Matter Experts (SMEs) and other staff.

- Collected data on four bridges and one corridor segment, including one bridge undergoing construction repair of joints.
- Collected 10+ hours of traffic data along I-96 west bound and at nearby intersections, including detour areas of interest to construction SME Jason Early.
- Demonstrated using small quadcopter with obstacle avoidance to capture imagery from under bridges.

Performed initial training on the Bergen Hexacopter to MDOT Aeronautics staff.
Fieldwork conducted on an I-69 bridge near Lansing to demonstrate bridge inspection with multiple drone platforms including use of the Flyability Elios for difficult-to-access area imaging.
Began communications with MDOT SMEs on Traffic Operations (Milestone 1), Bridge Inspections (Milestone 2), Construction Inspection (Milestone 3), and Light Detection and Ranging (LiDAR) UAS for Design Survey (Milestone 4) to plan future fieldwork, training, and other implementation activities.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Continued development of fully automated traffic analysis tool using machine learning.
Collected traffic data from M-14/US-23 weaving location and I-96 / Williamston Rd corridor location.
Analyzed traffic video from I-96 East bound bridges with vehicle speed, trajectory, and vehicle numbers calculated.
Collected UAS-based LiDAR data for Standish / US-23 and US-127 / Rives Junction sites in collaboration with Surveying Solutions Inc., with accuracy comparisons completed for Standish site, and alternative ground control markers demonstrated as useful at US-127 sites.
Deployed multiple UAS at I-75 site near Monroe in collaboration with Collins Engineers to create 3D models and distress detection layers.
Assisted MDOT Aeronautics with Federal Aviation Administration (FAA) Part 107 training.
Refined the thermal delamination detection algorithm and implemented it and the Spallgorithm into an ArcGIS Pro tool for easy use by MDOT in bridge inspection processes.
Deployed UAS three times for Construction Inspection at the I-496 Pave the Way site, including the MD4-1000+ high-resolution photogrammetric survey UAS purchased for MDOT use through this project, and demonstrated measurement of construction progress using Computer Aided Design (CAD) and Graphic Information Systems (GIS) software tools.
Documented methods for using UAS-derived 3D data to create Building Information Models for bridges to help record location-specific element-level defect data.
The project is on schedule with approximately 45 percent of work complete.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Integrated traffic video data collection and automated analysis methods into a demonstration of collection traffic volume and origin/destination data for MDOT's US-23/M-14 weaving area near Ann Arbor. Developed a method to stream live traffic video to a Michigan Tech server for re-broadcast to MDOT Traffic Operations Centers.

Completed optical and thermal surveys of construction sites to demonstrate how these UAV-based sensors can be used to calculate payable milestones using quantitative UAS data. Submitted a paper for publication on these methods to the Transportation Research Record journal.

Collected hyperspectral data of bridge features in Houghton to understand how this technology could help identify steel beam distresses.

Re-surveyed the Uncle Henry and Beyer Rd bridges, previously surveyed via optical and thermal sensing in Phase II back in 2016, so we could evaluate how UAS sensing can be used to detect changes in spalling and delamination over time.

Documented our results on optimal LiDAR UAS ground control targets and shared results with MDOT Design Surveys and other interested staff.

Revisited the LaPlaisance Creek / I-75NB bridge during better thermal conditions to evaluate finding delaminations present at this bridge that a 2020 scoping survey showed has delamination distresses.

Advanced the thermal delamination (TADDA) and Spallgorithm analysis routines to the point of availability into MDOT's new standard for GIS software, ESRI ArcGIS Pro.

Started preparation of final data sets to share from traffic operations, construction inspection, and bridge inspection uses cases so that they can be integrated into MDOT workflows and databases. Finalized UAS lidar for design survey use case results in MDOT's preferred CAD format.

Held use-focused meetings for all four uses cases with MDOT's Subject Matter Experts (SMEs) to ensure that project results and methods continued to focus creating outputs useful for MDOT's operations and asset management efforts.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Conducted traffic analytics using UAV videos for both weaving area and Williamston Road applications and compared to the data provided by MDOT (Use Case 1).

Compared the change in delamination over time in the Uncle Henry and Bayer roads using TADDA algorithm. (Use Case 2).

Prepared user manual for the TADDA toolbox (Use Case 2).

Developed an automation framework for scaling and contouring the HMA behind the paver, to present the thermal differences (Use Case 3).

Developed a set of temperature segregation metrics as (a) Ratio of Cool Areas, (b) Ratio of Potentially Segregated Areas, and (c) Ratio of Highly Segregated Areas to quantify the temperature differentials and problematic areas on the HMA mat (Use Case 3).

Continued preparing examples from Uses Cases 1 through 4 to share with Mixon-Hill for potential integration into TFM database (Milestones 5 and 6). Scheduled meeting with Mixon-Hill for TFM integration.

Complete live traffic video streaming demonstration using UAS high-resolution video sent from the UAS via the Michigan Tech server to a MDOT TOC.

Create a 3D model of post-construction environment for the I-69/Charlotte site to compare paved asphalt volumes to planned volumes.

Complete analysis of 2016 vs. 2021 changes in delamination and spalling extent at Uncle Henry and Beyer Road bridges.

Complete LaPlaisance Creek exit ramp thermal analysis.

Document results of Houghton-area hyperspectral data collection of steel beam distresses.

Meet with traffic monitoring, construction inspection, and bridge inspection SMEs to ensure that project results are being integrated into appropriate MDOT workflows and databases such as DUAP/TFM.

Held training meetings on UAV data collection and analysis methods with SMEs.

Held UAS data collection training and site visit in Bay Region for MDOT bridge inspectors.

Submitted Research Spotlight document.

Completed and submitted Final Report meeting MDOT requirements, including holding final project review meeting.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project results have been documented and shared with MDOT in preparation for use in an Implementation Action Plan.

Subject Matter Experts were met with for Traffic Monitoring, Bridge Inspection, Construction Inspection, and LiDAR UAS for Design Surveys for training and to share project results with a goal of implementation into MDOT workflows and databases.

All project equipment received and turned over to Linn Smith, MDOT Aeronautics Division.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE:	Synthesis of National Best Practices on Pedestrians and Bicycle Design, Guidance and Technology Innovations			
FUNDING SOURCE: ☒ SPR, Part II	☐ OTHER (*PLEASE EXPLAIN)*			
PROJECT MANAGER: Mark Bott				
CONTRACT/AUTHORIZATION NO.	2019-0369		PROJECT START DATE	4/1/2019
PROJECT NO.	204654		COMPLETION DATE (Original)	9/30/2020
OR NO.	OR19-072		COMPLETION DATE (Revised)	12/31/2021
RESEARCH AGENCY	Michigan State University (MSU)			
PRINCIPAL INVESTIGATOR	Timothy Gates			

BUDGET STATUS

FY 2022 Budget			Total Budget	
Vendor Budget FY 2022	$0.00		Total Vendor Budget	$206,101.91
MDOT Budget FY 2022	$0.00		Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$12,869.92		Total Budget	$206,101.91
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$206,058.27
			Total Amount Available	$43.64

PURPOSE AND SCOPE

This synthesis is a comprehensive review of the Department's scoping and design guidance, along with a comparison of national efforts and best practices supporting active transportation to accelerate our efforts. This review is to be followed by recommendations related to traffic signing, traffic signal, and operational technologies to minimize excessive delays or detours and improve roadway crossings for pedestrians and bicyclists. Additionally, recommendations on geometric design changes that can improve user visibility, improving access, safety and mobility for people who travel on foot or by bicycle, should be considered. The project scope includes the following tasks:

- Identify best practices nationally or internationally.
- Review current MDOT best practices and all research available currently.
- Review lessons learned from other cities, state, etc. on processes they utilized and implementation.
- Review Americans with Disabilities Act (ADA) compliance and innovations.
- Develop/update best practices.
- Broaden scoping and design review to consider additional elements related to bike/pedestrian.
- Provide recommendations within MDOT scoping/design processes.
- Provide technical assistance to the Multimodal Development and Delivery (M2D2) process.
- Develop materials to promote bike/pedestrian importance within MDOT.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task 1 – Identify Best Practices: A synthesis of the reviewed literature is ongoing. All pertinent references have been collected (400-500 total) and have been synthesized in a best practices document and summarized in appendices. This document is under internal review.

Task 2 – Review Current MDOT Practices: Several M2D2 documents are currently unavailable and, thus, not ready for review by the MSU team. MSU has reviewed and provided comments on the draft crosswalk guidance sent to the team by Carissa McQuiston. Other relevant documents are being reviewed.

Task 3 – Examine Lessons Learned from Other Cities and States: A review of lessons learned from other cities and states is ongoing and a synthesis document has been prepared. This document is under internal review.

Task 5 – Conduct Interviews of Stakeholder Groups: MSU is developing a "State of the State" survey they believe will be an appropriate instrument to obtain necessary statewide sampling of stakeholder opinion to consider additional elements related to bike/pedestrian. A draft set of questions was circulated at the kickoff meeting and feedback has been received back from MDOT. The research team has corroborated this feedback and is in the process of modifying the survey for distribution. This will include three separate surveys for advocacy groups, agencies, and public opinion. Advocacy groups and public agencies have been identified for distribution.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Task 1 – Identify Best Practices: A synthesis of the reviewed literature has been completed. Pertinent references were collected, reviewed, and synthesized in a best practices document and summarized in appendices. The summarized best practice findings were presented at the December 2019 Research Advisory Panel (RAP) meeting. The draft document was submitted to MDOT for review.

Task 2 – Review Current MDOT Practices: MSU has reviewed and provided comments on two drafts of the MDOT Guidance for Pedestrian Crosswalks on Trunklines. They submitted a first draft of the revised Best Design Practices for Walking and

Bicycling in Michigan. MDOT comments were returned and MSU has made most of the modifications. Some items need to be settled before the second revision can be submitted back to MDOT for finalization, including the following:

- Inclusion of the Safe Routes to School (SRTS)/Transit Assistance Program (TAP) funding discussion - Initially requested by MDOT but some reviewers suggested removing or expanding to include other funding sources for ped/bike treatments.
- Address how to handle the interim approval situation.
  - All relevant interim approvals are noted but limited detail on the process.
  - What about situations where there is an established interim approval process, but the treatments have not been used in Michigan to date?
  - What about situations where new treatments are compliant with the Manual on Uniform Traffic Control Devices (MUTCD) but there are no approved devices (such as bicycle detection)?

Task 3: Examine Lessons Learned from Other Cities and States: A review of lessons learned has been completed and a synthesis document has been prepared. The summarized lessons learned were presented at the December 2019 RAP meeting. The draft document was submitted to MDOT for review along with an executive summary.

Task 4: Review ADA Compliance with Innovations: A review of ADA compliance as it relates to MDOT manuals was completed and a synthesis document has been prepared. The summarized findings were presented at the December 2019 RAP meeting. The draft document was submitted to MDOT for review along with an executive summary.

Task 5: Conduct Interviews of Stakeholder Groups: This will include three separate surveys for advocacy groups, agencies, and public opinion.

- Public Survey
  It was decided that the MSU "State of the State" survey would be the appropriate instrument to obtain necessary statewide sample for the public opinion survey. The questions have been vetted by the MDOT RAP and submitted to the MSU State of the State survey manager for inclusion in the summer 2020 survey. The State of the State survey manager has noted that the summer survey was delayed due to COVID-19 work restrictions, and has subsequently been shifted to an online survey of 1,000 Michigan residents. The MSU team worked with the MDOT panel to quickly modify the survey to an online format and the final survey was sent to the SOSS manager for contracting and implementation in late September 2020. The MSU team expects to have the final survey results in-hand by the end of 2020. Topics noted in the survey will include:
  - Frequency of Ped/Bike travel by trip purpose
  - Satisfaction with Ped/Bike infrastructure availability
  - Satisfaction with Ped/Bike infrastructure safety.
  - Direct vs. safer route.
  - Side of the road when walking/biking.
  - Temporary/sustained change in Ped/Bike travel frequency due to the COVID-19 pandemic.
- Advocacy Group Survey
  The team has also received input from MDOT regarding specific advocacy groups to survey. This includes the League of Michigan Bicyclists, Complete Streets Coalition, and the Kent County Disability Network. Due to COVID-19 restrictions, the MSU team plans to interview the leadership of the advocacy groups and not attempt to distribute broadly to constituents. The advocacy group survey questions are being developed by MSU and will be circulated to MDOT RAP shortly.
- Agency Survey
  The MSU team implemented a series of online surveys through the Qualtrics platform of professionals involved with implementation of multimodal transportation infrastructure. This includes Michigan local agencies and Metropolitan Planning Organizations (MPOs), out-of-state DOTs, and local agencies identified within Tasks 1 and 3 as exhibiting best practices for multimodal design. The survey was reviewed by the MDOT Project Manager (PM) and finalized.
  Questions included the following topics:
  - Implementation of Ped/Bike, and traffic calming strategies.
  - Use of National design guides.
  - Use of State and Local design guides.
  - Non-motorized masterplan availability and updates.
  - Collection and inventory for non-motorized data.
  - Micro-mobility considerations.

  The survey was sent to the ped-bike coordinator within all 50 states. It was modified slightly and sent to local agencies, both nationwide and within Michigan. The survey was kept open for response collection until September 2020. The data has been obtained and preliminary results were presented to the MDOT RAP panel in early October 2020. Final analysis of the survey results will be included in the Final Report for the project.

Task 6: Develop and Update Best Practices: MSU has assisted MDOT with updates to the following best practice documents:

- Guidance for Pedestrian Crosswalks on Michigan State Trunkline Highways (completed)
- Best Design Practices for Walking and Bicycling in Michigan
  - First draft sent to MDOT for review
  - Feedback received from MDOT RAP and PM
  - MSU is awaiting final clarification on select feedback and will submit second/final revision soon.
- MSU has also been asked to develop guidance for bicycle detection at traffic signalized intersections. It may be possible to include these guidelines within the MDOT Traffic Signal Design Procedures. MSU will follow up with Wayne Pikka and Nathan Bouvy to get this process underway.
- MDOT identified a new document for inclusion in the research project, entitled the Federal Highway Administration (FHWA) Step Studio. There is interest in developing a version of this document for Michigan. The data in the document can be used as an implementation guide for MDOT. MSU suggested MDOT review to identify what elements are appropriate for Michigan and how it may be integrated with current guidance. MDOT suggested to coordinate the review of the FHWA Step Studio with the Multi-Modal/Complete Streets Project, which is led by Brad Peterson and most of the MSU team is also involved in this project.

Task 7: Provide Assistance to M2D2 Process:

- Relevant M2D2 documents are in the process of being reviewed to determine if they are too motor-vehicle centric and identify potential opportunities to add multimodal aspects. These primary documents for review include the following MDOT manuals: Road Design, Project Scoping, Bridge Design Manual, and Bus Stop Guidance. After completing the reviews/comments of the primary documents, additional secondary documents that may be reviewed include a selection of those in the back of the Smart Growth America document: Scope Verification Forms, Work Zone Safety and Mobility Manual, Roundabout Guidance, Traffic and Safety Note 211 (Pedestrian Hybrid Beacon), Traffic Signal Design Procedures, Guidelines for Use and Operation of Traffic Signals, and MDOT's Design Process Flowchart. The review of these documents began during FY20 and will continue.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 6: Develop and Update Best Practices: MSU has assisted MDOT with updates to the following best practice documents:

- Best Design Practices for Walking and Bicycling in Michigan.
- MSU also created a draft Step Studio outline based on the FHWA document for MDOT to implement in Michigan.
- These documents were submitted to MDOT for review, feedback was received back from MDOT, and the document has been revised to be included as part of the final report.

Task 7: Provide Assistance to M2D2 Process: Relevant M2D2 documents were reviewed at the request of MDOT to determine 1.) if they are too motor-vehicle centric and 2.) potential opportunities to add multimodal aspects. MSU has reviewed and provided comments on 12 MDOT policy or procedural documents to determine where ped/bike considerations may be added or expanded. Findings and recommendations were submitted in a memo to MDOT and will be included as part of the final report.

- Guidance for Installation of Pedestrian Crosswalks on Michigan State Trunklines
- Best Design Practices for Walking and Bicycling in Michigan
- Road Design Manual
- Bridge Design Manual
- Project Scoping Manual
- Bus Stop and Shelter Guide
- Roundabout Guidance Document
- Local Agency Programs Guidelines for Geometrics on Local Agency Projects
- Sight Distance Guidelines
- School Area Traffic Control Guidelines
- Guidelines for Traffic Safety Planning in School Areas
- Guidelines for Pedestrian Push Button Use & Location (Traffic and Safety Note 207C)

Task 8: Develop Materials to Promote Pedestrian/Bicyclist Issues: MSU has also assisted MDOT with development of guidance for bicycle detection at traffic signalized intersections. MSU developed a best practices document that will help MDOT clarify how bicycle detection should be implemented within Michigan. This document was submitted to MDOT for review, feedback was received back from MDOT and the document is being revised and will be included as part of the final report.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 9: Prepare Final Project Report and Other Deliverables. Updates were made by the MDOT PM/FAM to the Best Design Practices for Walking and Bicycling in Michigan document and new graphics were added. Also, updates were made to the Tools for the Planning and Design of Pedestrian Crossing Enhancements guide (including fixing broken website links). These were loaded on to the MDOT website.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date was extended to December 31, 2021, to complete review and finalization of documents.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The research suggested many changes to different documents to incorporate/update VRU aspects. These changes were made or suggested to the document owners. The Tools for the Planning and Design of Pedestrian Crossing Enhancements guide was completed and added to the website for use.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Evaluating the Impacts of the 2017 Legislative Mandated Speed Limit Increases

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Mark Bott

CONTRACT/AUTHORIZATION NO.	2019-0275	PROJECT START DATE	3/1/2019
PROJECT NO.	204655	COMPLETION DATE (Original)	2/28/2022
OR NO.	OR19-107	COMPLETION DATE (Revised)	6/30/2022
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Peter Savolainen		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$5,694.73	Total Vendor Budget	$230,104.19
MDOT Budget FY 2022	$1,388.89	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$52,155.72	Total Budget	$230,104.19
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$230,104.16
		Total Amount Available	$0.03

PURPOSE AND SCOPE

In 2017, the Michigan legislature passed legislation requiring speed limits to be increased to 75 mph on 600 miles of trunkline freeways and 65 mph on 900 miles of trunkline non-freeways. In addition, the truck speed was raised to 65 mph on all freeways posted 65 mph or higher. Since the early stages of these legislative speed limit policy discussions, MDOT has initiated several research projects to quantify the safety, operational, and economic impacts associated with speed limit increases. According to a recently released report by (NHTSA), speeding is considered one of the major contributing factors to traffic crashes. In 2016, there were 31,722 speed related crashes in Michigan, with 192 of them being fatal. Existing studies that evaluated the impact of speed limit changes on non-freeways/freeways have found a positive association of changes in crash severity/frequency with changes in posted speed limit. The purpose of this research is to evaluate if the conclusions regarding crashes and an increase in operating speed in response to an increase in posted speed limits are still valid today on freeways and establish a conclusion regarding non-freeways and trucks. The research tasks include the following:

1. Survey of results and studies from other states
2. Speed and crash data collection
3. Determination of influencing factors associated with driver speed selection
4. Crash, operations/speed, and cost analysis for trunkline network both effected and not effected by speed limit change
5. Evaluation of MDOT's selection process for routes to raise posted speed limit
6. Determine societal response to speed limit changes
7. Develop regional safety, operational and cost risk models development
8. Develop Project Report and Research Presentations

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task 1 Survey of Results and Studies of Other States
The research team reviewed recent literature related to speed limits and the relationship between speed and safety. This information is being used to supplement the existing content that has been reviewed as a part of prior studies.

Task 2 Data Collection
MSU has assembled an existing database with crash, speed, and roadway inventory data. Field data collection was conducted throughout the summer of 2019. The team has obtained available data from the Road Asset Inventory (RAI), in addition to traffic volume data from MDOT. The team has also obtained the 2018 year-end crash data extract from the Michigan State Police. These data are currently being integrated for analysis purposes.

Task 3 Determination of Influencing Factors Associated with Driver Speed Selection
Speed data analyzed at an aggregate level. In general, speed increase of between 1 and 3 mph have occurred at most locations where increases have occurred. Similar data for control sites has largely remained unchanged. The research team is in the process of compiling pertinent roadway geometry and traffic volume data to allow for a detailed assessment of changes in operating speeds that have resulted since the speed limit increases.

Task 4 Crash, Operations/Speed, and Cost Analysis for Trunkline Network
Aggregate-level crash trends were compared between 2018 and the years immediately preceding the speed limit increase. In general, crashes, injuries, and fatalities have increased.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Task 1 Survey of Results and Studies of Other States
The research team has reviewed literature related to speed limits and the relationship between speed and safety. A summary of this review has been prepared for inclusion in the project report.

Task 2 Data Collection
MSU has assembled an existing database with crash, speed, and roadway inventory data. Field data collection was conducted throughout the summer of 2020. The team has also begun reviewing 2019 year-end crash data extract from the Michigan State Police. Collectively, all data are being integrated for analysis purposes. The team is also coordinating field data collection activities with MDOT as a part of supplementary work being conducted through funding from the SHRP 2 implementation assistance program.

Task 3 Determination of Influencing Factors Associated with Driver Speed Selection
Speed data are being analyzed at various levels of detail. In general, speed increase of between 1 and 3 mph have occurred at most locations where increases have occurred. Similar data for control sites has largely remained unchanged. The research team has compiled pertinent roadway geometry and traffic volume data. These data were used to develop a manuscript that was submitted for consideration for presentation/publication by the Transportation Research Board as a part of the 2021 Annual Meeting.

Task 4 Crash, Operations/Speed, and Cost Analysis for Trunkline Network
Aggregate-level crash trends were compared between 2018/2019 and the years immediately preceding the speed limit increase. In general, crashes, injuries, and fatalities have increased.

Task 6 Determine Societal Response to Speed Limit Changes
The research team finalized and presented the SOSS report for the speed limit based on online collected data only. Based on feedback from the RAP, additional figures were developed to document public perceptions of the speed limit increases.

FISCAL YEAR 2021 ACCOMPLISMENTS

Task 2 Data Collection - Additional data collection RE: SHRP2 companion project.
MSU has assembled a database with crash, speed, and roadway inventory data.

Task 3 Determination of Influencing Factors Associated with Driver Speed Selection
Speed data have been analyzed from roadside LIDAR and cameras, as well as permanent traffic recorder (PTR) stations. Speed increases of between 1 and 3 mph have occurred at most locations where increases have occurred. Similar data for control sites has largely remained unchanged. Results for the non-freeway network have been published in the Transportation Research Record. Results for the freeway network are currently under review for potential publication in the Transportation Research Record.

Task 4 Crash, Operations/Speed, and Cost Analysis for Trunkline Network
The team has completed its analysis of traffic operations/speed data through calendar year 2019. Subsequent data (post-COVID) are being reviewed as a part of a separate evaluation. The team has completed preliminary analyses of impacts on safety. Additional work is ongoing in the form of an Empirical Bayes evaluation. Trends post-COVID are also being reviewed as they relate to the segments where speed limits were increased.

Task 5 Evaluate MDOT's Selection Process for Routes to Raise Posted Speed Limit
MSU began evaluating the criteria that were used to select the segments where speed limits were increased. These criteria are being assessed for the remaining pool of locations that would potentially be candidates for subsequent increases.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 2 Data Collection
The team reviewed available data from the Regional Integrated Transportation Information System (RITIS) to examine changes in speeds that occurred over the course of the COVID-19 pandemic.

Task 3 Determination of Influencing Factors Associated with Driver Speed Selection
The team also reviewed changes that have occurred following the COVID-19 pandemic. Details of all analyses have been incorporated into the project report.

Task 5 Evaluate MDOT's Selection Process for Routes to Raise Posted Speed Limit
MSU has reviewed the level-of-service of safety (LOSS) for the freeway and non-freeway systems. Details are included in the project report.

Task 8 Develop Project Report and Research Presentations
Completed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date was extended to June 31, 2022, to examine further the impacts of COVID-19 on the various tasks.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The information gathered from the research will be used internally to address questions from the legislature on future proposals to raise speed limits on state trunkline and the impacts such changes will have on safety and economics.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Performance and Safety of the US-23 Flex Route

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Jason Firman

CONTRACT/AUTHORIZATION NO.	2019-0289	PROJECT START DATE	3/1/2019
PROJECT NO.	204656	COMPLETION DATE (Original)	11/30/2022
OR NO.	OR19-114	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Eva Kassens Noor		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$7,557.08	Total Vendor Budget	$184,675.91
MDOT Budget FY 2022	$909.09	Total MDOT Budget	$398.79
Vendor FY 2022 Expenditures	$45,754.52	Total Budget	$185,074.70
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$184,350.53
		Total Amount Available	$724.17

PURPOSE AND SCOPE

MDOT has built its first Flex Route, which is intended to reduce congestion and improve safety. It includes actively managing lanes of traffic and temporarily using the inside shoulder lane during peaks or other times when traffic is backed up due to incidents or other events. MDOT needs to understand what the performance and safety impacts of the Flex Route are. MDOT needs to understand how the traveling public is responding to the Flex Route and following the directions provided. Many improvements were made to US-23 that were not related to the Flex Route and MDOT would need to reasonably understand which changes were attributable to the Flex Route. The Flex Route increases capacity and could impact traffic downstream and MDOT needs to understand if it did and to what degree. The Flex Route also has some unique challenges for enforcement agencies which need to be identified for possible adjustments in the future. The scope of the research project includes the following tasks:

1. Quantify various changes in performance of traffic during peak and non-peak times. (Travel times, delays, reliability, etc.)
2. Evaluate the safety impacts when shoulder lane is and is not in operation.
3. Determine how much of the traffic performance/safety changes were due to the Flex Route vs. other improvements of the roadway, for example ramp acceleration lane improvements.
4. Survey drivers of the Flex Route to determine their understanding how to drive the Flex Route, how it changed driving habits and if they felt it improved their driving experience.
5. Determine the compliance rate when the temporary shoulder is not open.
6. Determine the effectiveness of the Flex Route during an incident within its limits which includes operating the temporary shoulder lane and crash investigation sites.
7. Evaluate the cost/benefit of the Flex Route. Include but is not limited to construction costs, maintenance, software upgrades, additional personnel.
8. Determine the effects of traffic upstream/downstream of the Flex Route on US-23 and M-14.
9. Determine what challenges and successes were seen by enforcement agencies.
10. Develop best practices (planning, design, operations, maintenance, public relations) of the Flex Route for potential additions to other freeways in Michigan.

FISCAL YEAR 2019 ACCOMPLISHMENTS

In 2019, the research team completed and submitted the Literature Review on Flex Routes (*Deliverable 1*).
Task 1 (quantify changes in performance of traffic), *Task 2* (evaluate the safety impacts), *Task 3* (Flex Route vs. other improvements), and *Task 5* (determine the compliance rate) have been conducted.
MDOT data has been reviewed, addressing arising questions jointly with Research Advisory Panel (RAP) members, and requested operational data from the Active Traffic Management (ATM), Microwave Vehicle Detective System (MVDS), and Freeway Courtesy Patrol (FCP) databases was received.
The team has identified trends before and during the flex Route implementation including but not limited to performance (*Task 1*), crashes (*Task 2*) including taper areas, bottleneck dynamics (*Task 3*), and speed and lane violations (*Task 5*).
The driver survey (*Task 4*) has been designed and mailed three times to residents living in counties adjacent as well as upstream and downstream of the US-23 Flex Route.
The research team provided a very rough high-level, but quick, analysis of public perceptions (RAP in early September).

They have also analyzed incident management on US-23, including clearance times, paying particular attention to the change in vendors (*Task 6*). The research team has held and analyzed three focus groups (*Task 9*) in Whitmore Lake: Brighton, and for First Responders:

FISCAL YEAR 2020 ACCOMPLISHMENTS

The research team made significant progress in quantifying the changes in performance of traffic (Task 1) and in evaluating the safety impacts (Task 2). Specifically, they provided preliminary trends with respect to speeds and volumes based on US-23 sample data after (a) developing procedures and codes to integrate information from the MVDS and ATM reports, and (b) comparing travel times and speeds before and after Flex Route implementation using probe vehicle data from RITIS. A review of crash data from calendar years 2014 to 2016 and 2018/2019 for the Flex Route and adjacent segments was completed. To assess how much of the traffic performance and safety changes were due to the Flex Route compared to other improvements of the roadway (Task 3), RITIS data was analyzed to determine historical changes in travel times during the periods when the Flex Route was and was not in operation. The goal is to measure the differences in the off-peak periods over time which may be attributable to the other improvements.

The team also surveyed 892 drivers of the Flex Route (Task 4) and determined what challenges and successes were seen by enforcement via three focus groups in fall 2019 (Task 9). Both tasks were completed, and findings have been presented and delivered.

Using the ATM and MVDS data, compliance rates when the temporary shoulder is not open (Task 5) were investigated in terms of lane utilization and speed limit compliance. To examine performance during incidents (Task 6), trends in incident management and clearance time with FCP and ATM data from 2018 and 2019 were reviewed by measuring differences in operational performance when incidents of various types occurred. To estimate the costs and benefits of US-23 (Task 7), the research team conducted a review on best-practices of cost-benefit analyses for temporary lanes and identified cells in the TOPS BC tool that need modifications. To determine the effects of traffic upstream/ downstream of the Flex Route (Task 8), RITIS data have been used to compare speeds upstream and downstream of the Flex Route. Crash data have also been collected for the same five years and have been integrated with roadway and volume data. The research team has investigated crash trends on the sections immediately upstream and downstream of the Flex Route.

FISCAL YEAR 2021 ACCOMPLISHMENTS

To assess the operational performance of the Flex lanes (Task 1) further, the research team evaluated lane-by-lane traffic volume and speed data from the microwave vehicle detection system (MVDS) data using various measures of travel time (e.g., mean travel time) and travel time reliability (e.g., planning time index). The team also conducted detailed analyses of crash data for the Flex route and the segments upstream/downstream to assess safety performance since the Flex route went into operation (Task 2). In parallel, the team assessed operational and safety performance when the Flex Lane was not in operation to discern whether other (i.e., non-Flex Lane) improvements had any tangible impacts (Task 3). Impacts on travel times and crash risks upstream and downstream of the Flex route (Task 8) were also determined and driver compliance with advisory speeds and lane utilization (Task 5) were determined. The research team finalized the analyses of incident, vehicle breakdown, and other FCP data for a detailed comparison of clearance processes since the Flex route went into operation (Task 6). They conducted a cost-benefit analysis (Task 7) using 2018/2019 Flex route data. A best practice manual (Task 10) was developed summarizing key findings and recommendations for improving the safety, performance, and perceptions on US-23 and future flex routes in Michigan.

FISCAL YEAR 2022 ACCOMPLISHMENTS

A RAP meeting was held to discuss project wrap-up and results of the final analyses conducted by the research team. The team completed all analyses and submitted the final report, along with the associated best practice document and Spotlight.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The research team has identified recommendations for future flex routes. A separate best practices document has been provided and disseminated to regions that are currently building flex routes and/or will be in the future. A presentation was given at the Transportation Systems Management and Operations (TSMO) conference in September 2022 to discuss the final results.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Eastern Massasauga (Sisturus catenatus) Road Ecology and Population Dynamics in Michigan

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Jeff Grabarkeiwicz

CONTRACT/AUTHORIZATION NO.	2019-1007	PROJECT START DATE	11/25/2019
PROJECT NO.	208773	COMPLETION DATE (Original)	5/31/2023
OR NO.	OR19-137	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Gary Roloff		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$120,033.76	Total Vendor Budget	$358,958.81
MDOT Budget FY 2022	$7,558.00	Total MDOT Budget	$7,909.76
Vendor FY 2022 Expenditures	$94,978.85	Total Budget	$366,868.57
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$240,865.25
		Total Amount Available	$126,003.32

PURPOSE AND SCOPE

Eastern massasauga rattlesnakes (EMR) are listed as threatened under the Endangered Species Act. In 2017, the Federal Highway Administration (FHWA), Michigan Department of Transportation (MDOT), and the U.S. Fish & Wildlife Service (FWS) developed a statewide Programmatic Agreement (Programmatic) on the conservation and management of EMR in relation to road construction and maintenance projects. Presently, MDOT and County Road Commissions maintain roads through approximately 9,300 miles of EMR habitat (modeled as Tier I and Tier II; https://ecos.fws.gov/ipac/). These roadways and associated Right-of-Way (ROW) are subjected to a variety of development and maintenance activities that have the potential to affect EMRs. Due to many factors, including the secretive nature of the species and a lack of research, the potential effects of construction and maintenance activities are not understood. Yet, federal regulators require many best management practices (BMPs) to protect EMR during both construction and maintenance activities. These BMPs include silt fence installation, inspections, alternative erosion control measures, species surveys, and seasonal restrictions for mowing, clearing, culvert replacement, and ditching. Research and monitoring that addresses EMR use of ROW areas is needed to calibrate these BMPs, maintain compliance with the Endangered Species Act, and ensure the wise use of transportation funds.

The scope of work includes:

1. Year 1, Survey potential study sites, complete pilot telemetry study
2. Year 2, Finalize study sites, initiate telemetry study, and monitor habitat use
3. Year 3, Continue telemetry study and habitat use monitoring, begin exposing EMR to maintenance activities, begin data analysis.
4. Year 4, Analysis of data, draft final report to understand patterns of EMR habitat use around MDOT roads and behaviors in response to maintenance activities; evaluate efficacy of required BMPs.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The first year of this project was important to build a strong foundation for the remaining three years of research. The research team responded with several key accomplishments despite a year complicated by COVID-19. Below are some of the more notable items:

- Hired a graduate student to spearhead research activities as well as two assistant field technicians
- Acquired three state and federal permits for the research, in addition to an internal MSU animal care approval
- Identified candidate research sites and coordinated sites with MDOT and regulators
- Acquired written permission from 16 landowners to access their properties for research
- Performed numerous surveys at candidate sites, with field work adding up to 200+ person-hours
- Found and applied transmitters to four adult Massasauga rattlesnakes at two different sites
- Tracked telemetered snakes for two months to document movements near MDOT right-of-way
- Hosted a field event with MDOT staff to demonstrate field techniques and talk about research progress

PROPOSED FISCAL YEAR 2021 ACCOMPLISHMENTS

Proposed activities for FY 2021 include:

- The project investigators have established two research sites: I-75 in Holly and US-12 at Onsted. The research team pursued additional sites in 2021 but were not able to get access or find EMR at the sites.
- Completed 37.5 hours of formal survey effort consistent with the published survey protocol.

- Spent over 300 informal hours searching for EMR to radio tag in 2021. A total of ten individuals were captured – six at the US-223 Onsted site and four at the I-75 Holly site.
- Obtained an average of 4.3 visual and 7.7 triangulated EMR positions in 2021 per individual EMR. Confirmed EMR litters near US-12 shoulder.
- The research team had some success coordinating with MDOT Oakland County mowing contractors to conduct before and after surveys.
- Hosted an advisory committee meeting at the Onsted field site to discuss project with MDOT and DNR staff

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Project researchers continued monitoring the I-75 Holly location and US-12 site at Onsted, where six snakes were captured at Holly and eight snakes at Onsted this year.
- More than 40 hours of formal detection surveys and 6 vegetation surveys were conducted in Iosco County trying to find a “northern” EMR site, but those surveys were not successful in finding EMR.
- Field staff performed a total of 166 hours of informal detection surveys.
- Across the project lifespan, a total of 173 EMR locations have now been recorded at Holly and Onsted, with 11-14 average locations per individual (11 Holly, 14 Onsted).
- Ongoing data cleaning and analysis is being performed in preparation for the final report.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Ongoing monitoring of snakes to follow to hibernaculum in October and November
- Data entry and processing, analysis, and QA/QC from data collected during 2022
- Development of the final report, including providing a draft report to the MDOT by February 28th, 2023
- MSU presents draft report in March 2023
- Presentations to larger MDOT audience and external partners May 2023
- Project ends on May 31st, 2023

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project completion expected FY 2023.

Michigan Department
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5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Safety Enhancements at Short-Storage-Space Railroad Crossings

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Nikkie Johnson

CONTRACT/AUTHORIZATION NO.	2019-1033	PROJECT START DATE	1/1/2020
PROJECT NO.	208774	COMPLETION DATE (Original)	12/31/2022
OR NO.	OR19-032	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Texas A&M University Transportation Institute		
PRINCIPAL INVESTIGATOR	Subasish Das		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$34,801.36	Total Vendor Budget	$106,642.26
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$25,935.38	Total Budget	$106,642.26
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$87,890.10
		Total Amount Available	$18,752.16

PURPOSE AND SCOPE

MDOT regulates safety devices at public railroad crossings. MDOT also invests state and federal dollars on a prioritized basis to enhance safety at public railroad crossings. Other than pre-signals, there is not currently prescribed enhancements to address crossings that do not have sufficient space for traffic to queue at nearby roadway intersections without backing over the crossing. Although the points of conflict are less frequent, because of the severity of car-train crashes, MDOT would like to establish additional potential solutions for crossings that are near roadway intersections that don't warrant traffic signals (and, therefore, a pre-signal is not an option). Any potential safety enhancements for these crossings, at a minimum, should not negatively impact the road intersection. Typically, storage space is limited when a primary road runs parallel to the track with a secondary road intersecting the track and primary road within 200' of each other. MDOT estimates there are at least 300 crossings that have these conditions throughout the state, including but not limited to, crossings along the CSX corridor that parallels Chicago Drive from Hudsonville to Zeeland.

1. Identify additional approaches currently utilized by other State DOTs to enhance safety at crossings w/ short storage space.
2. Identify novel or emerging solutions, such as in-vehicle auditory alerts.
3. Utilize SHRP2 Naturalistic Driving Study data to analyze driver behavior at crossings w/ short storage space and at the nearby roadway intersection.
4. Utilize simulation to test impacts of potential safety enhancements on driver behavior at the crossing, as well as the intersection.
5. Evaluate the potential transfer of risk from the crossing to the roadway intersection, including the expected type of crashes and the severity of those crashes. Quantify, when possible.
6. Plan & facilitate a meeting between Traffic & Safety and Office of Rail to present findings & facilitate discussion regarding next steps for inclusion in MDOT guidance documents.
7. Summarize findings in a final report.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Fiscal year 2020 accomplishments by the Principal Investigator and research team included work on the following research tasks:

Task 1 – Project Management: Progress meetings between the Research Advisory Panel (RAP) and research team were held, February 4, 2020, June 2, 2020, and October 1, 2020. Quarterly reports noting research activities and progress were submitted 2nd, 3rd, and 4th quarter. Invoices have been submitted monthly.

Task 2 – Literature Review/Current Knowledge: A review of key literature, federal guidelines, other state practices and state-of-the-art practices for treatments for short storage crossings has been conducted. Findings from this task have been compiled into a draft interim report which was submitted to the RAP for review October 2020.

Task 3 – Site Selection & Data Integration: A status report on rail crossing related geometric data and crash data in Michigan was provided to the RAP. MDOT provided the research team a list of short-storage crossings in Michigan. Site selection, data integration and analysis are on-going.

Task 4 – Strategic Highway Research Program 2 (SHRP 2) Naturalistic Driving Study (NDS) and Simulation: Begin collecting information from the data query tool available from the SHRP-2 Insight website.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 1 – Project Management: Progress meetings between the RAP and research team were held, January 19, April 20, and September 14, 2021. Quarterly reports noting research activities and progress were submitted 2nd, 3rd, and 4th quarters with invoices submitted monthly.

Task 2 – Literature Review/Current Knowledge: Complete. A draft interim report was submitted to the RAP for review October 2020. An updated report was submitted in December 2020 and a final draft interim report was provided February 2021.

Task 3 – Site Selection & Data Integration: Complete. Research team provided an overview of the database in September 2021.

Task 4 – SHRP-2 NDS & Simulation Study: 41 short-storage locations in North Carolina and Washington were identified in the SHRP 2 data. Simulation study is on-going.

Task 5 – Guideline Development & In-person Meeting/Workshop: Begin developing recommended MDOT guidelines which will cover enhancing railroad crossings, driver behavior, selection of effective countermeasures, limitations, and future research. Begin preparing for workshop and discussion with Traffic & Safety and Office of Rail.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 1 – Project Management: On-going. Progress meetings between the RAP and research team will be held January 26, April 26, and September 19, 2022. Quarterly reports noting research activities and progress were submitted 2nd, 3rd, with invoices submitted monthly.

Task 4 – SHRP-2 NDS & Simulation Study: SHRP-2 NDS analysis and simulation study was completed. Results will be included in final report.

Task 5 – Guideline Development & In-person Meeting/Workshop: The research team and MDOT RAP coordinated the Task 5 Peer Exchange that took place on September 15, 2022. The workshop provided an opportunity for communication between MDOT Traffic and Safety and the Office of Rail to discuss and refine guidelines for referencing and implementing research findings developed in this research project. Recommended guidelines will cover enhancing railroad crossings, driver behavior, selection of effective countermeasures, limitations, and future research. Conduct workshop and discussions with Traffic & Safety and Office of Rail.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Task 6 – Final Report: All findings from tasks 1-5 will be compiled for the final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Quantifying Effectiveness and Impacts of Digital Message Signs on Traffic Flow

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Eliseo Gutierrez

CONTRACT/AUTHORIZATION NO.	2019-0313 Z1	PROJECT START DATE	11/1/2019
PROJECT NO.	208775	COMPLETION DATE (Original)	12/31/2021
OR NO.	OR19-056	COMPLETION DATE (Revised)	3/31/2022
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Kwigizile		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$14,623.56	Total Vendor Budget	$172,466.82
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$7,927.50	Total Budget	$172,466.82
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$165,770.76
		Total Amount Available	$6,696.06

PURPOSE AND SCOPE

As MDOT continues to invest in the advancement of intelligent transportation systems, the use of different types of Dynamic Message Signs (DMS) for various applications, such as variable speed limit, real time travel delay information, detour options, queue warning signs, work zone signs, etc., remain prevalent. A significant budget is required to invest in the deployment, operation, and maintenance on each of these technologies. Therefore, effective applications need to be selected based on the impacts that they have on traffic flow tailored to the geographic area. A major factor in the effectiveness evaluation of these signs is the compliance rate among travelers and the diversion influenced by motorist communications. Another factor which can influence motorist compliance are the installation details of these technologies, such as the vertical and longitudinal locations, size, font, color, light intensity, etc. Sign applications can also be influenced differently at various locations such as urban, suburban, and rural areas. These variables will need to be assessed qualitatively regarding the impacts of sign applications on traffic based on location. Travel is required as part of the study with time at field and MDOT Operation Center locations.

1. Perform a state-of-the-practice review comparing MDOT's existing Dynamic Message Signs messages and deployment guidelines to best practice applications of digital message signs at other states and propose recommendations for guideline updates.
2. Collect data before and after installation of digital message signs at different locations to monitor traffic flow, evaluate effectiveness and public perception.
3. Develop a value matrix of message and sign type per geographic area (urban, suburban, and rural).
4. Study which sign type and message categories have the greatest influence on the driver compliance and could be automated to maximize their effectiveness.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Task 1: Literature Review. - Completed.
Task 3: Data Collection – Completed survey data collection of travelers and requested historical traffic data from MDOT.
The project schedule is slightly behind with percent of work complete approximately five percent behind the planned project duration timeframe.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 2: Selection of Study Sites – Completed selecting four study sites through unavailable historical traffic data, and untimely data acquisition due to new Michigan IT policy.
Task 3: Data Collection – Completed gathering fielding data for 3/4 study sites. Continue gathering driving simulation data.
Task 4: Data Analysis – Continue to gather data to develop a value matrix and effectiveness criteria.
Task 5: Final Reporting and Presentation – Continue documenting a final draft.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 3: Data Collection – Completed driving simulation and field data for 4/4 study site.
Task 4: Data Analysis – Completed developing a value matrix and effectiveness criteria.
Task 5: Final Reporting and Presentation – Submitted draft and accomplished revisions for final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

In April 2021, a project completion date revision was authorized to extend the project end date due to the COVID-19 pandemic. Included was a shifting of funds to accommodate a change in data sources. Additionally, a new Project Manager was named due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The research recommendation for implementation results in changes to the MDOT's Dynamic Message Sign guidelines. These changes are for mainline large dynamic message signs and PCMS in urban and rural locations and should require low departmental efforts and result in high effectiveness. Established state practices should be re-evaluated. Further research is specifically requested for optimal message phase changes. Deployment of these type of signs at alternative routing and inclement weather prone locations are the most cost beneficial. An effective traffic data collection system should increase accuracy for future evaluations.

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5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Evaluation of MDOT's Long-Life Pilot Projects

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Michael Eacker

CONTRACT/AUTHORIZATION NO.	2019-0997	PROJECT START DATE	10/25/2019
PROJECT NO.	208776	COMPLETION DATE (Original)	9/30/2021
	OR19-081	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Kutay		

BUDGET STATUS

FY 2022 Budget		Total Budget)	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$396,892.19
MDOT Budget FY 2022	$12,163.00	Total MDOT Budget	$22,020.79
Vendor FY 2022 Expenditures	$66,638.94	Total Budget	$418,912.98
MDOT FY 2022 Expenditures	$2,707.56	Total Expenditures	$389,946.27
		Total Amount Available	$28,966.71

PURPOSE AND SCOPE

As a result of Public Act 175 of 2015 and the Roads Innovation Task Force (RITF) Report, the Michigan Department of Transportation (MDOT) committed to designing and constructing four long-life pavements using hot mix asphalt (HMA) and concrete. The four different long-life pavements are as follows: 30-year HMA on US-131 in the Grand Region, 30-year concrete on I-69 in the Bay Region, 50-year HMA on I-475 in the Bay Region, and a 50-year concrete on US-131 in the Grand Region. In 2017, the first of these pilot projects was constructed (30-year HMA on US-131). In 2018, three more will be let with two being built in 2018 and one in 2019. Several changes were made to standard designs and materials to increase the design life. These include increased structural support (increased layer thicknesses, etc.), improved material selection (HMA binder selection, etc.), improved construction specifications (lower initial ride requirements, etc.), and improved design aspects (increased drainage freeboard, etc.). Before further long-life projects can be planned, an assessment of the potential of the four pilot projects for meeting their intended design and services lives (50 and 75 years) should be performed. An evaluation of the effectiveness of all improvements will help transportation investments on future designs result in longer pavement life. The scope of work includes the following:

1. Review the Roads Innovation Task Force report, project plans and available materials information
2. Interview Region MDOT personnel for construction related details.
3. Laboratory testing of HMA, concrete, base, subbase, and subgrade samples from test sections within each of the four projects
4. Update DynaMOD and other MDOT materials databases.
5. Use the mechanistic-empirical pavement design method (and other pavement design methods as warranted) to predict pavement performance using all information collected in previous tasks.
6. Use the MDOT life cycle cost analysis (LCCA) process or other appropriate method to estimate service life.
7. Suggest other improvements/changes that could be made to future long-life projects that have potential to help achieve the desired service life.
8. Final report documenting all work in the project, test results of laboratory testing, and suggested improvements/changes.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- The project kick-off meeting and quarterly meetings for Q1, Q2, and Q3 have been held with reports prepared by the research team in advance of each project meeting.
- Task 1 - Completed. Reviewed the Roads and Innovation Task Force (RITF) Report and all project plan and construction information was gathered. A summary of the RITF recommendations was prepared and verification of the recommendations regarding structure, material, construction, and QA/QC measures for each of the long-life projects was completed.
- Task 2 - Completed. Organized and reviewed project construction, materials, and testing data provided by MDOT. Had meetings with MDOT construction personnel for all projects where MSU prepared a list of questions and clarifications on the projects. Began review and summarization of post construction data.
- Task 3 – Ongoing. Material Testing and Characterizations. Project material samples were received from MDOT, organized, and cataloged. Began various flexible and rigid material testing. Began to characterize materials following completed tests. So far, no concerning data was observed.

- Covid-19 restrictions closed testing labs and material testing was delayed. Labs reopened in July 2020 and material testing resumed. As of September 30, 2020, work is approximately 33 percent complete with approximately 42 percent of project duration complete.
- Task 5 – Ongoing: The project team began comparing the predicted (using Pavement-ME) performance of the designed and as-built sections by using laboratory-measured inputs and measured material properties.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The research team completed a significant amount of laboratory testing on materials from the long-life pilot projects:

- HMA Materials
  - Dynamic modulus testing
  - Indirect tensile strength testing (IDT)
  - 3 point bending testing
- Cement Stabilized Materials
  - Compression testing
- Concrete Materials
  - Compression testing
  - Flexural strength testing
- Aggregate Materials
  - Sieve analysis
  - Classification
  - Atterberg limits
  - Optimum moisture and maximum density
  - Resilient modulus

In addition, analysis of Falling Weight Deflectometer (FWD), Light Weight Deflectometer (LWD), and Dynamic Cone Penetrometer (DCP) data from construction testing were analyzed for stiffness properties of unbound materials.

The results of all testing were used to choose inputs that best represent the as-built properties for use in pavement design software. These input values were used in the PerRoad and Pavement ME design programs. The performance predictions from Pavement ME are being compared to those from MDOT's initial designs using expected project material properties.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Work completed in fiscal year 2022 is as follows:

- Remainder of lab testing to characterize materials provided by MDOT was completed.
- Data from lab testing was added to MDOT's DynaMOD database.
- A database was created to house all the construction and material information for the 4 long-life projects.
- Performance prediction of the 4 long-life projects using the ME design software and the research team's MEAPA software, was completed.
- The life-cycle cost analysis task was started and completed.
- The draft final report was delivered on October 2, 2022.

Quarterly RAP update meetings and meetings with MDOT staff to discuss the life-cycle analysis task were held.

FISCAL YEAR 2023 PROPOSED ACTIVITES

Anticipated activities for fiscal year 2023 include:

- MDOT review of the draft final report.
- Completion and acceptance of the final report.
- Acceptance of the other deliverables: DynaMOD update and project database.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

In FY 2021, the project end date was extended because of delays due to COVID-19 along with a change in Project Manager due to staffing changes at MDOT. Another extension was granted to allow more time to complete all objectives and required deliverables.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Testing Protocol, Data Storage and Recalibration for Pavement-ME Design

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Justin Schenkel

CONTRACT/AUTHORIZATION NO.	2020-0235	PROJECT START DATE	1/21/2020
PROJECT NO.	208777	COMPLETION DATE (Original)	12/31/2022
OR NO.	OR19-092	COMPLETION DATE (Revised)	NCTE Pending
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Haider		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$80,503.29	Total Vendor Budget	$435,289.62
MDOT Budget FY 2022	$11,079.99	Total MDOT Budget	$106,054.67
Vendor FY 2022 Expenditures	$177,358.02	Total Budget	$541,344.29
MDOT FY 2022 Expenditures	$12,734.66	Total Expenditures	$482,054.55
		Total Amount Available	$59,289.74

PURPOSE AND SCOPE

Pavement-ME (mechanistic-empirical) analysis and design procedure are in the implementation stages for designing new and rehabilitated pavements in Michigan. Several studies were performed in the recent past to characterize traffic, material properties, and local calibration of the performance models to address the local materials and construction practices in the Pavement-ME procedure. While all the local materials and calibration of performance models were addressed to improve the local applicability and the accuracy of the approach, there are still some data gaps, especially for material characterization and pavement construction. For example, typical Resilient Modulus (MR) values were used for base, subbase, and subgrade moduli and initial International Roughness Index (IRI) values were back casted for the pavement sections used in MDOT's local ME calibration. Since these values are estimated, they may not be accurate for the location, so having the actual values for new projects improves ME calibration accuracy. In addition, a limited number of Michigan rigid pavement sections were available for ME calibration, so adding more data from new sections would improve ME calibration. Furthermore, MDOT currently does not have criteria for selecting future projects for calibration and material sampling and testing for ME inputs. Thus, there is a need to have a consistent procedure to include new pavement sections in the performance model calibration and to obtain actual as-constructed material properties for ME inputs. Such procedures will be essential to enhance the accuracy and adequacy of the performance models for future pavement designs. Additionally, with updated Michigan ME data, MDOT would benefit from a recalibration of AASHTOWare Pavement ME Design to improve design prediction accuracy. The scope of work includes the following, (which can be reordered as needed per the Principal Investigator (PI)):

1. Review of Literature
2. Develop a Prioritized Inputs List and Relevant Testing Protocols
3. Develop a Test Matrix and/or Set of Criteria for ME based Testing
4. Conduct Laboratory Testing and Collect/Analyze Falling Weight Deflectometer (FWD) Data
5. Evaluate Databases
6. Review of Project Data for Calibration
7. Evaluate the Local Calibration of Performance Models
8. Re-Calibrate Performance Models
9. Evaluate the Impact of Re-calibration on Pavement Design
10. Final Report and Technology Transfer

FISCAL YEAR 2020 ACCOMPLISHMENTS

The project team has conducted a review of original work related to calibration. The objective of the evaluation is to identify any gaps in construction, materials, and performance data in Task 1. More recent literature from other states has been reviewed to determine and confirm important input variables related to traffic, design features, material properties, and climate.

In Task 2, the team developed a prioritized input list and testing protocols. Based on testing protocols, they identified four pavement sections (I-75, I-196, I-94 BL, and US-41) for testing and sampling for the year 2020. Two of these projects are Jointed Plain Concrete Pavement (JPCP) reconstruct (I-75 SB and I-196 EB), while the other two (I-94 BL and US-41) are Hot Mix Asphalt (HMA) overlay projects. Also, research team selected projects for the next year (2021). These projects include I-75 (JPCP unbonded concrete overlay and HMA rubblized reconstruct), US-41 (HMA reconstruct and aggregate lift, and HMA overlay), I-69 (JPCP and HMA reconstruct), M-3 (HMA reconstruct), and US-24 (Demo HMA reconstruct).

Per Task 4, the research team and MDOT has conducted Dynamic Cone Penetrometer (DCP) and Light Weight Deflectometer (LWD) testing on the I-196 and I-75 projects. MDOT performed FWD testing on I-94 BL existing pavement for the overlay project. Material samples for subgrade, subbase, and base are being collected for the 2020 projects. In addition, the HMA samples from some pre-selected projects by MDOT were tested in the laboratory. The test results were documented.

Due to COVID-19 safety protocols, Task 6 began earlier than originally planned since the type of work activities under this task limited human exposure/contact. The team accomplished the following work under Task 6:

(a) The Pavement Management System (PMS) data were used to extract pavement distresses for the selected projects. While exploring the data source and converting the measured distress units to the Pavement-ME compatible units, a project length issue was discussed with MDOT. MDOT PMS sections provided the updated PMS data with additional PDs to address the discrepancy in project lengths.
(b) The research team has been working on automating the distress data extraction from the PMS data by utilizing MATLAB codes. This automation will improve the efficiency of data extraction significantly.
(c) The team has already summarized the average IRI, faulting and rutting data for all the selected sections. In addition, spatial variability of the distresses was quantified in terms of the standard deviation, using the automated analysis algorithms written in MATLAB. With the standard deviation data, Pavement ME standard deviation equations will be evaluated.
(d) The MATLAB coding for cracking data is in progress.

MDOT provided a comprehensive database of all the projects constructed in Michigan. Initially, all the existing projects (108 flexible and 20 JPCP) used in the previous calibration effort were reviewed. Based on distress data in terms of distress index (DI), the team identified and selected 206 potential new candidate pavement projects. The potential projects include 27 HMA reconstruct, 24 JPCP reconstruct, and 155 rehabilitated (i.e., HMA overlay, rubblized overlay, unbonded concrete overlay) pavement projects. The project is slightly behind schedule as of September 30, 2020. Approximately 19 percent of the planned work is complete with approximately 28 percent of the project duration complete.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The research project team (with MDOT assistance) has continued to work on Task 4, conducting DCP and LWD testing and collecting material samples for subgrade, subbase, base, and pavement on the selected 2021 construction projects. MDOT (and their consultant support staff) performed FWD testing on projects, except for I-69 as this project is still early in its construction progress. In addition, lab testing continues for those available sample materials not yet tested.

In addition, the research team continued work on Tasks 6, through 8 of the study, accomplishing the following items of work:

(a) The research team completed PMS data extraction for all required distress types in a compatible format with the Pavement-ME.
(b) The MDOT PMS data was further analyzed to identify damage at the PCC joints, which correspond to medium and high severity spalling levels, to evaluate the spalling model in the Pavement-ME. As part of this effort, assumed PCC joint spacing was also evaluated/verified.
(c) The Pavement-ME input files for pavement sections and their distress data were prepared for use in the calibration assistance tool.
(d) Compared MERRA and MDOT climatic data and used MERRA data in Pavement-ME.
(e) Updated traffic data for the existing and newly selected JPCP projects, prepared the Pavement-ME (.dgpx) files and performed the preliminary calibration of distress models for all the rigid pavement sections.
(f) Evaluated the representation of the selected JPCP sections used to calibrate the overall JPCP performance within the entire state.

The project has approximately 69 percent of the planned work complete and 66 percent of the project duration complete. However, it is anticipated a time extension will be needed to accommodate lab testing and unexpected subtasks that are expected to further improve the research outcomes.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The research team continued work on Tasks 4 through 8 of the study, accomplishing the following items of work:

(a) Conducted laboratory testing of the materials (unbound layers, loose asphalt mixtures, cores, etc.).
(b) Obtained/determined Pavement-ME inputs from the construction records for the selected pavement projects for the local calibration of performance models.
(c) Performed model calibrations for rigid Pavement-ME performance models, which included:
    a. Use of Modulus of Resilience (MOR) versus the 28-day compressive strength for the PCC layer
    b. Using a cap on the average faulting and the number of faulted joints to eliminate the possibility of including false counts for faulted joints.
    c. Using input for widened lanes as 12.5 ft (versus 14 ft).
(d) Started model calibrations for flexible Pavement-ME performance models.
(e) Continue to analyze a storage/organization system for material and testing data (Task 5) for the Pavement-ME use for designs and model calibrations.
(f) Per the rigid model calibration, the research team is evaluating of their impacts to the MDOT Pavement Design.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

In the next fiscal year, the research team will work on the following remaining items:

- Complete model calibrations for flexible Pavement-ME performance models.
- Final recommendations for future MDOT pavement project sampling and testing needed for Pavement-ME. Accordingly, recommendations will be made to define potential correlations with non-destructive testing to reduce physical sampling.
- Recommend/establish the storage/organization system for material and testing data used for Pavement-ME designs and model calibrations. Accordingly, the lab testing results from this research and past available data will be added to this system.
- Final Reporting with deliverables will be provided.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The completion date was extended due to new subtasks, which included multiple rigid local calibration iterations to improve the calibration, data correction for MDOT's performance data, and the refinement of inputs for flexible design local calibration. An additional extension was granted to accommodate additional subtasks to improve the Pavement-ME model calibrations.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project completion expected in FY 2023.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Developing a Consistent Data Driven Methodology to Multimodal, Performance Based, and Context Sensitive Design

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: John Martin

CONTRACT/AUTHORIZATION NO.	2019-0996		PROJECT START DATE	10/11/2019
PROJECT NO.	208778		COMPLETION DATE (Original)	9/30/2022
OR NO.	OR19-100		COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)			
PRINCIPAL INVESTIGATOR	Peter Savolainen			

BUDGET STATUS

FY 2022 Budget			Total Budget	
Vendor Budget FY 2022	$96,516.00		Total Vendor Budget	$299,999.53
MDOT Budget FY 2022	$3,600.00		Total MDOT Budget	$4,015.22
Vendor FY 2022 Expenditures	$123,306.58		Total Budget	$304,014.75
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$304,014.75
			Total Amount Available	$0.00

PURPOSE AND SCOPE

MDOT designers are tasked with understanding the context of a community and balancing modal needs with limited funding resources. Transportation decisions are currently made from input provided by communities. This is often in a reactive rather than proactive process, with qualitative data and quantitative data evaluated separately to assist in transportation decision making. Methods for evaluating modal characteristics have typically been applied to individual modes. A new methodology is needed that will analyze and aggregate qualitative and quantitative pertinent data to assist in making decisions on competing interests such as to what roadway features should be designed and/or what mode(s) of transportation should be implemented for a given highway corridor.

The scope of work includes the following:

1. Provide and develop a listing of the national best practices.
2. Obtain and compile data needed for multimodal, performance based and context sensitive design decisions.
   2A. - Review MDOT's existing processes.
   2B. - Review MDOT's existing data sets and tools.
3. Develop a more quantitative and qualitative aggregated data analysis to define the context of all transportation modal demands and long-term needs in a community and transportation corridor.
4. Evaluate the methodology by applying it to a diverse set of community projects. Evaluation to include the use of a Focus Group made up of the following representative members: Planners, Metropolitan Planning Organizations (MPOs), Consultant Designers, and MDOT employees.
5. Develop a process for modal options and create a way to assign weighted values

FISCAL YEAR 2020 ACCOMPLISHMENTS

Task 1 – Review National State-of-the-Practice
MSU has finished its initial review of national-level guidance documents, research reports, and articles related to context-sensitive and performance-based design. A summary of this review has been prepared and was submitted to MDOT.

Task 2 – Collect Internal and External Data
The research team has identified and collected data available from MDOT and other public (non-MDOT) sources. A detailed summary of these data has been prepared and was submitted to MDOT.

Task 3 – Assess MDOT Practices and Available Data
MSU participated in a series of meetings focused on Lean Process Improvement (LPI). Current MDOT practices will be discussed at the next Research Advisory Panel (RAP) meeting. Additional meetings may be scheduled with MDOT design staff in coordination with the Project Manager, as necessary.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 4 – The team is finalizing the assessment framework. Began discussing ideas for the final input/output method (digital, matrix, combination).

Task 5 – The team is further assessing the applicability of input/output formats to be able to evaluate corridor planning with a "sliding range" of solutions methods centered on the research program criteria. It is hoped the effort will yield a Context Sensitive Solution (CSS) approach in greater detail for the stakeholders.

FISCAL YEAR 2022 ACCOMPLISHMENTS

1. Continued Task 5 – Evaluate Analysis Framework
2. Prepared pro and con points to evaluate the final analysis framework input/output (digital vs. matrix etc.)
3. Identified target training groups
4. Identified and implement training formats
5. Completed the development of the following deliverables:
   a. Provide analytical process for collection, aggregation, and maintenance of qualitative and quantitative data sets pertinent to the development decision making tools for context driven modal development. Creation of a decision tool to illustrate the proposed process.
   b. Provide tool sets for data aggregation and evaluation for MDOT corridor analysis.
   c. Case studies applying tools and processes to a diverse set of community projects.
6. Finalized list of deliverables
7. Made tool modifications base on presentation comments within MDOT
8. Finalized a training format for near- and long-term objectives
9. Setup presentation dates and pre presentation procedures.
10. Finalized reviews of the report via RAP
11. Finalized reviews of the design tool via RAP
12. Finalized presentation format
13. Accepted final report
14. Accepted final tool

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The implementation of the MSU CSS tool and manual target market lye both inside and out of MDOT. The first phase of the manual and tool rollout will be via conference presentation. The intent is to obtain feedback on the tools ease of use and performance. Prior to the conference, the tool will be distributed to the session attendees via a graphic email announcement. The email will contain direct links to a 15–20 minute video (YouTube) demonstrating the use of the tool and its features. The email will also contain a direct link to the user's manual and the study report. This format is easy and convenient for the user to reference the materials and tool.

Conference attendees who have not evaluated the tool, prior to a conference, will be able to learn about the tool and its use in the session presentation. For those who have used and reviewed the tool, the session will allow them to ask point specific questions or provide feedback. This approach will put the tool in the user's hands with a video guide on its use. Furthermore, the new user / conference attendees can ask questions or get clarification on points based on the tool use. The dialogue will further refine the reference ease and use of the tool.

Post internal presentation and review, the tool will be distributed to our MPO and consulting partners for use. Any comments and reviews received will be rolled into a future "2.0" version of the tool.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Innovative Contracting Best Practices

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Ryan Mitchell

CONTRACT/AUTHORIZATION NO.	2020-0222	PROJECT START DATE	2/1/2020
PROJECT NO.	209076	COMPLETION DATE (Original)	11/30/2020
OR NO.	OR20-002	COMPLETION DATE (Revised)	12/15/2021
RESEARCH AGENCY	WSP Michigan Inc.		
PRINCIPAL INVESTIGATOR	Jeff Chenault		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$290,863.66
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$26,225.54
Vendor FY 2022 Expenditures	$0.00	Total Budget	$317,089.20
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$316,409.96
		Total Amount Available	$679.24

PURPOSE AND SCOPE

Innovative contracting methods have been used by MDOT for several years because of the significant improvements these methods bring to project delivery. They have generated substantial value in safety, cost, and time benefits. Many transportation departments use innovative contracting methods to reduce the costs of constructing facilities and to obtain greater certainty regarding future costs. Techniques to avoid and manage risk are important tools in achieving this goal. Contracting methods have been tested and utilized in Michigan and many other states to improve safety, cost, risk and/or time management. Documenting the contracting methods that have been effectively utilized in Michigan or adopted from other states for future use in Michigan will help MDOT innovate and improve its project delivery program. The scope of work includes the following:

1. Conduct a survey of the literature (such as federal and other state guidance documents as well as scholarly research, Industry journals and publications) to identify best practices
2. Conduct a state of the practice survey of other DOT's
3. Evaluate MDOT's current state of the practice and documentation needs
4. Conduct a Peer Exchange for technology transfer between states, planning travel, and event costs.
5. Develop an innovative contracting engineer's guidance document for use statewide that outlines practices for MDOT staff.
6. Develop a Research Report with summary of findings and recommendations

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Conducted literature review for best practices related to innovative contracting. Identified 58 documents and evaluated 20 of them as part of this research.
- Prepared Best Practices Literature review report and submitted to MDOT for review and comment.
- Conducted Owner Outreach Survey of 27 owners from across the country to solicit feedback regarding their innovative contracting programs to compare to best practices.
- Prepared Owner Outreach report and submitted to MDOT for review and comment.
- Conducted an Industry Outreach effort to obtain feedback regarding MDOT's current program from contractors and consultants who have participated in MDOT's design-build, Construction Manager/General Contractor (CM/GC), and Public Private Partnerships (P3) projects.
- Prepared Industry Outreach report and submitted to MDOT for review and comment.
- Evaluated 8 previous design-build projects for consistency across the program.
- Reviewed change orders from previous projects to determine if there are issues with the template documents or other areas of the procurement and delivery process.
- Coordinated and conducted a Peer Exchange event that included 10 representatives from state agencies who utilize similar innovative contracting methods for delivery.
- Prepared and delivered a presentation to the Research Advisory Panel for the literature review, owner outreach survey, and the industry outreach effort.
- Evaluated the existing Innovative Construction Contracting guidelines for effectiveness and ease of use and recommended format revisions.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Completed and submitted final reports.
- Submitted the final Spotlight template.

- Provide suggested updates to Innovative Contracting Guidelines, Design Build and CM/GC manuals.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Published research report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This project was extended because of delays due to COVID-19 restrictions and to allow additional time to complete and review three innovative contracting guides.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

MDOT's Innovative Contracting Unit has initiated the implementation of several recommendations from the study. Guidance documents are being updated to reflect current practices and suggested best practices captured through literature review and peer agency recommendations. Procurement document templates have been revised and are now being utilized on new projects. Finally, lessons learned from are being solicited from project teams and documented for use in addressing programmatic issues.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Research Administration Section Planning and Communication

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Mary Hoffmeyer

CONTRACT/AUTHORIZATION NO.	2020-0776	PROJECT START DATE	10/1/2020
PROJECT NO.	209437NI	COMPLETION DATE (Original)	9/30/2025
OR NO.	OR21-001	COMPLETION DATE (Revised)	
RESEARCH AGENCY	CTC & Associates, LLC.		
PRINCIPAL INVESTIGATOR	Patrick Casey		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$98,462.94	Total Vendor Budget	$492,314.72
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$76,462.94	Total Budget	$492,314.72
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$205,944.78
		Total Amount Available	$286,369.94

PURPOSE AND SCOPE

MDOT works diligently to deliver innovative research projects that improve operations and services. Research Administration (RAd) works to effectively communicate these research findings clearly and in platforms for wider public reach. This project works with RAd to continue to improve operations and provides the means to communicate department research efforts in a multitude of platforms (i.e., publications, social media, and visual media) that will share the outcomes of innovative research. These high impact tools are essential to enhance the visibility and presence of the department's work to a diverse set of end-users to further educate and implement the outcomes for the improvement of applicable operations and services. Effective communication and subsequent implementation of research will aid MDOT to work more efficiently, more safely, and increase economic benefit to the traveling public. The improvement of services and operations because of implementation will assist the department to aligning further with its core vision and values

FISCAL YEAR 2021 ACCOMPLISHMENTS

Completed the At-A-Glance report summary of funding statistics and project progress for FY 2020. Completed spotlight newsletters including, but not limited to, Bridge Structural Analysis for Staged Construction, Construction Price Index, Evaluation of Camber and Deflections for Bridge Girders, and Developing Michigan Pedestrian and Bike Safety Models. Completed production of video spotlights on Carbon Fiber Reinforced Concrete and Effectiveness of Green Strobes on Winter Maintenance. Developed needed communication distribution strategies for spotlights. Began providing technical editing for final research project reports on Innovative Contracting. Developed RAd's first ArcGIS StoryMap to highlight MDOT's collaboration with other states on research projects through the Transportation Pooled Fund program. This interactive StoryMap highlights MDOT's success stories with research topics ranging from bridge design to intelligent transportation systems to highway maintenance.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed the At-A-Glance report summary of funding statistics and project progress for FY 2021. Completed spotlight newsletters including, but not limited to, Integration of Unmanned Aerial Systems Data Collection into Day-to-Day Usage for Transportation Infrastructure - A Phase III Project, Connected/Automated Vehicle and Infrastructure Research [Michigan Mobility Transformation Facility (MTF)], Infrastructure Protection and Rehabilitation Response to High Lake Levels, Quantifying Effectiveness and Impacts of Digital Message Signs on Traffic Flow, Evaluation of an Active Traffic Management System with Part-Time Use of the Inside Shoulder, and Synthesis of National Best Practices on Pedestrian and Bicycle Design, Guidance, and Technology Innovations. Completed spotlight videos on Slope Restoration on Urban Freeways and High-Tech Workforce Preparation for Emerging Transportation Technologies. Developed needed communication distribution strategies for spotlight newsletters and videos. Continued providing technical editing for final research project reports on Innovative Contracting.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Expect completion of additional spotlight newsletters, production of additional video spotlights, continued development of distribution strategies for communicating innovative research findings, and technical/editing writing services. CTC will assist with other services as needed. RAd and CTC will continue to meet quarterly for status update meetings to discuss progress on communication projects; the Project Manager and CTC will continue to remain in contact via email/phone between meetings for day-to-day activities.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Innovative Contracting Risk Management Best Practices

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Ryan Mitchell

CONTRACT/AUTHORIZATION NO.	2020-0673	PROJECT START DATE	8/1/2020
PROJECT NO.	210214	COMPLETION DATE (Original)	12/31/2021
OR NO.	OR20-004	COMPLETION DATE (Revised)	
RESEARCH AGENCY	RS&H		
PRINCIPAL INVESTIGATOR	Andrew Keetley		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$321,804.32
MDOT Budget FY 2022	$2,371.91	Total MDOT Budget	$29,827.06
Vendor FY 2022 Expenditures	$58,503.92	Total Budget	$351,631.38
MDOT FY 2022 Expenditures	$2,371.91	Total Expenditures	$331,850.47
		Total Amount Available	$19,780.91

PURPOSE AND SCOPE

Many transportation departments use innovative contracting methods to reduce the costs of constructing facilities, accelerate project completion schedules, manage project risks efficiently, and to obtain greater certainty regarding future costs. Techniques to identify, evaluate, avoid, and manage risks are critical in achieving this goal. MDOT Innovative Contracting Unit (ICU) currently manages project risks based on project size and complexity, except for Federal Highway Administration (FHWA) classified Major Projects ($500m+), for which FHWA required risk management protocols are observed. MDOT ICU is seeking to research risk management best practices to develop and formalize its project risk management procedures and template. The study will also improve the institutional understanding of the importance, benefits, and practicality of risk management and provide guidance to educate and train staff to implement the recommended best practices. Documenting the risk management best practices that have been effectively utilized in Michigan, in other states or internationally for future use in Michigan will help MDOT better manage project risk to improve its project delivery program. The scope of work includes the following:

1. Conduct a survey of the literature (such as federal and other state guidance documents as well as scholarly research, Industry journals and publications) to identify risk management best practices
2. Conduct a state of the practice survey of other DOT's
3. Evaluate MDOT's current state of the practice and documentation needs, including outreach to Michigan contractor and consultant professional organizations
4. Conduct a Peer Exchange for technology transfer between identified best practice states/agencies.
5. Develop an innovative contracting engineer's guidance document for use statewide that defines risk management practices for MDOT staff.
6. Develop risk management templates and tools, including but not limited to project risk management plan, risk breakdown structure, risk assessment matrix, and risk register.
7. Develop Training Materials and conduct training on the use of templates, tools, and other deliverables.
8. Develop a Research Report with summary of findings and recommendations.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Performed risk management best practices literature review and desktop survey.
- Conducted public sector and contractor interviews both within Michigan and nationally to identify current state of practice, risk management best practices, including guidance documents and risk mitigation strategies for high-risk items, and lessons learned.
- Developed summary table of key feedback and best practice recommendations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Revised draft research report based on MDOT Research Advisory Panel comments.
- Completed development of risk assessment and management guidance documents.
- Developed Risk Workbook tools and templates.
- Initiated training related to Risk Workbook tools and templates.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Beta-test Risk Workbook tools and templates on a project.
- Gather feedback from users and improve Workbook, complete all guidance and templates.
- Finalize all deliverables and close out project.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)
The Risk Workbook toolset will be utilized on all MDOT design-build projects and as appropriate on other delivery models. Training on the toolset will be offered regularly to MDOT staff and consultants.

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RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Assessing System Performance of the Michigan Trunkline: Measures and Analytical Procedures for Planning and Operations

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Robert Maffeo

CONTRACT/AUTHORIZATION NO.	2020-0783	PROJECT START DATE	8/1/2020
PROJECT NO.	210791	COMPLETION DATE (Original)	7/31/2022
OR NO.	OR20-005	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Ali Zockaie		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$80,969.36	Total Vendor Budget	$180,204.74
MDOT Budget FY 2022	$13,560.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$109,568.23	Total Budget	$180,204.74
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$147,246.35
		Total Amount Available	$32,958.39

PURPOSE AND SCOPE

Since 1961, the Michigan Department of Transportation had been conducting yearly Sufficiency Reviews of the trunkline system, which included a systematic evaluation of the condition and relative operational performance of individual highway segments. This process produced a yearly Sufficiency Report that was a single-source document containing a variety of condition and operational data. The information found in this Report was intended to serve as an initial planning tool for MDOT staff and management to guide development of more comprehensive studies. As part of an MDOT Systems and Process Improvement Review (2010-2014), it was determined that the 2015 Sufficiency field reviews would be the last to be completed. Thus, the Sufficiency Program was retired after the release of the 2015 Report, with most data items provided by this program to be accessible in the future from various sources within MDOT. Two data items that were part of the Sufficiency Program that were not designated as having an alternate source were the “Capacity Volume” and “Level of Service” metrics. Internal MDOT “customers” continue to utilize the values provided in the 2015 Sufficiency Report, which are quickly becoming outdated. A review of past practices and recommendations for moving forward, based on MDOT staff needs, is critical for maintaining current and future trunkline condition assessment capabilities for planning and operational analysis purposes. The scope of work includes the following:

1. Conduct a review of MDOT past practices for calculating Sufficiency “Capacity Volume” and “Level of Services” metrics, and conduct a survey of the internal MDOT customers that identifies pertinent staff and their informational needs regarding performance measurement,
2. Conduct a traditional literature search / review regarding system performance metrics; Conduct a review of other agency (FHWA, State DOT, MPO) plans and documents regarding system performance metrics
3. Develop an Interim Project Status Report
4. State of the Practice Review, including: What performance metrics / measures meet our needs? What thresholds / targets are appropriate; What are the quantitative / qualitative approaches used to calculate PMs; Perform a data needs and gap analysis, including cost assessment,
5. Develop an Interim Project Status Report
6. Develop a Technical Report - Guidance Document, that: Documents the recommendations based on MDOT past practices and the state of the practice review; details the methodologies for calculating performance metrics; provides guidance regarding appropriate thresholds and target values; provides a data needs and gap analysis summary; and includes an implementation strategy.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Fiscal year 2020 accomplishments included the project kick-off meeting held September 30th, 2020. The meeting provided an opportunity for RAP and PI team introductions, a review of the contract specifics and deliverables, a review of the objectives, Gantt chart and work plan for the research project. The Principal Investigator (PI) and research team provided information on the following research tasks:

Task 1 – Literature Review: The key literature from federal guidelines, state DOTs, MDOT, and other agencies were carefully reviewed as part of developing the research plan for this project.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Fiscal year 2021 activities included the following research tasks:

Task 1 – Literature Review. Completion of a comprehensive literature review of documented measures and targets suggested by FHWA, MPO, and NCHRP, other state DOTs via plans and documents and applicable journal publications, project reports, conference proceedings, to capture the following information: 1) Federal requirements, 2) Implementation of operational performance measures 3) Guidelines and strategies, 4) Data sources, needs and costs to calculate measures, 5) Calculations methods and estimation approaches, 6) Tools and methodologies, and 7) Threshold and target values used by other agencies.

Task 2 – Nationwide State DOT Survey. Developed and distributed an online survey for state DOTs and MPOs to capture the following information: 1) Performance measures, 2) Threshold and target values for performance measures, 3) Data sources used for calculations and estimation of mobility related performance measures, 4) Costs associated with data collection, storage, and analysis, 5) Tools, methodologies, and platforms used for data analysis and 6) Current approaches in reporting and communication of measures.

Task 3 – Review Current / Historical MDOT Practices & Available Data for MI Trunkline Performance. A review of the following items was completed: 1) Available data sources for calculating mobility related trunkline performance measures including, but not limited to RITIS, MVDS, GIS, 2) The MDOT sufficiency report including, but not limited to AADT, DHV, Capacity Volume, LOS, 3) Comparison of alternative performance measures to sufficiency report, and 4) Identify MDOT divisions pertinent to the highway systems assessment.

Task 1 thru 3 – Completion of a DRAFT Interim Report summarizing the results of Task 1, 2, and 3, and a work plan for subsequent tasks.

Task 4 – Perform MDOT Staff Interviews. Began to develop the survey, and a listing of staff, for interviews of pertinent MDOT divisions and Michigan MPOs that will be performed [next fiscal year] through phone calls and an online questionnaire to identify Michigan's current needs and practices. Topics of inquiry may include, but are not limited to, the following: 1) Utilized and recommended performance measures, 2) Thresholds and target values, 3) Data needs and assessments, 4) Tools and methodologies for data analysis and reporting.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Fiscal year 2022 activities include the following research tasks:

Task 1 thru 3 – Completion of Final Interim Report summarizing the results of Task 1, 2, and 3, along with a work plan for subsequent tasks.

Task 2 – Initiate and complete a follow-up [nationwide] survey of select State DOTs to obtain further clarification as to: 1) Performance measures used and their purpose, 2) Threshold and target values for performance measures, 3) Data sources used for calculations and estimation of mobility related performance measures, 4) Costs associated with data collection, storage, and analysis, 5) Tools, methodologies, and platforms used for data analysis and 6) Current approaches in reporting and communication of measures.

Task 4 – Perform MDOT Staff Interviews. Finalize the survey and complete interviews of pertinent MDOT divisions and Michigan MPOs through phone calls and an online questionnaire to identify Michigan's current needs and practices. Topics of inquiry may include, but are not limited to, the following: 1) Utilized and recommended performance measures, 2) Thresholds and target values, 3) Data needs and assessments, 4) Tools and methodologies for data analysis and reporting.

Task 5 – Identify Potential Performance Measures. The information collected in the previous tasks will be synthesized to determine the potential set of operational performance measures for MDOT trunklines. In addition to the performance measures, associated appropriate thresholds and target values will also be determined. Finally, the methodologies and tools to estimate/calculate, store, and report these potential performance measures to technical and non-technical audiences will be explored. In this step, the team will also seek to propose a consistent approach for communicating the performance measures between the various platforms to which they are published.

Task 6 – Perform a Needs Assessment, Gap Analysis and Cost Assessment. The project team will compare the different potential performance measures identified in Task 5 with performance needs and available data for the Michigan trunkline system. For each potential performance measure, the project team will compare the data needs with the available datasets to identify any data gaps. Furthermore, the cost associated to fill these data gaps for each potential performance measures will be assessed.

Task 4 thru 6 – Completion of a Draft and Final Interim Report summarizing the results of Task 4, 5, and 6, along with a work plan for subsequent tasks.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Fiscal year 2023 proposed activities include the following research tasks:

Task 7 – Recommendation of Performance Measures and Guidelines for Implementation and Evaluation. The final recommended performance measures will be presented, with adequate justification provided for performance measures and/or data sources that are recommended for replacement/upgrading.

Task 8 – Deliver Final Report. The final project report will include the literature review and current practices of state DOTs and MDOT for the highway system assessment. The synthesis of these data collection efforts will provide a potential set of performance measures and their associated target values, calculation approach, data needs, and demonstration tools and

methodologies. Finally, the team will include concluding remarks, as well as final recommendations and an implementation strategy for the operational performance measures.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A no-cost time extension was approved in April 2022 due to the below:

- There were unexpected delays in conducting task 2 of the research plan “Perform Nationwide State DOT Survey”. Identifying proper listserv to receive an acceptable response rate from different states required multiple rounds of survey distribution.
- After conducting the survey for task 2, the research team, after consulting with the project manager and RAP members, decided included a follow up survey after conducting task 4 of the research plan and perform MDOT Staff Interviews.
- Based on the task 2 feedback, the research team, in consultant with the project manager and RAP members, decided to select a different hybrid strategy for the MDOT staff interviews, which would address the remote work with the department, but including multiple virtual meetings and distributing an on-line survey. This hybrid strategy calls for additional time to conduct this research task successfully.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Remote Electronic Water Level Sensors for Monitoring Scour Critical Structures

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Zwolinski, Andrew

CONTRACT/AUTHORIZATION NO.	2019-0312 Z5	PROJECT START DATE	4/1/2021
PROJECT NO.	211053	COMPLETION DATE (Original)	12/31/2023
OR NO.	OR21-003	COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Kerkez		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$187,180.00	Total Vendor Budget	$442,505.15
MDOT Budget FY 2022	$74,000.00	Total MDOT Budget	$90,800.00
Vendor FY 2022 Expenditures	$180,435.37	Total Budget	$533,305.15
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$184,493.96
		Total Amount Available	$348,811.19

PURPOSE AND SCOPE

During widespread or long-term rain events, it is difficult to reach every scour critical structure for observation. Although numerous USGS/NOAA stream gauges exist throughout Michigan, additional installations and maintenance can cost upwards of $23,000 per sensor, and $6,000 annually for maintenance and calibration. A more cost-effective system of remote sensors capable of providing live data to bridge owners would help efficiently prioritize site visits, on-site monitoring, and closures/detours. The scope of work includes the following:

1. Conduct literature search on remote water surface monitoring devices, alert, data logging and power systems.
2. Survey other state DOTs on the utilization of remote systems
3. Catalog the attributes of scour critical bridges to identify the conditions for sensor performance.
4. Select ideal system to satisfy the research problem including life cycle costs.
5. Based on performance in Michigan river and weather conditions and other critical factors such as tamper resistance, perform modifications if improvement is needed.
6. Install the sensor systems on 20 MDOT bridges and monitor for 18-24 months.
7. Monitor network and data transfer performance, if necessary, modify the system to improve performance, reliability, and connectivity.
8. Develop an implementation plan with cost and phasing to install sensors on all recommended bridges.
9. Develop a research report documenting the study and recommendations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Tasks 1-3 were rescheduled to accommodate initiating Tasks 4-6. An initial installation of five sensors was performed to expose the units to the longest duration in varying seasonal conditions. Improved functionality of solar panels and battery, cellular connectivity, and improvement and standardization of the deployment process. Data dashboards and streamlining data capture was also improved.

Site scoping was performed for optimal locations and installation process. Right of Way permitting was acquired through MDOT. After installing these sensors, data capture and improvements to processing were being developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 4-6 are complete. Ongoing monitoring as part of Task 7 will continue until the end of the project. Task 1 has been provided to the panel as a draft, open for comment. Tasks 2, 3, 8 and 9 are ongoing

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Continuation of Task 7 with a focus on Tasks 8 and 9. Monitoring of the sensor system will provide more detail for the implementation plan and increase accuracy of cost estimates.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Competitive Bidding in Construction Contracting

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Strzalka, Larry

CONTRACT/AUTHORIZATION NO.	2019-0313 Z5	PROJECT START DATE	1/1/2021
PROJECT NO.	211054	COMPLETION DATE (Original)	9/30/2022
OR NO.	OR21-017	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Hexu Liu		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$48,846.65	Total Vendor Budget	$105,898.65
MDOT Budget FY 2022	$7,200.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$41,644.95	Total Budget	$105,898.65
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$105,896.95
		Total Amount Available	$1.70

PURPOSE AND SCOPE

The purpose of this research is to investigate MDOT's processes related to advertisement, bidding and award of contracts by collecting bid data, monitoring contractor's bidding tendencies, surveying other Departments of Transportation (DOTs), etc. to resolve potential problems including the following:

1. Overall increase of bid prices, despite a low inflation rate in the overall economy.
2. Lower number of actual bids received and how it affects the number or projects that can be built.
3. Concerns as to whether current MDOT Bidding practices help foster bidder collusion.
4. Inconsistent and unbalanced bids on traffic control pay items, especially lump sum pay items.
5. Inaccurate price estimating of traffic control pay items.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 1 – Collect bid data from MDOT or other sources as needed: WMU and MDOT signed a data-sharing agreement in March 2021. WMU then collected pay item data from MDOT and additional bid data from the following DOTs: Indiana, New York, Ohio, Texas, and South Dakota.

Task 2 – Survey state DOT's bidding and estimating practices: WMU developed a nationwide survey to learn more about bidding and estimating practices. Reviewed and approved by the Research Advisory Panel (RAP), the final survey was distributed in July 2021. Distribution of survey was extended to DOT bid contacts provided by RAP, FHWA, AASHTO estimating contacts, and members of the Technical Committee and Cost Estimating from the AASHTO website. WMU received 30 responses and the results of the survey were presented the RAP in August 2021.

Task 3 – Focus group interviews with selected DOTs on bidding and estimating: Based on Task 1 and 2 WMU drafted questions to garner further information on estimating and bidding practices. These interviews are intended to provide an opportunity to collect more details from the state DOTs that have different practices than MDOT. Interviews are planned to take place October 2021.

Task 4 – Development of a methodology for monitoring contractor's bidding tendencies: WMU provided the RAP with a very preliminary graphic user interface for an in-house application for monitoring contracting bidding tendencies. An additional question as approved by the Project Manager and distributed to select MDOT staff to establish needs for a GIS application in bidding practices within the department. The Internal survey was distributed in September 2021.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 3 – Focus group interviews with selected DOTs on bidding and estimating: The research team reached out to DOTs that participated in the Task 2 survey and invited them to participate in the interview process. Of those contacted 13 DOTs provided responses to participate via email. Results of the interviews covered information pertaining to 1) Prequalification; 2) Bid evaluation; 3) Information release; and 4) Cost estimation. In addition to the DOT interviews the research team also reviewed the following provided by the participating DOTs: 1) DOTs prequalification policy and instruction; 2) Contract award manual; 3) Standard specification manuals (SPEC Books); and 4) DOTs cost estimation procedures.

Task 4 – Development of a methodology for monitoring contractor's bidding tendencies: A survey was developed by the research team to identify the requirements and needs for GIS application in bidding practices within the department. Results were analyzed and based on the requirements for GIS, the research team proposed the use of an in-house app for monitoring

tendencies that would be able to monitor tendencies via three perspectives: 1) Bidders – Unit price trend comparison for bidder and EE; 2) Time – Vendor competition mapping; and 3) Spatial pattern – Work location and contract competition mapping.

Task 5 – Development of methodology for unbalanced bidding analysis: WMU verified and validate mathematical models for unbalanced bids. WMU used data mining and machine learning techniques (e.g., outlier detection and cluster analysis) to analyze the historic bid price of pay items for their "true" bid prices, considering project characteristics such as project location, size, and type. The engineer's estimate of historic bids was checked for reliability and determinations were made whether they are within ±10 percent of the low bid for at least 50 percent of the historical projects, as suggested by FHWA (2004). Following this, a rating-based system was developed to score the bids and detect mathematically unbalanced bids. The 'true' price identified in the previous step were used in the rating system. Additionally, a risk-based method was designed to further identify materially unbalanced bids, capitalizing on Monte Carlo Simulation. WMU compared and evaluated different unbalanced bidding detection models to deliver the more effective unbalanced bidding detection. The collected bid data (MDOT provided 2016-2022 contract data) was used to validate the effectiveness of the new methods.

Task 6 – Development of bid analysis tool for MDOT: WMU investigated an advanced approach in automating bid analysis, such as unbalanced bidding and bidder tendencies, as well as spatial visualization. The developed tool provides flexibility for generating the appropriate comparison information through reports and queries. Additionally, a backend database was created using Excel to store the bid data. The algorithms developed in Task 4 and Task 5 were encoded into the standalone application and a user manual of the tool was developed.

Task 7 – Recommendations and implementation procedures for new practices: Based on the findings of projects in Tasks 1 thru 6, WMU developed recommendations and implementation procedures that address alternative methods for bidding project traffic control, possible estimating methods, e.g., on traffic control and maintenance costs, an analysis of how the competitiveness of Michigan's bids might be improved and procedures to improve the competitiveness of bids in Michigan.

Task 8 – Development of final report and presentation: WMU compiled the activities from Tasks 1 through 7 and prepared the materials needed in a final report document that covered research findings, recommendations, and the implementation plan for proposed bidding and estimating practices. Associated materials (bid analysis tool and user manual were delivered).

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Proposed implementation recommendations are being reviewed internally to determine practical applications.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Infrastructure Protection and Rehabilitation Response to High Lake Levels

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Harold Zweng

CONTRACT/AUTHORIZATION NO.	2021-0266	PROJECT START DATE	2/15/2021
PROJECT NO.	211055NI	COMPLETION DATE (Original)	1/3/2022
OR NO.	OR21-013	COMPLETION DATE (Revised)	3/31/2022
RESEARCH AGENCY	Arcadis of Michigan, LLC		
PRINCIPAL INVESTIGATOR	Craig Hebebrand		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$21,924.30	Total Vendor Budget	$198,811.02
MDOT Budget FY 2022	$70.00	Total MDOT Budget	$70.00
Vendor FY 2022 Expenditures	$28,566.52	Total Budget	$198,881.02
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$198,833.95
		Total Amount Available	$47.07

PURPOSE AND SCOPE

Record Lake Michigan and Huron highs were set in January of 2020 after a record low in 2013. Wet seasons have filled the lake basins. Embankment erosion, high water tables, stream outlet tailwater changes, and other impacts have affected infrastructure throughout the system. MDOT wants to understand needed improvements for currently impacted roads, bridges, and culverts including the long-term impacts of sustained inundation and saturation of subbase or other components that may need repair after water levels subside. The scope of work for this project includes the following:

1. Compile list of impacted asset types and classification of impacts statewide.
2. Perform a thorough literature review of available research.
3. Identify each type of site to be included in the study.
4. Perform a basic engineering analysis of each site.
5. Identify remediation options for each site
6. Analyze cost-benefit-risk for each option for each site.
7. Apply the cost benefit assessment on specific locations to the class and type of issues broadly across the state.
8. Develop decision making matrix based on statewide assessment.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The PI and MDOT RAP agreed upon a list of five sites that would be reviewed in greater detail. The PI developed a plan including drone video collection and interviews with region staff. That work was completed in spring of 2021. During the summer of 2021 the PI performed site analysis, lake level forecasting and modeling, and drafted final deliverables with input from MDOT. A complete draft final report is anticipated in December 2021.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Final report was submitted and accepted in March of 2022.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Due to staff changes at Arcadis, there was a change in Principal Investigator in July 2021, along with an associated two-month end date extension. A small budget increase for additional scope was added during FY 2022 to will allow for greater understanding of regional concerns such as politics, jurisdictional issues, and local economic needs.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Implementation activities will include disseminating the report through MDOT, and discussion about how to use the site risk analysis tool in planning activities.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Utilizing Video Analytics w/Connected Vehicles for Improved Safety

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Mueller, Michele

CONTRACT/AUTHORIZATION NO.	2021-0250	PROJECT START DATE	2/15/2021
PROJECT NO.	211056	COMPLETION DATE (Original)	1/31/2024
OR NO.	OR21-005	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Kimley Horn of Michigan Inc.		
PRINCIPAL INVESTIGATOR	Good, Amanda		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$194,750.39	Total Vendor Budget	$349,662.20
MDOT Budget FY 2022	$85,000.00	Total MDOT Budget	$115,000.00
Vendor FY 2022 Expenditures	$70,119.75	Total Budget	$464,662.20
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$145,041.50
		Total Amount Available	$319,620.70

This project will investigate the use of video analytics to operate in a proactive way by identifying crash challenges in real time to help form an understanding of near misses and crashes. The research will include installing a video analytics system along a test corridor to analyze, evaluate, and validate the effectiveness and improved traffic efficiencies when implementing solutions at MDOT's most challenging signalized intersections. The system could take this information and provide a notification through connected vehicle technology to vehicles, pedestrians, and other non-motorized users. Initially, this notification capability would be set up in test vehicles and MDOT could expand installations to other vehicles once proven effective.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Completed a draft Market Assessment memo by interviewing multiple agencies and researching various vendors. Drafted a Request for Information (RFI) to obtain additional input from vendors on the industry capabilities. Developed several use cases and presented a Use Case Memo. Began development on initial functional requirements that will be used to identify and potentially select a vendor(s) to implement at selected corridor(s)/intersection(s). Began to identify the process of evaluating potential locations (corridor/intersection based).

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed work necessary for the RFI proposals to be received. Solicitation pending where after vendor solicitation, vendors will be afforded an opportunity to demonstrate their system per the RFI information (during FY 2023).

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Information gathered from vendor's demonstrations will be used to help support the final development of functional requirements and finalization of the Market Assessment Memo; Identify any nuances that need to be considered for the Corridor Evaluation process; and locations for implementation will be identified and a Request for Proposal (RFP) style process will be used to identify vendor(s) to implement their system at those locations. Initial analysis of the data and performance will begin.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion fiscal year 2024.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Effective Bridge Deck Weather Warning Technologies

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Smith, Dave

CONTRACT/AUTHORIZATION NO.	2021-0412		PROJECT START DATE	2/15/2021
PROJECT NO.	211058		COMPLETION DATE (Original)	7/31/2023
OR NO.	OR21-016		COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)			
PRINCIPAL INVESTIGATOR	Tim Gates			

BUDGET STATUS

FY 2022 Budget			**Total Budget**	
Vendor Budget FY 2022	$157,059.91		Total Vendor Budget	$351,167.11
MDOT Budget FY 2022	$13,000.00		Total MDOT Budget	$4,000.00
Vendor FY 2022 Expenditures	$23,943.48		Total Budget	$355,167.11
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$23,943.48
			Total Amount Available	$331,223.63

PURPOSE AND SCOPE

Weather related crashes continue to be a problem on Michigan roadways. Crashes caused by inclement weather are especially problematic on bridges where historically, MDOT has mounted seasonal warning signs to warn drivers of such conditions. Recently, MDOT has begun installing new condition-responsive technology that uses environmental sensors to detect icy bridge decks and roadways that when the correct conditions are met, will light up flashing yellow or Light-Emitting Diode (LED) lights on nearby warning sign) to help the motoring public understand the upcoming road conditions. This research project will explore more dynamic messaging strategies, such as displaying a warning message on a nearby Dynamic Message Sign (DMS) or incorporating vehicle to infrastructure communication to improve driver's behavior response to adverse weather conditions thereby hoping to reduce the number of these types of crashes.

FISCAL YEAR 2021 ACCOMPLISHMENTS

1. Worked to determine guidelines for weather related DMS ad Static sign parameters, including location, messaging, and communication needs.
2. Survey questions for other states and/or countries pertaining to what they are doing with weather related DMS and static sign parameters have been sent out to approximately 50 different locations.
3. Testing has not yet started on materials and technology
4. Began investigating crash data for the three known existing locations.
5. Review of the driver behavior assessment study has not yet started.

FISCAL YEAR 2022 Accomplishments

Continued work on project objectives noted above and selected locations for field study. Overall research work is approximately 45% complete.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Researcher will work with MDOT experts to install the additional test Bridge Deck Warning System (BDWS) sign at selected Lansing area site on NB 127 at Willoughby Rd.

1. Collect data winter 2022/2023
2. Coordinate with the State Transportation Operations Center (STOC) to test DMS messaging strategies
3. Survey members of the Aurora project
4. Update manuscript covering FY 2022 activities

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Determining State and Federal Transportation Responsibilities to Residents on Islands

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Shultz, Valerie

CONTRACT/AUTHORIZATION NO.	2021-0207		PROJECT START DATE	1/15/2021
PROJECT NO.	211059		COMPLETION DATE (Original)	4/30/2023
OR NO.	OR21-012		COMPLETION DATE (Revised)	4/30/2023
RESEARCH AGENCY	Michigan State University (MSU)			
PRINCIPAL INVESTIGATOR	Zockaie			

BUDGET STATUS

Vendor Budget FY 2022	$85,209.48		Total Vendor Budget	$160,573.35
MDOT Budget FY 2022	$13,560.00		Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$116,114.58		Total Budget	$160,573.35
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$138,401.90
			Total Amount Available	$22,171.45

PURPOSE AND SCOPE

Michigan residents are choosing to live on Drummond, Neebish, and Sugar Islands located in St. Mary's River in the eastern Upper Peninsula, and on Beaver Island located in Lake Michigan off the coast of Charlevoix. The residents expect the same access to work, emergency services, and economic opportunities on the mainland as mainland residents receive. The purpose of this research project is to determine the State and Federal transportation responsibilities to residents residing on islands in the State of Michigan.

The tasks outlined below from Michigan State University are in response to the following objectives of this Ferryboat Research Project: (1) level of service provided to the island residents, (2) repair/maintenance of docks on the islands, (3) number of back-up ferries needed, as ferries are required to be removed to drydock every five years for Coast Guard inspection/repair, (4) the requirement/need for maintaining a ferry with crew 24/7 for emergency services, and (5) whether ferries on all islands need to be able to accommodate logging trucks. The tasks are tracked and evaluated to determine the status of this research project.

Task 1: Literature Review
Task 2: Review of Michigan Regional Background
Task 3: Perform a Nationwide State DOTs and Ferry Operators Survey
Task 4: Survey/Interview of Island Residents and Ferry Operators
Task 5: Island Residents Mobility Gap Analysis
Task 6: Assessment of Current Ferry Operations and Developing Maintenance Plan
Task 7: Evaluate Ferry Operation in Other Islands
Task 8: Final Recommendation for Michigan Island Accessibility
Task 9: Develop and Deliver Draft and Final Reports

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 1 - Literature Review- Reviewed key literature from previous studies, federal guidelines, state DOTs, MDOT, other agencies and information collected by researchers.

Task 2 - Review of Michigan Regional Background: Provided data by MDOT were analyzed to review the financial and ridership data. The ridership data were compared with predicted values in the earlier published reports for the islands of interest in this study. The research team also followed up with BITA and EUPTA to get their operational data.

Task 3 – Perform a Nationwide State DOTs and Ferry Operators Survey: To review the state-of-the-practice the developed on-line state DOT survey was further updated to address MDOT RAP feedback. Various approaches were explored to distribute the survey to relevant DOT staff. A combination of on-line search and inquiry from AASHTO committees was used to distribute the survey. Multiple rounds of reminders including group emails, individual emails, and phone calls were used to increase the survey response rate.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 4 - Survey/Interview of Island Residents and Ferry Operators: The research team conducted in person data collections for three islands serviced by EUPTA in July 2022 (July 7th-9th). The collected survey results were processed and analyzed. The initial analyzed results were presented at the MDOT RAP meeting.

Task 5 - Island Residents Mobility Gap Analysis: The collected data was part of the survey of residents of Michigan islands, in addition to conducted interviews with business owners and different groups of users and ferry operators were analyzed to identify service gaps and mobility needs for the main islands of interest in this study.

Task 6- Assessment of Current Ferry Operations and Developing Maintenance: Ferry operations were assessed to determine their current expenditure on maintenance.

Task 7- Evaluate Ferry Operations in Other Islands: The basic operational details and island profiles were collected for these other island (Manitou, Bois Blanc, Grand and Harsens). This was followed up with interviews with ferry operators and several members of the Great Lakes Islands Alliance (GLIA) who connected the researchers to certain stakeholders in these islands.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Task 4- Survey/Interview of Island Residents and Ferry Operators: The research team will summarize ferry operators' and owners' interviews and present the results to the MDOT RAP. In addition, further cross reference analysis will be made on the data of users' surveys.

Task 5 - Island Residents Mobility Gap Analysis: The identified service gaps and mobility needs for the main islands of interest in this study will be finalized and alternative modes of transportation will be compared to ferry operations at different islands.

Task 8 – Final Recommendation for Michigan Island Accessibility

Task 9 – Develop and Deliver draft and final reports

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date of the project was extended due to the COVID-19 pandemic postponing data collection.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Evaluation of MDOT's Methodologies for both Quantifying Pavement Distress & Modeling Pavement Performance for LCC and RSL Estimation Purposes

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Eacker, Michael

CONTRACT/AUTHORIZATION NO.	2021-0288	PROJECT START DATE	2/2/2021
PROJECT NO.	211061	COMPLETION DATE (Original)	5/31/2023
OR NO.	OR21-007	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Kutay		

BUDGET STATUS

FY 2022 Budget		**Total Budget**	
Vendor Budget FY 2022	$231,858.48	Total Vendor Budget	$543,031.80
MDOT Budget FY 2022	$16,640.00	Total MDOT Budget	$52,000.00
Vendor FY 2022 Expenditures	$208,355.92	Total Budget	$595,031.80
MDOT FY 2022 Expenditures	$5,264.15	Total Expenditures	$309,885.60
		Total Amount Available	$285,146.20

PURPOSE AND SCOPE

Since the inception of its pavement management system in the early 1990's, the MDOT has been using the Distress Index (DI) as a measure of surface condition for pavements. The DI is based on an assignment of increasing-value numeric "points" to specific distress type-and-severity observations obtained through detailed surveys; the more detrimental a distress type/severity observation is to pavement structural condition, the higher the assigned point value. The distress information is collected via digital images by vendors on roughly half the MDOT network every year. There appears to be a gap between what the state of the practice in the pavement data collection industry typically provides nationwide, and the complexity of the distress information MDOT asks for. MDOT has decided to suspend collection of the full extent of the distresses typically requested and to suspend the use of DI as the pavement condition measure. This research is expected to investigate and recommend a new condition measure, or revisions to the existing DI system, that MDOT can utilize moving forward. This new/revised measure is expected to be compatible with what the pavement data collection industry can deliver in an accurate and timely manner. It is also expected to have low impact on MDOT's business practices and processes, including the Remaining Service Life (RSL) estimation process and the Life-Cycle Cost Analysis (LCCA) process.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The research team did an exhaustive literature search to find what other states are using as measures of pavement performance. Typically, most states hire one of a small set of vendors to survey their pavements for condition assessment. The capabilities and standard practices of these vendors was investigated and assessed. The pavement condition assessment methodologies of 18 different states were studied to evaluate the details of the types of pavement distresses they assess. Based on this investigation, the research team narrowed it down to the five most promising methodologies.

The team began using detailed data from MDOT's PMS database for specific sections of pavements to create the pavement condition index using the selected five methodologies. These index values were compared to MDOT's DI values to create an initial assessment of applicability to Michigan's pavements.

Finally, the research team created a survey that will be sent to MDOT staff most closely involved with the pavement evaluation and scoping for fix type selection.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Out of five choices from other states for distress index methodologies, the Minnesota method was chosen to implement in Michigan. The distress definitions and severity levels were finalized, and calibration of the point system was begun. MDOT decided that the new index will be called the Pavement Distress Score (PDS).

The research team also began reviewing different methods for modeling the predicted performance for families of pavements (reconstructs, rehab fixes, etc.). MDOT's method for splitting project lists into families were utilized with the PDS numbers to see the fix life predictions from each of the models. These fix life values were compared with MDOT's existing fix lives to judge reasonableness of each of the models. These families, however, were based on the old Distress Index (DI) scores. So, the research team began working on a method to break project groups into families using the PDS.

The research team delivered the first draft of one of the three anticipated computer modules for the PDS. This first module is intended to take MDOT's previous distress data and covert it to the new PDS distress types and severities. MDOT began reviewing that JAVA code.

Lastly, the research team began reviewing literature for ways to model International Roughness Index (IRI) data to predict future IRI values.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

A presentation of the proposed PDS and performance model methodologies to internal and external stakeholders is planned for early December. Finalization of the PDS point system, PDS distress definitions, and performance modeling is expected. Delivery of all three computer modules for converting old distress calls to PDS, calculating PDS from the new definitions, and the performance model are expected.

Development of a methodology for IRI modeling will be developed and a way to incorporate into MDOT's life-cycle process will be recommended. This will include software for creating life-cycle service lives.

Development of methodologies for modeling network-level IRI, cracking, rutting and faulting will be started.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Request for a no cost time extension is in process due to the development of PDS and performance modeling being more complicated than anticipated.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023 or 2024.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Quantifying the Impact of Super Single (Wide Base) Tires
Tires on Pavement Damage in Michigan

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Schenkel, Justin

CONTRACT/AUTHORIZATION NO.	2019-0311 Z2	PROJECT START DATE	3/15/2021
PROJECT NO.	211062	COMPLETION DATE (Original)	8/31/2022
OR NO.	OR21-008	COMPLETION DATE (Revised)	12/31/2022
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	You		

2022 BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$24,171.26	Total Vendor Budget	$244,484.26
MDOT Budget FY 2022	$27,500.00	Total MDOT Budget	$32,951.14
Vendor FY 2022 Expenditures	$124,960.51	Total Budget	$277,435.40
MDOT FY 2022 Expenditures	$6,020.08	Total Expenditures	$202,547.63
		Total Amount Available	$74,887.77

PURPOSE AND SCOPE

Dual tires have been the trucking industry standard for many decades. For this reason, existing modelling of the stresses imparted to the pavement through the tires is based on dual tires. However, the freight industry has started to use wide-base single tires (WBT), also known as super single tires (SST) because of their economic benefits and safety advantages. Therefore, SSTs may gradually replace conventional dual tires. Early design types of SSTs induced excessive pavement damage, especially to flexible pavements. These types of SSTs can generate much higher vertical contact stresses as compared to traditional dual tires, resulting in more significant deformations and more severe damage in bound and unbound layers within a pavement structure. Subsequently, the latest generation of SSTs now have contact areas that are like traditional dual tires and potentially offer improved performance. Therefore, these SSTs would inflect less bottom-up cracking in the asphalt concrete layer and less permanent deformation in all pavement layers. It is not clear what effect SSTs have on dynamic loading when the pavement surface exhibits high surface roughness, (measured in terms of the International Roughness Index (IRI). Moreover, weight measurements obtained by roadway Weigh-in-Motion (WIM) sensors may have errors as compared to the actual axle load for such tires. Therefore, there is a need to investigate the impact of such wide-based tires on pavement performance for Michigan's climate and construction practices, identifying the impacts that these have on the current MDOT flexible and rigid pavement design methods. For example, the presence of SSTs may influence the axle load spectra (ALS) to be used in ME analysis and load equivalency factors (LEF) for the AASHTO design method. The scope of work per task number includes the following, (which can be reordered as needed per the Principal Investigator (PI)

1. Literature review
2. Investigate WBT usage in Michigan pavements
3. Determine the impacts of WBT have on pavement performance
4. Update of the MDOT permanent traffic recorder (PTR) data
5. Identify the WBT trucks in the mix of FHWA classification
6. Final report and summarizes the recommendations

FISCAL YEAR 2021 ACCOMPLISHMENTS

During this fiscal year, the following tasks have been accomplished:

- The research team completed the literature review task, (Task 1). Review of published documents pertaining to WBT in the US, provinces in Canada, and a few countries in Europe. Research subject matter consisted of tire–pavement contact loads, pavement response and damage, life-cycle assessment, and lifecycle costing.
- The research team obtained the annual construction permit for operations within the state highway right-of-way and trial take videos in US41, M26, and Mackinaw Bridge using a GoPro video camera. The research team also visited sites in Fowlerville, Grass Lake, Monroe, New Buffalo, Coldwater weigh stations to study the percentage of wide-based tires.
    - Therefore, videos were taken at five different weigh stations, rest areas, and truck stops downstate to obtain the percentage of trucks with wide-base tires. Additionally, data was obtained in three key locations in the upper peninsula to accomplish the same task.
- Using the video imagery, the research team wrote a MATLAB code to complete the image processing to distinguish the various truck classes and identify the percentage of trucks utilizing wide-base tires using neural network (CNN) technology.
- The research team also finalized and distributed the WBT survey form (tire manufacturer version and user versions). Accordingly, responses have been catalogued for evaluation and reporting.

- The research team received the AASHTO Pavement ME software to prepare for assessment of the impacts of WBT on pavement performance.

Therefore, to summarize, Task 1 is complete, Task 2 is nearing completion, and Task 3 is underway.
The project is slightly behind schedule as of September 30, 2021, with approximately 27 percent of the planned work complete and approximately 35 percent of the project duration complete.

FISCAL YEAR 2022 ACCOMPLISHMENTS

During this fiscal year, the following tasks have been accomplished:

- The research team obtained survey results from different tire manufacturers and dealers. Accordingly, this data with previously collected data was consolidated to conclude their investigation of WBT usage in Michigan (Task 2).
- For Task 3, the team conducted analysis of WBT and dual tire arrangements using JULEA and ILLISLAB for flexible and rigid pavement structures, respectively. Accordingly, the team conducted Pavement ME analysis based on the mechanistic inputs and database from MDOT to account for the measured WBT usage found on Michigan trunkline routes. Accordingly, the research team derived recommendations for potential pavement design adjustments to account for WBT.
- The research team summarized possible PTR equipment refinement that will help MDOT track WBT in the future.
- Draft final reporting was worked on to account for all project findings.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The research team will complete their final report and submit all deliverables to MDOT.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Field investigation at weigh stations in the Lower Peninsula shows that the percentage of trucks with any WBTs is 11% on average, contributed to mainly by Class 9 trucks. The percentage of load axles with WBTs in all load axles in the Lower Peninsula is 7.32%, from the limited data set in this study. The percentage of trucks using any WBTs is 5.8% on average in the Upper Peninsula, and it is estimated that less than 5% of load axles would contain WBTs. Based on field investigation, the research team recommends assuming 10% as the current proportion of WBTs in the quantitative impact analysis to account for near-term growth during the pavement design life and conservativeness in design.

The impact of WBT loads on pavement distress are all related to the proportion of WBTs, such that more WBTs would cause more risk of pavement failure.

To account for WBT increased potential for pavement distress, the research team proposes adjustment of the design threshold(s) in Pavement ME, considering different WBT load impacts. An impact of less than 2.5% is considered minor in this approach, and no action is recommended in the design process. However, if the impact exceeds 5% for a given distress prediction, the adjusted Pavement ME design threshold is recommended. Specific adjustment(s) will be denoted in final reporting.

For AASHTO 93 pavement design, the research team proposes adjustment of the terminal PSI (from 2.5) to indirectly account for additional loss in serviceability due to WBT loads. Specific adjustment(s) will be denoted in final reporting.

Some advanced WIM technologies from Kistler, OptiWIM, and Fiscal Tech America show potential in identifying WBTs in addition to other factors such as wheel spacing and tire pressure that can further help to identify critical factors that affect pavement response and distress development.

MDOT will consider these recommendations for potential changes to pavement design procedures and placement of future WIM technology.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Corridor and Systemwide Application of Performance Based Practical Design

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Miller, Nathan

CONTRACT/AUTHORIZATION NO.	2021-0221	PROJECT START DATE	2/1/2021
PROJECT NO.	211063	COMPLETION DATE (Original)	1/31/2024
OR NO.	OR21-015	COMPLETION DATE (Revised)	
RESEARCH AGENCY	WSP Michigan, Inc.		
PRINCIPAL INVESTIGATOR	Wendling		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$93,935.00	Total Vendor Budget	$246,705.08
MDOT Budget FY 2022	$23,040.00	Total MDOT Budget	$23,040.00
Vendor FY 2022 Expenditures	$116,067.68	Total Budget	$269,745.08
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$143,948.04
		Total Amount Available	$125,797.04

PURPOSE AND SCOPE

Performance Based Practical Design (PBPD) represents a change in mindset from traditional design techniques that mainly focused on meeting specific standards. PBPD places an emphasis on planning-level corridor or system performance needs and objectives to be utilized when scoping and developing individual projects. It is an outcome-oriented approach to design by development of performance-based goals for a corridor or system, and then utilizing practical design to meet those goals. Performance measures such as: safety, system reliability, congestion reduction, freight movement/economic vitality, accessibility, context sensitivity, life cycle costs, long range corridor goals, livability, environmental sustainability, operational performance/Level of Service, infrastructure integrity, and maintenance are some of the components to evaluate. The use of data driven analysis tools, balanced with stakeholder input, can be utilized to objectively develop the purpose, and need (performance-based goals and objectives) for the corridor or system. Specific scope for this project includes the following:

1. Conduct a survey of literature to identify best practices
2. Conduct a state of the practice survey of other DOT's, MPOs, and FHWA.
3. Evaluate MDOT's current state of the practice and documentation needs
4. Identify performance data sources that could be used as thresholds to establish design performance measures.
5. Identify predictive tools that can be used to establish performance measures.
6. Develop and recommend design tools that MDOT can implement.
7. Develop a guidance document for use statewide that outlines PBPD practices for MDOT staff.
8. Develop a Research Report

FISCAL YEAR 2021 ACCOMPLISHMENTS

Initiation of the research project was delayed several months due to a change in the MDOT project manager. Despite this, the team has been working expeditiously to remain on schedule and had generated and submitted a list of survey questions to AASHTO state participants to benchmark current initiatives. All responses will be received at the end of this year.

FISCAL YEAR 2022 ACCOMPLISHMENTS

In 2022, all current benchmarking with other DOTs has been completed and communicated out to the RAP. Additionally, existing process identification has been completed at MDOT. This information has been amalgamated into a report that was sent out for review to the RAP members.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

In 2023, the research project will be entering the more difficult phase of identifying PBPD design tools that can be used at MDOT. This will not be a simple handoff of tools; there will be a lot of discussion about if these tools can even be integrated into the existing design processes, and if so, what cascading changes will need to be made to ensure that the tool(s) are successful.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager at the beginning of the project due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion fiscal year 2024.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Right of Way Mapping Conversion to GIS

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Matthew Fitch

CONTRACT/AUTHORIZATION NO.	2021-0272	PROJECT START DATE	2/1/2021
PROJECT NO.	211064	COMPLETION DATE (Original)	11/30/2022
OR NO.	OR21-002	COMPLETION DATE (Revised)	2/28/2023
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Bunting		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$123,978.00	Total Vendor Budget	$386,327.00
MDOT Budget FY 2022	$4,800.00	Total MDOT Budget	$ 600.00
Vendor FY 2022 Expenditures	$132,511.15	Total Budget	$386,927.00
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$190,256.75
		Total Amount Available	$196,670.25

PURPOSE AND SCOPE

Current MDOT Right-of-Way (ROW) Maps are outdated and do not support integration with current MDOT Design and Survey Initiatives and processes. There is no integration with public information or MDOT's current Real Estate IT database. Internal and external users rely on the ROW Maps to determine ownership and are not able to make accurate decisions based on the inaccuracy of the ROW Maps. It is difficult to search for information on the ROW Maps and several resources must be utilized. The scope of the research includes the following:

1. Identify mapping best practices from other state DOT's and agencies.
2. Catalog map data that would be useful for map modernization.
3. Assess the status of MDOT's current efforts to modernize maps.
4. Determine the business needs and functions that an updated map should support.
5. Prioritize requirements for ROW map system.
6. Devise ROW map modernization designs and costs.
7. Implement modernization pilot.
8. Test the maps developed to see if they support MDOT's business needs and search functionality.
9. Adapt design to feedback from Beta testing.
10. Track work required for modernization and develop a statewide implementation plan.
11. Implement modernization in 2 counties.
12. Report on process and recommendations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Subcontractor DLZ has identified best practices utilized in other states, mainly Wisconsin, Ohio, Indiana, and Oregon. They have also contacted AASHTO and JCG Land Services, Inc. regarding best practices. Several forums were administered, receiving input from MDOT employees regarding their opinions on ROW Maps. Meetings with LAMDA representatives were held to determine proper integration with the new LAMDA database.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Altered "Modernize data for two counties" to "Developing Methodologies for Incorporating New Data into the GIS." Identified and cataloged MDOT ROW map data. Assessed current MDOT modernization plan. Needs assessment and follow-up interviews. Established Project Requirements. ROW Map Modernization Design. Pilot Study.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Implementation plan and modernization implementation; Software Solution and Final Report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The end date was extended to February 28, 2023, due to lack of personnel available to assist MSU's RS & GIS Division.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Evaluating the Performance and Safety Effectiveness of Roundabouts - An Update

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Jason Ealy

CONTRACT/AUTHORIZATION NO.	2021-0403		PROJECT START DATE	3/1/2021
PROJECT NO.	211065		COMPLETION DATE (Original)	1/31/2023
OR NO.	OR21-009		COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)			
PRINCIPAL INVESTIGATOR	Peter T. Savolainen			

BUDGET STATUS

FY 2022 Budget			**Total Budget**	
Vendor Budget FY 2022	$104,597.58		Total Vendor Budget	$249,999.99
MDOT Budget FY 2022	$6,500.00		Total MDOT Budget	$2,500.00
Vendor FY 2022 Expenditures	$124,262.19		Total Budget	$252,499.99
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$136,806.82
			Total Amount Available	$115,693.17

PURPOSE AND SCOPE

The purpose of this project is to study current roundabout environmental, operational and safety performance efficacies, along with maintenance best practices and costs to determine the future application of roundabouts in Michigan.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Kickoff meeting was held on March 15, 2021. Literature review is nearly complete. Specific study locations have been identified and preliminary data collection has begun. Crash, geometric, and volume information has also been collected.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Literature review has been finalized. Data collection from study locations has been completed. Other data related to environment, operations, safety, maintenance, and construction costs have also been compiled. All data has been analyzed, and results and conclusions drawn.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Some safety data still needs to be analyzed. A draft report will be submitted and reviewed by the RAP. A presentation of the results will also be prepared. Project will be finalized.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Influence of Revising CFCC Guaranteed Strength on Performance of CFCC Prestressed Highway Bridge Beams Subjected to Various Environmental Conditions

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Steve Kahl

CONTRACT/AUTHORIZATION NO.	2019-0309 Z3	PROJECT START DATE	10/1/2021
PROJECT NO.	213122NI	COMPLETION DATE (Original)	9/30/2024
OR NO.	OR21-018	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Nabil Grace		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$154,264.60	Total Vendor Budget	$481,165.90
MDOT Budget FY 2022	$3,333.33	Total MDOT Budget	$6,666.66
Vendor FY 2022 Expenditures	$65,366.78	Total Budget	$487,832.56
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$65,366.78
		Total Amount Available	$422,465.78

This project includes $94,496.40 in University Matching Funds over and above the reported project budget.

University Match				
By Fiscal Year	**Annual Budget**	**Annual Expenditures**	**Total Expenditures**	**Total Amount Available**
2022	$31,180.80	$13,121.52	$13,121.52	$81,374.88

PURPOSE AND SCOPE

The current manufacturer of carbon fiber composite cable (CFCC) has introduced a 0.7” diameter strand, which is more of a one-to-one replacement for steel strands, and MDOT is pursuing using these strands. Based on extensive tensile test results, the manufacturer of CFCC strands updated the guaranteed breaking load of different strand diameters to reflect the current material strength with the proper safety margin. The increase in the guaranteed strength ensures an efficient and economical use of the material. Implementing the new value in the design and construction of highway bridge beams necessitates the support of comprehensive experimental and analytical investigations to adequately predict the performance of the constructed beams under different loads and environmental conditions. LTU is conducting an extensive experimental program, including breaking load tests, elongation tests, creep rupture tests, fire load tests, environmental chamber tests, and full-scale bridge model tests. These results will then be compared to numerical modeling results using complex finite element analysis software to calibrate the material resistance factors for use in bridge design applications. Mathcad calculation templates, and specifications will be developed to aid designers.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Project start was delayed until FY 2022 due to COVID, and the impacts on LTU’s abilities to onboard research assistants. Project kickoff meeting was held on 10/26/2022. Experimental program has already begun with the procurement of 0.7” diameter strand from the manufacturer and loading into hydraulically controlled load frames from creep rupture testing and strain recordings.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The research team worked on Tasks # 2, 3, 4, 6, and 7 of the research project:
Task # 2: Creep/relaxation/prestress loss: The test specimens for creep and relaxation have been under continuous monitoring since 2017. The research team continued to evaluate the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level.
Task # 3 Transfer and Development Length: The research team is analyzing the test results of the three decked bulb T beams in the light of the test results obtained from pull-out testing and the ongoing shear testing of the end zone of similar decked bulb T beams. The objective of the research is to evaluate the end zone and establish the minimum amount of confinement reinforcement to avoid concrete cracking/splitting at beams ends.
Task # 4: Decked bulb T beam shear testing: The research team completed the shear testing of one end of a decked bulb T beam with steel stirrups at a spacing of 3.0 in. Test results showed that the shear capacity exceeded the flexural capacity and that the modified compression field theory for shear capacity calculations underestimated the capacity of the section. The team is currently evaluating the other end of the beam with CFCC stirrups at a spacing of 3.0 in.
Task # 6: Freeze-thaw test: Like the Beams under Task # 3, three half-scale decked bulb T beams were constructed with lengths of 8,12, and 16 ft. The beams will be placed in the environmental chamber and exposed to 300 cycles of freezing and thawing. After completing the cycles, the beams will be tested under three-point loading to failure. Test results will be compared

to those from Task # 3 to evaluate the impact of freeze-thaw cycles on development length and bond strength between concrete and CFRP strands. Due to hardware malfunction, the environmental chamber has gone under extensive maintenance and the freeze-thaw test is delayed until the repair of the chamber is completed.
Task # 7: Full-scale precast beams: The research team constructed two full-scale AASHTO I beams prestressed with CFCC strands using the new guaranteed strength and the new prestressing force. The first beam was tested to failure, while the second beam is currently under testing.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The research team will continue to work on different research items according to the proposed work schedule. During the next quarter, it is expected that the research team will work on Tasks 2, 3, 4, 6, and 7 and will continue to share and discuss the test results with MDOT Engineers.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Leveraging Crowd-sourced Data in Planning, Design, Analysis, and Evaluation of Pedestrian and Bicycle Traffic

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: DeBruyn, Josh

CONTRACT/AUTHORIZATION NO.	2019-0312 Z6	PROJECT START DATE	10/1/2021
PROJECT NO.	213124NI	COMPLETION DATE (Original)	3/31/2023
OR NO.	OR22-006	COMPLETION DATE (Revised)	7/15/2022
RESEARCH AGENCY	University of Michigan (UM)		
PRINCIPAL INVESTIGATOR	Misra		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$186,005.77	Total Vendor Budget	$309,241.98
MDOT Budget FY 2022	$18,600.00	Total MDOT Budget	$27,900.00
Vendor FY 2022 Expenditures	$138,359.64	Total Budget	$337,141.98
MDOT FY 2022 Expenditures	$216.72	Total Expenditures	$138,576.36
		Total Amount Available	$198,565.62

PURPOSE AND SCOPE

Collecting data on the number of people walking or bicycling along or across Michigan's vast transportation network is difficult to achieve, it can be time consuming and expensive. However, knowing the numbers of people walking or bicycling would be immensely useful in project planning, design, analysis, and evaluation of the transportation network for safety and accessibility among other measures. This research will help improve the assessment of the pedestrian and bicycle traffic exposure and help make informed decisions when planning, designing, and evaluating projects. The research includes the following tasks:

1. Literature review
2. Evaluation of the different types of crowd-sourced data pertinent to capturing data on activity related to people walking and bicycling.
3. Acquire crowd sourced data
4. For select urban areas acquire, analyze and map samples of crowd-sourced data from different platforms and assess the data captured
5. produce reports and analysis including validation/adjustment factors for rectifying discrepancies in data collection methods
6. Investigate commonly used models, count data storage programs and other similar types of programs for their ability to incorporate crowd-sourced data.
7. Produce guidelines on how MDOT, MPOs, and local agencies can utilize and import crowd-sourced data in their planning and design processes

FISCAL YEAR 2022 ACCOMPLISHMENTS

Accomplishments for the year include:

- The literature review was completed and a bibliography style report of 52 projects/publications was provided to MDOT
- Extensive outreach efforts were taken to connect with multiple DOTs and agencies for a nationwide survey of crowd-sourced data. It was determined to keep the survey active the project duration for additional feedback. To date 38 responses have been recorded.
- Equipment (5 Eco Counters) for field data collection was procured, locations were reviewed and selected with the research team and RAP, necessary permits were acquired, equipment was placed, and count data in the field was initiated.
- Outreach was made with third party data providers like Streetlight, Strava, and Placer to acquire data for evaluation. Research team is analyzing crowdsourced data from Strava at the location sites for the placed counter data.
- The Principal Investigator accepted a position with the University of Colorado – Denver. UMTRI expressed they would not be able to adequately fulfill remaining project tasks/deliverables and canceled project effective 7/15/2022. MDOT has obtained sole source approval from FHWA to move remaining contract balance and establish a new contract with UC-Denver.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Proposed activities include the following:

- New contract with UC-Denver will be established to complete remaining tasks/deliverables.
- Evaluation, comparison and analysis of the crowdsourced data and field collected data will be completed.
- The drafting of the findings and final report completed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This project was terminated during FY 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Implementation information will be available as part of a new contract with the University of Colorado – Denver.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Repair of Bridge Deck Fascias

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Beatty, Matt

CONTRACT/AUTHORIZATION NO.	2019-0314 Z2	PROJECT START DATE	10/1/2021
PROJECT NO.	213309NI	COMPLETION DATE (Original)	9/30/2023
OR NO.	OR22-002	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Wayne State University (WSU)		
PRINCIPAL INVESTIGATOR	Menkulasi		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$123,877.00	Total Vendor Budget	$234,817.00
MDOT Budget FY 2022	$64,000.00	Total MDOT Budget	$37,995.00
Vendor FY 2022 Expenditures	$106,384.17	Total Budget	$272,812.24
MDOT FY 2022 Expenditures	$6,995.24	Total Expenditures	$113,379.41
		Total Amount Available	$159,432.83

PURPOSE AND SCOPE

The deck fascia on bridges deteriorates more quickly than other portions of the bridge. This causes the fascia concrete to become debonded from the reinforcement and over time concrete can spall off the fascia. These spalled pieces of concrete can fall onto traffic lanes or pedestrian walkways posing a safety risk to the public. The current maintenance strategy has limitations. Our current practice is not to patch these areas, overhead patches can spall off posing a safety risk, and there is not a method to anchor false decking in these area. Delaminated concrete can be removed to prevent debris from falling unexpectedly, but when reinforcement is left exposed it leads to increased degradation of the bridge deck fascia and traffic barrier. Over time continually scaling these areas can cause the traffic barrier to become undermined without any option for repair. These current methods lead to the need for continual scaling in these areas. The research includes the following tasks:

1. Review existing research studies on similar projects. Survey state DOTs regarding best practices for design, construction, maintenance and long term repair. Document MDOT's current practices.
2. Identify at least 20 bridges that show signs of fascia deterioration.
3. Gather new data related to potential causes of fascia degradation.
4. Develop small scale laboratory simulations of the proposed maintenance and long term repair techniques and evaluate how they respond to long term accelerated weathering.
5. Analyze data and report on findings.
6. Draw conclusions in order to develop solutions to the research objectives.
7. Finalize report detailing research results, conclusions, solutions to objectives, and an implementation plan

FISCAL YEAR 2022 ACCOMPLISHMENTS

Task 1. Conducted a literature review of existing research studies on similar projects was completed. A survey of other state DOTs regarding best practices for design, construction, maintenance, and long-term repair was conducted. MDOT's current practices were reviewed.

Task 2. Compiled a list of greater than 20 bridges that show signs of fascia deterioration was identified and examined to draw correlations on the cause of deterioration.

Task 3. Completed field visits and sampling was conducted. The field data and information gathered from reviewing bridges in item 2 were analyzed to gather new data related to potential causes of fascia degradation.

Task 4. Small scale laboratory simulations were developed and tested to examine the materials and methods of the proposed repair. These tests included accelerated weathering. The concept for large scale testing was developed and discussed.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Task 4. Continue analysis of the small-scale testing and conducting the large-scale testing of the repair and materials.

Task 5. Analyze data and report on findings. Including the repair technique and options for improved MDOT practices for future construction.

Task 6. Draw conclusions in order to develop solutions to the research objectives.

Task 7. Finalize report detailing research results, conclusions, solutions to objectives, and an implementation plan.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Establish Policies and Procedures for Use of Subgrade Stabilization in Michigan

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Eacker, Michael

CONTRACT/AUTHORIZATION NO.	2019-0309 Z4	PROJECT START DATE	10/1/2021
PROJECT NO.	213313NI	COMPLETION DATE (Original)	3/31/2023
OR NO.	OR22-003	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Lawrence Technological University (LTU)		
PRINCIPAL INVESTIGATOR	Bandara		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$75,849.48	Total Vendor Budget	$164,968.38
MDOT Budget FY 2022	$25,333.33	Total MDOT Budget	$ 38,000.00
Vendor FY 2022 Expenditures	$45,713.90	Total Budget	$ 202,968.38
MDOT FY 2022 Expenditures	$5,756.50	Total Expenditures	$51,470.40
		Total Amount Available	$151,497.98

PURPOSE AND SCOPE

MDOT has, on occasion, stabilized the subgrade as part of a pavement reconstruction project. These have generally been in situations where it was more cost-effective than undercutting the subgrade, or when building a longer life pavement. MDOT would like to explore the use of subgrade stabilization more often. Projects where subgrade stabilization has been used appear to be performing very well. However, MDOT does not have any criteria for when/where subgrade stabilization would be a cost-effective choice to improve the performance of the constructed pavement. Where it has been used, special provisions outline the mix design process and testing protocol, but is this the optimum methodology? Multiple versions of these specifications with different allowable stabilization agents, acceptance methods and testing requirements have been used. These need to be unified.

Traditionally, fine-grained soils have been viewed as candidates for stabilization due to their lower support characteristics and high loss of modulus in moist conditions. There has been some interest in exploring stabilization of coarse-grained soils to see if pavement performance can be increased. However, does the potential loss of drainage through the subgrade outweigh the potential increase in support?

The work completed and documented in research report RC-1635, “Performance Evaluation of Subgrade Stabilization with Recycled Materials” started some of this analysis. This project will use the information from this previous project to create policies for when stabilization of the subgrade can be used, what the construction procedures should be, and finalize inputs used in the pavement design process. The research includes the following tasks:

1. Literature search with a particular emphasis on research already completed in Michigan (RC-1635, etc.)
2. Review Michigan DOT stabilized subgrade specifications and how stabilized subgrade is accounted for in pavement design.
3. Interview MDOT personnel to gather lessons learned from previous stabilized subgrade projects.
4. Develop specifications
5. Develop guidance for project selection including drainage
6. Finalize pavement design inputs
7. Final report

FISCAL YEAR 2022 ACCOMPLISHMENTS

This research project was authorized to begin in FY 2022. The list of accomplishments for FY 22 are as follows:

- Literature search with results divided into literature specific to Michigan and literature outside of Michigan.
- Discovery of past MDOT projects that utilized subgrade stabilization and the specification used.
- Review of other state’s subgrade stabilization specifications.
- Sent a survey to MDOT construction personnel, other states, and MDOT contractors to gather best practices, problems encountered, etc.
- Compiled the survey results.
- Initiated development of guidance documents for subgrade stabilization. The guidance is focused on three main areas:
    - Project selection
    - Mix design
    - Construction
- Initiated development of draft specifications

In addition to these accomplishments, several meetings were held between the research team and the MDOT RAP. These meetings included the kickoff, regular quarterly update, and guidance document feedback meetings.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Anticipated activities for FY 23 are as follows:

- Complete guidance documents
- Complete recommended specifications
- Recommend pavement design inputs
- Final report

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

One contract revision was completed during FY 2022 to correct the vendor's Indirect Cost Rate.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Effective Pedestrian/Non-Motorized Crossing Enhancements along Higher Speed Corridors

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Bott, Mark

CONTRACT/AUTHORIZATION NO.	2019-0313 Z6	PROJECT START DATE	10/1/2021
PROJECT NO.	213314NI	COMPLETION DATE (Original)	9/30/2023
OR NO.	OR22-004	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Ron Van Houten		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$81,902.57	Total Vendor Budget	$160,263.30
MDOT Budget FY 2022	$3,650.00	Total MDOT Budget	$3,650.00
Vendor FY 2022 Expenditures	$85,106.86	Total Budget	$163,913.30
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$85,106.86
		Total Amount Available	$78,806.44

PURPOSE AND SCOPE

MDOT desires solutions for enhanced pedestrian/non-motorized crossings along highway corridors with speeds 45 mph or greater at both signalized and unsignalized intersections. Specific treatments are desired (rapid flashing beacon, HAWK signal, etc.) but do not meet minimum warrants per various guidance documents. In response, MDOT must rely on its judgment as to what we believe will work for additional enhancement features. MDOT would like research on effective treatments where pedestrian/non-motorized crossing warrants are not met for the bigger enhancements on corridors with speeds 45 mph or greater. The research includes the following items:

1. National synthesis of crossing treatments
2. Data analysis of pedestrian crashes/risks to determine types of crossings needed/types of locations needed
3. Discussion of treatments and how they correspond to the MMUTCD and MDOT Crosswalk Guidance
4. Graphic typical development of treatment options (displaying markings, signs, enhancements, etc.)
5. Summary and breakdown of findings and best use situations
6. Summary of relative cost of overall treatments and effectiveness
7. Discussion points/presentation material for public involvement/public education

FISCAL YEAR 2022 ACCOMPLISHMENTS

To date approximately 53% of the overall research work is completed.

Task 1 – National and International Synthesis – Completed.
Task 2 – Review of Related Guidelines – Write up completed.
Task 3 – Crash Analysis – Initial analysis of crashes completed.
Task 5 – Development of Best Practices – Task started, collected speed data, and examined speeds before and after installation of the gateway, consisting of side mounts.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Task 3 – Complete Crash Analysis.
Task 4 – Complete determination of Cost Effectiveness.
Task 5 – Complete Best Practices findings.
Task 6 – Complete Development of Outreach and Educational Materials.
Task 7 – Final Report Preparation and Implementation Plan.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Michigan Hydrologic Calculation Procedures

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Erik Carlson

CONTRACT/AUTHORIZATION NO.	2019-0313 Z3	PROJECT START DATE	11/1/2021
PROJECT NO.	213316NI	COMPLETION DATE (Original)	12/31/2024
OR NO.	OR21-019	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan Technological University (MTU)		
PRINCIPAL INVESTIGATOR	David W. Watkins		

BUDGET STATUS

FY 2021 Budget		Total Budget	
Vendor Budget FY 2022	$161,895.74	Total Vendor Budget	$556,935.71
MDOT Budget FY 2022	$23,000.00	Total MDOT Budget	$51,000.00
Vendor FY 2022 Expenditures	$159,496.92	Total Budget	$607,935.71
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$159,496.92
		Total Amount Available	$448,438.79

PURPOSE AND SCOPE

The Federal Highway Administration (FHWA), the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and the Michigan Department of Transportation (MDOT) reviewed the approved procedures for calculating discharges from simulated Michigan rainfall events. The current hydrologic methods rely on older data sets where newer data is available. The purpose of this project is to update these methods to incorporate modern data sets and improve calculated discharge results.

1. Interview MDOT and EGLE staff to understand the current hydrologic methods and their application.
2. Update and validate the method outlined in “Computing Flood Discharges for Small Ungauged Watersheds” (Sorrell, 2010)
3. Identify GIS data for developing SCS Curve Numbers
4. Update the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka “Statistical Models for Estimating Flow Characteristics of Michigan Streams.”
5. Investigate alternative hydrologic techniques to calculate recurrence interval peak discharges at ungagged sites.
6. Report on findings

FISCAL YEAR 2021 ACCOMPLISHMENTS

The start of this project was delayed until FY 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The following activities were completed in FY 2022:

1) Task 1: Interview MDOT and EGLE staff to understand the current hydrologic methods and their application is complete.
2) Task2: Update and validated the method outlined in “Computing Flood Discharges for Small Ungauged Watersheds” (Sorrell, 2010) using current National Oceanic and Atmospheric Administration (NOAA) “Atlas 14” rainfall and recommended distributions had the following progress:
    a. Developed an understanding of the existing methodology that uses “Rainfall Atlas of the Midwest (Bulletin 71)” rainfall and Type II Soil Conservation Service (SCS) rainfall distribution including records that EGLE has from when the method was developed.
3) Task 3: GIS data for developing SCS Curve Numbers had the following progress:
    a. Collected information on the following:
        i. Existing 1978 land use dataset
        ii. United States Geological Service (USGS) Multi-Resolution Land Characteristics Consortium’s Land Cover raster set.
        iii. EGLE’s process for preprocessing curve numbers by county, based on merged soils and land use datasets.
    b. Identified where the 1978 land use data could be substituted with the more recent land cover datasets to improve hydrologic calculations.
    c. Considered other GIS data sets that could be used for SCS curve number development.
    d. Became familiar with current RCN procedures and evaluate data sets to provide automated workflows for developing SCS Curve Numbers in GIS.

4) Task 4: Update the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka “Statistical Models for Estimating Flow Characteristics of Michigan Streams” had the following progress:
    a. Developed an understanding of the existing linear regression calculations that used data from 180 gages and identified parameters for calculating discharge. The current method uses Quaternary Geology parameters. There should be a focus on reconsidering the use of this dataset, and consideration of other parameters to replace these parameters. Other key parameters include drainage area, slope of watershed, percent of length that is swamp, slenderness ratio, and rainfall.
    b. Identified parameters and collect data now available in GIS that should be considered in a regression update.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The following activities are proposed for FY 2023:

1) Task 1 is complete and not additional work is anticipated on this task.
2) Task 2: Update and validate the method outlined in “Computing Flood Discharges for Small Ungauged Watersheds” (Sorrell, 2010) using current National Oceanic and Atmospheric Administration (NOAA) “Atlas 14” rainfall and recommended distributions will have the following activity:
    a. Collect and evaluate data from existing and discontinued USGS gages with small drainage areas and a sufficient period of record. Compile rainfall data from gaged watersheds.
    b. Develop updated methods following guidelines outlined in The United States Department of Agriculture’s National Engineering Handbook Part 630 (Hydrology) using current NOAA Atlas 14 rainfall and recommended distributions.
    c. Evaluate and update (if necessary) the time of concentration method.
    d. Calibrate updated method using the new rainfall data, recommended rainfall distribution, and discharges from gaged watersheds.
    e. Review data from additional gaged watersheds to validate the calibration.
    f. Develop an automated process.
    g. Conduct a comparison analysis between the developed method and the Army Corps of Engineers’ HEC-HMS and EPA’s SWMM. Identify differences and report on findings.
3) Task 3: GIS data for developing SCS Curve Numbers will have the following activity:
    a. Continue to evaluate data sets to provide automated workflows for developing SCS Curve Numbers in GIS.
4) Task 4: Update the regression equation from the 1984 Michigan linear regression for large watersheds greater than 10 square miles aka “Statistical Models for Estimating Flow Characteristics of Michigan Streams” will have the following activity:
    a. Collect discharge data from the original set of gages and any newer gages with 15 years of record and at least one significant event or 20 years of record regardless of the existence of a significant event.
    b. Update additional data sets necessary such as rainfall.
    c. Conduct a parametric data analysis using gage data on new identified parameters to find the parameters of statistical significance.
    d. Update the regression method to include new parameters.
    e. Develop an automated process.
5) Task 5: Investigate alternative hydrologic techniques to calculate recurrence interval peak discharges at ungagged sites will explore the following techniques:
    a. Rain on grid
    b. Non-stationarity
    c. Other approved techniques

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Michigan Cone Penetrometer Test Calibration

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Ryan Snook

CONTRACT/AUTHORIZATION NO.	2019-0312 Z8		PROJECT START DATE	1/1/2022
PROJECT NO.	213318NI		COMPLETION DATE (Original)	11/30/2024
OR NO.	OR21-020		COMPLETION DATE (Revised)	
RESEARCH AGENCY	University of Michigan (UM)			
PRINCIPAL INVESTIGATOR	Roman Hryciw			

BUDGET STATUS

FY 2022 Budget			Total Budget	
Vendor Budget FY 2022	$155,282.16		Total Vendor Budget	$503,426.52
MDOT Budget FY 2022	$4,800.00		Total MDOT Budget	$14,400.00
Vendor FY 2022 Expenditures	$57,819.00		Total Budget	$517,826.52
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$57,819.00
			Total Amount Available	$460,007.52

PURPOSE AND SCOPE

MDOT purchased Cone Penetration Test (CPT) equipment in 2019 to better define the geotechnical conditions at project sites. Statistical comparison is needed to calibrate the Michigan CPT test and identify procedures that should be followed to produce and interpret Michigan soil data reliably. In addition, MDOT could benefit from a standardized procedure that stores data in the Data Interchange for Geotechnical and Geo-Environmental Specialists (DIGGS) data storage format and provides automated output that assists with risk-based design. Further identifying site variability may help with appropriate site characterization and design savings. The scope of work includes the following items:

- Conduct literature search and survey of state DOT state of the practice.
- Collect existing datasets from MDOT, published literature, and other sources.
- Evaluate correlation of MDOT CPT data to published soil type behavior charts and other published CPT charts.
- Make recommendations on how to apply published correlations to Michigan soils, and/or what corrections might be needed.
- Develop MDOT CPT procedures for bridge foundation design using direct design as well as CPT correlations.
- Develop a DIGGS based data storage system.
- Identify frameworks to characterize sites and group site variability.
- Identify how to apply CPT to reduce uncertainty in foundation design decisions.
- Identify an acceptable software package(s) that assists with data visualization.
- Identify software package(s) that provide an automated output with statistical risk-based foundation design.
- Provide training, manuals, and implementation guidance.

FISCAL YEAR 2021 ACCOMPLISHMENTS

This project was delayed starting FY 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Conducted literature search and survey of state DOT state of the practice.
- Collected existing datasets from MDOT, published literature, and other sources.
- Began to statistically compare MDOT's soil boring data and lab test data to MDOT's CPT data. Analysis methodology should allow for continuous import of new CPT data to refine/update correlations.
- Began to evaluate correlation of MDOT CPT data to published soil type behavior charts and other published CPT charts.
- Made preliminary recommendations on how to apply published correlations to Michigan soils, and/or what corrections might be needed.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Finish statistically comparing MDOT's soil boring data and lab test data to MDOT's CPT data. Analysis methodology should allow for continuous import of new CPT data to refine/update correlations.
- Finish evaluating correlation of MDOT CPT data to published soil type behavior charts and other published CPT charts.
- Make final recommendations on how to apply published correlations to Michigan soils, and/or what corrections might be needed.
- Develop MDOT CPT procedures for bridge foundation design using direct design methods.
- Develop a DIGGS base data storage system using Data forensics services/software
- Begin to identify frameworks to characterize sites and group site variability

- Begin to identify how to apply CPT to reduce uncertainty in foundation design decisions
- Begin to identify an acceptable software package(s) that assist with data visualization.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in Project Manager due to staff changes at MDOT.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2025.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Operational Baseline for the 2nd Avenue Network Arch Bridge

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Purush Pakala

CONTRACT/AUTHORIZATION NO.	2019-0313 Z8	PROJECT START DATE	1/1/2022
PROJECT NO.	213321NI	COMPLETION DATE (Original)	5/31/2024
OR NO.	OR22-008	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University (WMU)		
PRINCIPAL INVESTIGATOR	Attanayake		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$103,600.00	Total Vendor Budget	$258,887.71
MDOT Budget FY 2022	$9,720.00	Total MDOT Budget	$17,700.00
Vendor FY 2022 Expenditures	$48,672.32.00	Total Budget	$276,587.71
MDOT FY 2022 Expenditures	$2,904.39	Total Expenditures	$51,576.71
		Total Amount Available	$225,011.00

PURPOSE AND SCOPE

A skewed, unbraced network arch bridge is being constructed to carry the 2nd Avenue over I-94. This 245 ft long, 96 ft wide structure will carry vehicular traffic, bicycles and pedestrians in separate dedicated lanes. The unique structural configuration and the use of innovative accelerated bridge construction (ABC) techniques make this one of the most significant projects in the United States. The bridge skeleton, consisting of trapezoidal steel arch ribs, tie girders, end diaphragms, and steel floor beams will be assembled in a staging area near the bridge site. This bridge skeleton will be moved into place using self-propelled modular transporters (SPMTs) during a weekend closure of I-94. Following SPMT move and placement of the skeleton on permanent bearings, the rest of the construction activities will be completed. The stresses in several major structural elements are monitored using a structural health monitoring (SHM) system to capture the stresses during construction and in service. The research includes the following tasks:

1. Develop an understanding of the structure by studying as-built drawings and taking necessary measurements
2. Evaluate the performance of instrumentation.
3. Evaluate the data collected during construction.
4. Collect data from instruments on a regular basis for two years providing MDOT quarterly updates.
5. Store and evaluate seasonal trends in data.
6. Conduct load testing to establish an operational baseline for the structure.
7. Develop finite element models for intrinsic and live loads to predict the envelope of performance and calibrate models to this structure. A) Compare assumptions in research model to Engineer of Record model. B) Perform parametric studies to evaluate the effect of different parameters (ex: temperature, loading cycles or fatigue, creep, overload traffic etc.) on the structural response of the bridge C) Perform analysis to evaluate the residual capacity of the tied-arch system subjected to failure of critical member(s) of the tied arch network. The number of failed members could be more than one based on the critical locations identified.
8. Identify instrumentation output envelopes within which the structure can be maintained.
9. Develop a long-term sampling plan and transfer responsibility and training to MDOT for long term instrument monitoring of the structure

FISCAL YEAR 2022 ACCOMPLISHMENTS

1. Instrumentation of the bridge is completed along with the installation of data acquisition system. Data has been collected continuously, reviewed frequently and compared with the data from laboratory and field specimens.
2. Tie girder concrete specimens were collected and used for evaluating the properties such as shrinkage, creep, strength, and modulus of elasticity. Data from the tests was used to develop material property models.
3. Analysis model developed by Janssen & Spaans was reviewed and a summary report was developed.
4. User-defined material models in refined analysis models was reviewed. Simple models were used to evaluate the application of user-defined models to simulate shrinkage, creep, and combined effects before implementing such models in bridge components.
5. Field visit and two progress meetings were conducted.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

1. Record construction activities and schedules to correlated with measurements. Acquire and review monitoring data collected by Geocomp during bridge move to correlated with strain measurements.
2. Evaluate the performance of instrumentation.
3. Evaluate the data collected during construction. Visit the site during major events to record activities and correlate with the measurements.

4. Develop refined finite element models of major components and simulated the effects of volume change loads.
5. Acquire the engineer of record (EOR) & Parson's structural analysis models to review and document the assumptions and model parameters and details.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2024.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Analysis and Deployment of an Unmanned Traffic Management System in Michigan – Phase 1 Feasibility Analysis

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Smith, Linn

CONTRACT/AUTHORIZATION NO.	220000000211	PROJECT START DATE	2/1/2022
PROJECT NO.	216349	COMPLETION DATE (Original)	1/31/2023
OR NO.	OR22-011	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Airspace Link		
PRINCIPAL INVESTIGATOR	Free		

BUDGET STATUS

FY 2022 Budget		**Total Budget**	
Vendor Budget FY 2022	$212,436.22	Total Vendor Budget	$257,424.97
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$150,000.00	Total Budget	$257,424.97
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$150,000.00
		Total Amount Available	$107,424.97

PURPOSE AND SCOPE

The Michigan Department of Transportation (MDOT) Office of Aeronautics (AERO), with support from the Michigan Economic Development Corporation (MEDC), and the Michigan Office of Future Mobility and Electrification (OFME) is committed to the advancement, integration, and deployment of technologies needed to prepare for the future of mobility in Michigan. AERO is collaborating with the OFME to identify opportunities to establish foundational aerial mobility infrastructure to support a range of commercial, civic and future urban air mobility use cases and working towards the commitment to creating a multimodal operating system for the Mobility Innovation district at Michigan Central Station and Ford Motor Company. The proposed scope of work for this project includes a complex and comprehensible feasibility assessment AND A recommendation of three (3) areas for advanced aerial mobility deployments in the state. In conjunction with existing autonomous ground-based vehicle deployment near the proposed connected corridor between Detroit and Ann Arbor MDOT Aeronautics seeks analysis and recommendations for deployment of infrastructure needed to ensure safe operation and regulatory approval of limited unmanned aircraft-based deliveries as part of a pilot study. This initial analysis and recommended deployment would provide the basis for establishing a statewide unmanned aircraft traffic management system. Research tasks include the following:

1. Preliminary assessment of three locations to determine feasibility of deployment of an unmanned aircraft systems corridor including:
   a) Assessment of economic, environmental, and community impacts.
   b) Assessment of existing air and ground infrastructure available to support deployment of the corridor.
   c) Assessment of air traffic and ground risk based on three use case scenarios.
   d) Assessment of communications network, command and control options, and real time tracking capability.
   e) Assessment of existing transportation network and demand for each mode of travel.
   f) Assessment of impacts a deployed UAS corridor would have on existing travel demand for each mode.
   g) Assessment of both United States and Canadian regulatory approval process to deploy the corridors.
2. Technology Assessment and Capital Infrastructure Development Strategy including:
   a) Strategy for establishment of an appropriate command and control structure.
   b) Strategy for, if applicable, enhancement for collocated communications infrastructure.
   c) Strategy for the deployment of supplemental airspace surveillance technology.
   d) Analysis of fully deployed capital infrastructure safety, security, and resiliency.
3. Safety case development to secure federal approval of corridor deployment.
4. 4. Analysis of Michigan's UAS corridor deployment and its ability to coordinated efforts and potential buildout strategies with MDOT's connected and autonomous ground-based vehicle projects

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Milestone 1 – Contract Award – Completed 2/1/22
- Milestone 2 – Acceptance of Project Management Plan – Completed 3/2/22
- Milestone 3 – Completion of Preliminary Assessment of Three Locations – Completed 3/11/22
- Milestone 4 – 1/3 Completion of Actionable Technology Assessment, Capital Infrastructure Deployment Strategy & Safety Case Plan

FISCAL YEAR 2023 PROPOSED ACTIVITIES
• Milestone 5 – 2/3 Completion of Actionable Technology Assessment, Capital Infrastructure Deployment Strategy & Safety Case Plan • Milestone 6 – Acceptance of Actionable Technology Assessment, Capital Infrastructure Deployment Strategy & Safety Case Plan
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)
Expected project completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Construction Digital Delivery Technology Scan

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Bowerman, Glenda

CONTRACT/AUTHORIZATION NO.	2022-0986		PROJECT START DATE	12/9/2022
PROJECT NO.	217421NI		COMPLETION DATE (Original)	12/31/2023
OR NO.	OR22-013		COMPLETION DATE (Revised)	
RESEARCH AGENCY	CRAFT			
PRINCIPAL INVESTIGATOR	Ketterl			

BUDGET STATUS

FY 2022 Budget			Total Budget	
Vendor Budget FY 2022	$0.00		Total Vendor Budget	$186,137.52
MDOT Budget FY 2022	$0.00		Total MDOT Budget	$24,500.00
Vendor FY 2022 Expenditures	$0.00		Total Budget	$210,637.52
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$0.00
			Total Amount Available	$210,637.52

PURPOSE AND SCOPE

MDOT is embarking on a digital delivery initiative to move from PDF-based processes to digital. Research is necessary to determine the impact of this change on statewide construction inspection activities including the surveying and computing technology that will be necessary in the field. Technology needs may differ by Transportation Service Center (TSC) depending on their percentage of consultant vs. internal inspection activities, the number of MDOT construction staff and the complexity of typical projects. This technology may include GPS units, Total Stations,
Levels, Laptops, Tablets, Smartphones, Monitors (UAVs and virtual reality are currently out of scope) and the proper software to consume digital deliverables, document inspection measurements and create content for downstream asset management functions. Digital delivery methods will rely on field connectivity to the internet. There are issues with the use of cell phone hotspots so other means of connectivity should be investigated. Research Tasks include the following:

1. Review and evaluate on going and recently completed research in digital construction inspection technology without a dependence upon virtual paper plans.
2. Survey other state departments of transportation and MDOT prequalified Construction Engineering and Construction Staking consultants to identify software and equipment used by industry leaders in digital delivery and the strengths and weaknesses of the equipment used.
3. Identify best practices among state departments of transportation for funding construction inspection equipment purchases.
4. Assess MDOT's Digital Delivery plans and goals and current practices. Document construction inspection services that could benefit from new technologies. Identify technology gaps.
5. Assess each TSC's current construction inspection equipment, equipment sharing practices and future needs.
6. Evaluate technologies currently on the market.
7. Recommend and quantify software and equipment to meet current needs and identify future equipment needed to meet future goals.
8. Demonstrate software that may be beneficial for use by MDOT construction staff.
9. Evaluate our current cellular/Wi-Fi technology available to connect construction sites to cloud based software and make recommendations for improvements. Demonstrate recommendations for cellular/Wi-Fi technology.
10. Document research and recommendations.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project was added to MDOT's program via Amendment 3. Contracting was delayed so project did not begin in FY 2022.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

It is anticipated this project will be contracted and begin in FY 2023. The following activities are proposed:

1. Review and evaluate on going and recently completed research in digital construction inspection technology without a dependence upon virtual paper plans.
2. Survey other state departments of transportation and MDOT prequalified Construction Engineering and Construction Staking consultants to identify software and equipment used by industry leaders in digital delivery and the strengths and weaknesses of the equipment used.
3. Identify best practices among state departments of transportation for funding construction inspection equipment purchases.
4. Assess MDOT's Digital Delivery plans and goals and current practices. Document construction inspection services that could benefit from new technologies. Identify technology gaps.
5. Assess each TSC's current construction inspection equipment, equipment sharing practices and future needs.
6. Evaluate technologies currently on the market.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)
Project expected completion FY 2024.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Enhanced Bridge Cost Estimating

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Davis, Kelly

CONTRACT/AUTHORIZATION NO.	2022-0435 Z1	PROJECT START DATE	10/15/2022
PROJECT NO.	217455NI	COMPLETION DATE (Original)	9/30/2023
OR NO.	OR22-012	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Wayne State University (WSU)		
PRINCIPAL INVESTIGATOR	Chris Eamon		

BUDGET STATUS

FY 2022 Budget		Total Budget	
Vendor Budget FY 2022	$0.00	Total Vendor Budget	$175,665.00
MDOT Budget FY 2022	$0.00	Total MDOT Budget	$16,800.00
Vendor FY 2022 Expenditures	$0.00	Total Budget	$192,465.00
MDOT FY 2022 Expenditures	$0.00	Total Expenditures	$0.00
		Total Amount Available	$192.465.00

PURPOSE AND SCOPE

The estimation of project cost plays an essential role in authorizing bridge repair and replacement projects. Estimating this cost efficiently and as accurately as possible is critical for the department to properly allocate funding and resources. This project will explore bid costs and bridge data to find correlations that can be used for more accurate estimates. The research tasks include the following:

1. Develop a method to efficiently analyze the annual weighted average item prices to produce an accurate forecast of the coming years pay item prices and appropriately handles outliers. This method will need to be repeatable using MDOT staff with minimal effort each year.
2. Develop a method to evaluate lump sum prices which produces an accurate estimate of those cost. This method will need to be repeatable using MDOT staff with minimal effort each year.
3. Develop a method to estimate the proposed replacement or rehabilitation costs for a given bridge using NBI bridge data, weighted average item prices and other variables. This method will need to be repeatable using MDOT staff with minimal effort each year.
4. Evaluate bridge scoping work types and identify pay items and quantities needed for specific work types. Develop spreadsheets that accurately estimate the cost of the specific work type based on current pay item prices but using the information typically available during scoping.
5. Produce an interactive computer-based worksheet that allows the user to input data and generate a rehabilitation scenario.
6. Provide a guidance document for performing these steps as the process will be repeated each year.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project went through the contracting process during FY 2022 with a delayed start date into FY 2023.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

1. Develop a method to efficiently analyze the annual weighted average item prices to produce an accurate forecast of the coming years pay item prices and appropriately handles outliers. This method will need to be repeatable using MDOT staff with minimal effort each year.
2. Develop a method to evaluate lump sum prices which produces an accurate estimate of those cost. This method will need to be repeatable using MDOT staff with minimal effort each year.
3. Develop a method to estimate the proposed replacement or rehabilitation costs for a given bridge using NBI bridge data, weighted average item prices and other variables. This method will need to be repeatable using MDOT staff with minimal effort each year.
4. Evaluate bridge scoping work types and identify pay items and quantities needed for specific work types. Develop spreadsheets that accurately estimate the cost of the specific work type based on current pay item prices but using the information typically available during scoping.
5. Produce an interactive computer-based worksheet that allows the user to input data and generate a rehabilitation scenario.
6. Provide a guidance document for performing these steps as the process will be repeated each year.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2023.

Michigan Department
Of Transportation
5312 (2014)

RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2022

PROJECT TITLE: Business Architecting for Digital Delivery

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (*PLEASE EXPLAIN)*

PROJECT MANAGER: Scott Douglas

CONTRACT/AUTHORIZATION NO.	To be determined		PROJECT START DATE	Delayed
PROJECT NO.	To be determined		COMPLETION DATE (Original)	To be determined
OR NO.	OR22-010		COMPLETION DATE (Revised)	
RESEARCH AGENCY	To be determined			
PRINCIPAL INVESTIGATOR	To be determined			

BUDGET STATUS

FY 2022 Budget			**Total Budget**	
Vendor Budget FY 2022	$0.00		Total Vendor Budget	$0.00
MDOT Budget FY 2022	$0.00		Total MDOT Budget	$0.00
Vendor FY 2022 Expenditures	$0.00		Total Budget	$142,000.00
MDOT FY 2022 Expenditures	$0.00		Total Expenditures	$0.00
			Total Amount Available	$0.00

PURPOSE AND SCOPE

The transportation industry is moving towards digital delivery of projects. The goal is to leverage data from Design to Construction and then into Operations & Maintenance. Traditional processes rely on paper plans. The Department would like to perform research on how digital deliverables can be developed and delivered in a way that meets our customer needs.

The expectation that all stakeholders on a construction project will be proficient enough with software to analyze and interpret a 3D model to perform their work is not reasonable. The goal is to create Digital Delivery in a way that allows fencing, pavement marking, excavation, paving, inspecting…. Stakeholders to assemble, in a self-serve manner, information from the 3D model, in the desired format, to perform their services. Research Tasks Include the following:

1. Gather all relevant documentation to use in harvesting MDOT's Business Architecture Model centered around the project/asset lifecycle which include Planning, Design, Construction and Maintenance phases. Documents include but are not limited to Call for Projects, Design Manual, Spec Book, Construction Manual and Maintenance Memorandums
2. Harvest the items of Goals, Processes, Roles, Locations, Events and Materials
3. Create ontologies for the extracted items
4. Create definitions for the ontology items
5. Identify relationships between the items

FISCAL YEAR 2022 ACCOMPLISHMENTS

This project was added to MDOT's program via Amendment 1. Contracting was delayed and did not begin in FY 2022.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Project start has been delayed. It is anticipated that the Department may complete proposed project activities using MDOT staff. Funds are reserved in case it's determined funding is needed for research support services.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion is yet to be determined.

100% FEDERALLY FUNDED PROJECTS

Sequentially Listed by TPF Number

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: AASHTO Engineering Technical Service Programs

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.		MDOT START DATE	10/1/2021
FEDERAL PROJECT NO.	SPR1801(179)	MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR22-202	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-749-9001 CloverA@michigan.gov		
LEAD AGENCY:	American Association of State Highway and Transportation Officials (AASHTO)		
PROJECT MANAGER	Various - Based on technical focus matter		
CONTRACTOR	Not Applicable		

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY Budgeted Funds	(Original)	$150,000.00		TOTAL COST	(Original)	$150,000.00
FY Billed Invoices	(Revised)				(Revised)	$165,000.00
TOTAL FY 2022 EXPENDITURES		$165,000.00		**Total Committed Funds Available**		$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.
Not applicable.

PURPOSE AND SCOPE

As a general practice MDOT technical experts each year analyze the benefits to MDOT of services and information shared by TRB's Technical Service Programs. The programs provide benefits to the member departments through the pooling of resources and expertise from across the country.

MDOT has the opportunity to support the development and continued operation of each of the following critical programs:

- AASHTO Innovation Initiative (A.I.I.) /Technology Implementation Group (TIG) - $6,000.
- Development of AASHTO Materials Standards (DAMS) - $10,000.
- Environmental Technical Assistance Program (ETAP) - $10,000.
- Transportation Curriculum Coordination Council (TC3) - $20,000.
- Snow and Ice Cooperative Program (SICOP) - $4,000.
- Transportation System Preservation (TSP2) - $20,000.
- Equipment Management Technical Services Program (EMTSP) – $5,000.
- National Transportation Product Evaluation Program (NTPEP) - $25,000. ($5,000 increase in FY 2022)
- Highway Safety Policy and Management TSP (SAFETY) - $10,000.
- Load and Resistance Factor Design (LRFD) Bridges and Structures Specification Maintenance (LRFDSM) - $15,000.
- Operations TSP (NOCoE) - $15,000.
- Design Publication Maintenance (DPM) - $15,000.
- Manual for Assessing Safety Hardware (MASH) Technical Support- $10,000 (Added in FY 2022.)

FISCAL YEAR 2022 ACCOMPLISHMENTS

The Subject Matter Expert's (SME's) recommendations were approved by Director Ajegba. SME's shared technology advancements, new improvements, and championed implementation efforts throughout the Department. In FY 2022, MDOT increased its commitment to NTPEP by $5,000 and added the MASH program with a commitment of $10,000.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Each fiscal year, MDOT will review and assess the return on its investment to the list of AASHTO TSP programs noted above. If value is added and the program benefits MDOT, the experts will continue to recommend contributions continue. If value is not being served from a particular program, MDOT may choose to discontinue its contribution.

Michigan Department
Of Transportation
5307 (9/13)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Traffic Analysis and Simulation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(176)		MDOT START DATE	6/1/2016
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2017
OR NO.	OR15-540		COMPLETION DATE (Pending)	2023 (closeout)
MDOT TECHNICAL CONTACT	Jason Firman, 517-636-4547 FirmanJ@michigan.gov			
LEAD AGENCY:	FHWA			
PROJECT MANAGER	Rachel James, 202-493-3205 Rachel.james@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$70,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

AL, CA, CO, FL, LA, MD, MI, MO, NC, NJ, NV, NY, OH, VA, WA and WI – Partner's Total Pledge Commitment Level: $1,490,000.00
MDOT Commitment Pledge FY 2016-2017

PURPOSE AND SCOPE

The goal of this study is to improve the state-of-the-practice in traffic analysis and simulation so public agencies can make the best possible transportation investment decisions based upon high-quality traffic analyses. The Highway Capacity Manual (HCM) and the Highway Capacity Software (HCS) are widely used analytical tools that assess the quality of service for conventional intersections and interchanges. However, they do not assess any of the alternative designs considered in this research study. In part, this study will develop the first edition of a national, definitive guide for transportation analysis, modeling, and simulation – the Transportation System Simulation Manual (TSSM). TSSM will include five major components: (1) Basic Modeling Concepts, (2) Model Building, (3) Verification and Validation, (4) Results Analysis, and (5) Modeling Case Studies and Supplementary Material. More specifically, TSSM will include:

- Definitions (and distinction) of model scoping, building, calibration, and validation.
- Recommended practices and needs for model scoping, building, calibration, and validation.
- Calibration and validation objectives and target values.
- Performance measurement reporting and visualization.

FISCAL YEAR 2016 ACCOMPLISHMENTS (Benefits to MDOT)

The active research project underway; titled "HCM Guidelines for Alternative Intersections", is nearing completion. Final chapters 23 & 34 (chapters on ramp terminals and alternative intersections) have been reviewed and accepted by the HCQS subcommittee for inclusion in the 6th Edition of the Highway Capacity Manual.

During this period the TAC met to discuss, reviewed, and approved a new research effort to fund. This new effort will develop a Transportation System Simulations Manual (TSSM). TRB formed a Task Force on simulation (AHB80T) in July 2015 to oversee the development of a TSSM. The development of the TSSM will build upon the framework outline that has been approved by this Task Force -- and will include five major components: (1) Concepts, (2) Model Building, (3) Verification and Validation, (4) Results Analysis, and (5) Case Studies and Supplementary Material. The TSSM project is anticipated to be awarded late September or early October 2016.

A research consultant was selected, and a consultant/contract kickoff meeting was scheduled for October 3, 2016.

FISCAL YEAR 2017 ACCOMPLISHMENTS

During this first quarter of the project, the FHWA project team completed an initial set of on-time deliverables including stakeholder meeting minutes, a comprehensive stakeholder list, a revised project work plan, and a state-of-the-practice outline. The team solicited and received a set of "top five TSSM priorities" from several members of the Pooled Fund Study. The team met with TRB representatives to formulate a tentative plan towards TSSM publication and distribution. The team coordinated with TRB Task Force members and friends towards obtaining their technical input, and towards renewing their motivation to maintain the TSSM after its initial period of development. The team received helpful feedback during the first stakeholder webinar, and during the TRB conference.

The FHWA project team completed a second set of deliverables including stakeholder meeting minutes, a state-of-the-practice report, and a TSSM annotated outline. The team identified a content management system and activated an online comment tracking system. The team received helpful feedback during the second and third stakeholder webinars. The team and its stakeholders reached agreement on an overall TSSM chapter sequence, and on a set of critical need chapters (i.e., chapters 5 through 9).

The project team began developing the critical need chapters (chapters 5 through 9) and obtained stakeholder feedback on these chapters. Stakeholders will continue to be provided opportunities for feedback and are invited to project team meetings on a bi-monthly basis (the most recent being July 10th). Developed state-of-the-practice report.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Glossary of Connected and Automated Vehicle technology terms was completed and published. Selected candidate projects for the calendar year were “V2I Queue Warning” and “Using Third Parties to Deliver V2I.” Pooled fund study transition planning was completed resulting in a change of study number to be effective for FY 2019.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The project was awarded to Leidos and discussions began on the project work plan.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Due to the growing use, need, and acceptance of traffic analysis and simulation tools; this coming fiscal year the project aims to develop a Transportation System Simulation Manual (TSSM) – delivering to users the concepts, guidelines, and procedures of simulation modeling. The development and advancement of the TSSM will help advance analysis for professionals lacking a centralized, unbiased, authoritative source of theory, best practices, and lessons learned. The goal of TSSM is to address; at a minimum, differing scales of modeling, integration of models, model inputs and data formats, data summary and analysis, data storage and model use, calibration/validation of simulation, alternative analysis, post processing of model data and interpretation. Draft of the TSSM pending.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Task 1: 40% complete. Task 2: 40% complete. Tasks 3 & 4: 100% complete. Task 5: 50% complete. A draft Guidebook (for Multi-Resolution Modeling) was submitted and is under review. Task 6: 75% complete. Task 7: 0% complete. Training Webinar - Estimated completion date: 01/31/2022- A Training webinar will be held after two months from the Guidebook TAC approval. This webinar is estimated to take place in 2021; if not, by no later than 1/31/2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Published three reports and ended in January 2022.

- MRM State of Practice and Gap Analysis Report: https://www.fhwa.dot.gov/publications/research/operations/21082/index.cfm
- MRM Case Studies: https://www.fhwa.dot.gov/publications/research/operations/22054/index.cfm
- MRM Guidebook: https://www.fhwa.dot.gov/publications/research/operations/22055/index.cfm

Final deliverables include:

- Trajectory Investigation for Enhanced Microsimulation Calibration: https://www.fhwa.dot.gov/publications/research/operations/21071/index.cfm
- Transportation Systems Simulation Manual: This will not be published by FHWA. It has been transferred to the TRB Standing Committee on Traffic Simulation and I know they’re actively reviewing/editing the document to try to release it soon.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This TPF Project has ended, and all work activities are completed. Final invoicing is anticipated in 2023.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT’s initial interest in joining this study was to make use of the project’s expected deliverable product- A Guidebook [for Multi-Resolution Modeling]. Since then, MDOT’s technical contact (TC) recommended not to continue to pursue or use outcomes from this study. The MDOT TC felt the results would not meet our needs and recommended something more specific, which we got through the development of a MDOT VISSIM protocol manual. Use of this protocol manual helps MDOT/Consultants to develop, review and evaluate future traffic simulation models for accuracy, completeness, and consistency. The manual streamlines the entire process from scoping through development of the project and meets the expectations of MDOT and FHWA.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Highway Safety Manual Implementation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(255)		MDOT START DATE	11/9/2015
PROJECT NO.	Not Applicable		MDOT COMPLETION DATE (Original)	12/31/2019
OR NO.	OR15-527		COMPLETION DATE (Revised)	Ext.- Pending FHWA action
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov			
LEAD AGENCY:	FHWA			
PROJECT MANAGER	Jerry Roche, 515-233-7323 Jerry.Roche@fhwa.dot.gov			
CONTRACTOR	Louisiana Transportation Research Center			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

Louisiana Transportation Research Center, CA, CT, ID, IL, KS, KY, LA, MI, MO, MS, NC, NJ, NV, OH, OK, OR, PADOT, TX, UT, WA, WI, WV. Partners Total Commitments: $1,595,000.00 MDOT: Pledge Commitment FY's- 2016-2020

PURPOSE AND SCOPE

The objectives of the study are (1) to advance ongoing efforts by lead states to implement the Highway Safety Manual (HSM), and (2) to expand implementation to all states. This study would be coordinated with other ongoing and planned implementation activities sponsored by AASHTO, FHWA, and TRB, including NCHRP Project 17-50 "Lead States Initiative for Implementing the Highway Safety Manual" It will also be coordinated with projects that develop content for future editions of the HSM including NCHRP Project 17-45 "Enhanced Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges" NCHRP Project 17-54 "Consideration of Roadside Features in the Highway Safety Manual" and Transportation Pooled-Fund Study TPF-5(099) "Evaluation of Low Cost Safety Improvements."

This study would conduct research tasks and develop products that would enable States to accelerate their implementation of the HSM. The specific tasks and products would be identified and prioritized by a Technical Working Group consisting of one representative each from participating agencies. Specific tasks may include: (1) developing a calibration manual to accompany the HSM that provides practical advice and examples on how best to adapt HSM calibration procedures to meet the needs of a particular agency, (2) developing technical guidance for agencies on developing safety performance functions, and (3) developing guidance for agencies on assembling and managing the data needed for safety analyses.

The study would also facilitate Technical Working Group representative's participation in peer exchanges and other forums through which agencies can exchange information, best practices, lessons learned, and remaining challenges in implementing the HSM appropriately into agencies' system planning, project planning and preliminary engineering, design and construction, and operations and maintenance procedures and processes. These exchanges would feed an annual process through which the Technical Working Group identifies and prioritizes future tasks to be conducted under the study.

FISCAL YEAR 2016 ACCOMPLISHMENTS

- A finalized list of State-adapted HSM Part C spreadsheets based upon input from State representatives was developed for posting at the Crash Modification Factor (CMF) Clearinghouse.
- A finalized a list of state developed or calibrated Safety Performance Functions (SPFs) based upon feedback from state representatives was developed for posting at the CMF Clearinghouse.
- A preliminary analysis comparing State developed SPFs and State calibration factors was conducted for HSM SPFs as a first step in an evaluation of the feasibility of a "quick and dirty" method that States could use to determine whether an existing SPF may be suitable for use in the State without calibration.
- The "Model State Policies and Procedures for Use of HSM" contractor delivered the draft final report on June 13, 2016. State representatives and FHWA staff provided review comments on July 5, 2016.
- The "Scale and Scope of HSM Implementation in the Project Development Project" contractor delivered the 3rd draft of the final report on June 19, 2016. State representatives and FHWA staff review comments are due July 15.

- Held a virtual quarterly business meeting on May 16, 2016.
- The payoff from participating in this pooled-fund study is minimizing duplication of efforts by all the states and maximizing our resources based on national priorities of delivering products that support the implementation of the HSM.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Virtual meetings were held on May 22 and June 27, 2017
- At the June 27th meeting participants provided feedback on the Life Cycle Benefit–Cost Analysis guide and an overview of an existing spreadsheet tool. The group is going through modifications of the tool to perform economic analysis of safety projects.
- A draft of the Safety Performance for Intersection Control Evaluation (SPICE) tool was developed and presented for feedback to state representatives.
- Modifications are being made to the Network Screening Best Practices contract for the NCHRP 17-50 project to enable the contractor to perform work for this study.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Meetings held on January 26 and April 5, 2018. As part of the Highway Safety Benefit Cost analysis tool, the Crash Cost Values report was finalized and is posted at https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf . A Safety Benefit Cost Analysis Guide was completed. A Safety Benefit Cost Analysis (BCA) Tool was finalized. The reports and tool are available online.

SPICE version 2.0 was completed and is currently undergoing testing. Safety Analysis Needs Assessment for Performance Based Practical Design (PBPD) and Transportation Systems Management and Operations (TSMO) project draft report was disseminated via webinar in April. Comments were received in May.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The lead agency conducted a project progress meeting with Technical Advisory Committee (TAC) members on May 29, 2019. The peer exchange summary report was completed and posted to pooled fund website. Safety Analysis Needs Assessment for PBPD and TSMO 3rd draft was completed and disseminated in May 2019. Ideas solicited and discussed for future projects.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Meeting held on April 22, 2020. Two final reports presented, and practical approaches guides on Safety Analysis Needs Assessment for PBPD and TSMO. These projects are completed. Further updates were discussed on HSM case Studies, Development of a Data Dictionary was researched, and a statement of work was prepared to be awarded by fall 2020. Development of a Safety Countermeasures Service Life Guide a was awarded, and a kickoff meeting was held on July 6th.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Meeting held on May 6, 2021.
- Safety Countermeasure Service Life Guide was completed in April 2021
- Continued work on HSM Case studies highlighting projects in Michigan, Wisconsin, Massachusetts, Alabama, and others.
- Continued work on the need for a data dictionary.
- MDOT fulfilled its pledge commitment in FY 2019 and remain an active partner state DOT.
- FHWA will begin work to initiate a new HSM2 Implementation Fund Study anticipated to begin July 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- A kickoff meeting for the Advancing Applications of DDSA task order which included three primary tasks – 1) use of multiple analysis methods in alternatives analysis, 2) implementation approaches for NCHRP 17-62 (Improved prediction Models for Crash Types and Severities), and 3) communications guide for explaining safety analysis to non-safety professionals was held with the contractor (VHB) on April 26. Draft outlines for Tasks 2 and 3 were created and updated based on two rounds of review and comment. Work on all three tasks is progressing.
- The contractor (VHB) on the Data and Analysis Case Studies project has completed three case studies (District of Columbia, Arizona, and Florida) which will be posted to the FHWA RSDP case studies website soon. California and Vermont have been developed and are under review. The purpose of the project is to share information to overcome challenges faced by users attempting to perform HSM project-level safety performance analysis. https://highways.dot.gov/safety/data-analysis-tools/rsdp/safety-data-case-studies 14 are posted and 6 more will be posted in the next couple of months.
- On April 22, FHWA posted a new transportation pooled fund solicitation to create a Highway Safety Manual Second Edition (HSM2) Implementation pooled fund, anticipated to begin in 2023.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Continue work on developing HSM Case Studies highlighting projects in California and Connecticut.
- Continue work on the three main tasks on Advancing Applications of DDSA project.
- FHWA hopes to meet or exceed the funding commitment necessary to establish the HSM2 Implementation Pooled Fund (to begin in FY 2023).

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Based on the last quarterly report, This TPF project will be extended upon FHWA action.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The Focus Area Manager (FAM) will review project products/deliverables and whether an implementation action can be developed at MDOT.

If a decision is made to develop an Implementation Plan; the work area will develop a draft Implementation Action Plan for the RAC chair to recommend review/approval by the MDOT Research Executive Committee.
Possible implementation activities may include:

- Developing and/or confirming an approved list of Crash Modification Factors for MDOT use.
- Updating the HSM spreadsheet based on results of current SPF research.
- Utilizing methodology for updating the SPFs.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(281)	MDOT START DATE	10/1/2017
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR18-012	COMPLETION DATE	Pending Closeout
MDOT TECHNICAL CONTACT	Rebecca Curtis, 517-449-5243 CurtisR4@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Justin Ocel, 202-493-3080 justin.ocel@dot.gov		
CONTRACTOR	S-BRITE Center [Purdue University]		

BUDGET STATUS

FY 2022 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$0.00	TOTAL BUDGET	(Original)	$125,000.00
	(Revised)			(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00	**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

FHWA, IADOT, IL, IN, KS, MI, MN, NM, SD, TX, WI. Total Commitment Level: $2,503,237.00
MDOT Pledge Commitment FYs 2018-2021.

PURPOSE AND SCOPE

The objective is to develop the Steel Bridge Research, Inspection, Training, and Education Engineering Center (S-BRITE Engineering Center) focused on existing steel highway bridges. This National Center will be the first of its kind and will become the leading education, training, research, and engineering center related to all aspects affecting the existing aging steel bridge and structure inventory. Although the Center will be focused on highway bridges, it will also support stakeholders of steel railroad bridges as well as steel ancillary structures, such as lighting towers and sign supports. The Center will contribute to improved asset management decisions for DOTs, FHWA, and other partners relative to existing steel bridge inventory. This impact will be realized by ensuring existence of the following:

- High quality inspection data
- Advanced predictive models
- Improved management decisions
- Timely and effective execution

This will be accomplished by providing solutions to the following:

- inspection reliability issues
- inadequate technical expertise
- training and education opportunities for students and professionals
- short-term and long-term research needs

Once the center is successfully operational, other materials and systems, such as concrete, prestressed, and post-tensioned structures may be added.

Educational Aspects

A long-term goal of the S-BRITE Center is to create the next generation of bridge engineers and inspectors who are properly educated to be effective stewards of the existing aging steel bridge inventory. At the university level, the development of a new “minor” or certificate within Civil Engineering is proposed that will prepare engineering students for a career in transportation structures. At the professional level, high-quality, specialized short courses for professionals will be developed and targeted at those individuals currently responsible for the existing infrastructure. The courses would go beyond the current NHI course level.

The Center would collaborate with external technical schools, to develop a new area of educational expertise, specifically, the Steel Bridge Infrastructure Specialist. Both one and two-year degree programs are envisioned and would involve the development of several new courses within existing degree programs.

A major goal is to develop training and performance testing criteria to establish rational criteria for defining a 'team leader”and developing reliable inspection protocols. Further, performance testing methodologies and criteria will be developed and implemented to improve the reliability of inspections by those who are certified through the Center.

Bridge Component Gallery

Although training, education, and research are the overall focus of the Center, the cornerstone of the S-BRITE Engineering Center will be a multi-acre gallery which will include full-scale bridge structures, portions of complete structures, and individual components that will

include a host of common and uncommon details used in steel bridges. Similar centers exist for the aircraft, ship, and offshore industries, though nothing has been developed for the steel bridge industry.

The gallery will provide a unique hands-on experience for education of individuals of all levels regarding steel fabrication, deterioration, inspection techniques, etc.

Since the bridge components will not actually be in service and will be in more accessible conditions, costly traffic control and extensive fall-protection will not be required during training. However, they will be situated so that real-world conditions exist to truly simulate in-situ inspection conditions. Having such a 'living laboratory"will also be incredibly useful for research tools being developed for inspection, durability modeling, and performance testing of inspectors.

Distributed Expertise Network (DEN)

To help fill the technical voids found at most DOTs, a unique team of experts will be assembled through the S-BRITE Center to create a Distributed Expertise Network (the DEN). Some of these individuals will be housed locally at the Center while others will be located at their respective institution. The DEN will serve the role that no longer exists in many individual state DOTs today, specifically the existence of a group of highly specialized technical experts that are "on-call" to assist as issues arise. These experts will effectively be "on call" to the Center and the participants and will be able to travel to the participant's location if required and per the funding level provided. There would be no need for special subcontracts between the individual state and the expert since the contracts will already be in place as participants of the Center.

FISCAL YEAR 2018 ACCOMPLISHMENTS

In 2018, MDOT received assistance in evaluating the Cut and Cooley River bridges. We also received guidance in pack rust removal techniques on riveted members and fatigue analysis of link plates.

FISCAL YEAR 2019 ACCOMPLISHMENTS

In 2019 MDOT sent one staff member to training at the SBRITE Center as well as hosted the SBRITE training course "Inspecting Steel Bridges for Fatigue". SBRITE performed field reviews on two MDOT structures (Grand Haven Bascule Bridge and M-14 & US-23 BR over MDOT RR & Huron River) and several plan reviews. We received guidance on CIF details and assistance in evaluating cracking in primary fracture critical girders. Plan reviews included the following structures:

- B02-70014: US-31 over Grand River (Grand Haven Bascule Bridge)
- R01-81075: M-14 & US-23 BR over MDOT RR & Huron River
- B01-23151: I-96 EB over Grand River & Billwood Highway
- B02-23151: I-96 WB over Grand River & Billwood Highway
- B01-31012: US-41 & M-26 over Portage Lake (Houghton Hancock Lift Bridge)
- S05-63103: I-696 over I-75 & 4 Ramps

Budgeted Amounts:
$30,000 in each FY 2019 and FY 2020, and $15,000 in FY 2021.

FISCAL YEAR 2020 ACCOMPLISHMENTS

SBRITE performed technical assistance for the following items:

- Box Girders at I-696 over I-75
- S11-25132-5&6, I-475 Ramps over I-69 & I-475
- Review of Bolt Strengths from 1930s
- Review of proposed repairs to Grand Haven Bascule Bridge
- Review of Rehab Job/Bolting Issues for Jn 126812, 126813, 203782
- Pin Plate Seal Weld for I-75 over Raisin River
- Providing report on delamination for Carpenter Road over I-475
- Aiding in construction quality review for B01&2-23151: I-96 over Grand River & Billwood Hwy CIF retrofit

FISCAL YEAR 2021 ACCOMPLISHMENTS

B01-41027-4: I-196 WB over Grand River
Detailed inspection and magnetic particle testing of damaged beams with cracking as well as crack like indications along many portions of weld toe.

JN 201632, 204861
Provided a presentation during the pre-bid meeting and assisted with other tasks.

Assisted with CFI detail discussions and Web Inclusion investigations.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- I-75 Seal weld issue related to a pin and hanger bridge with pack-out corrosion. Provided input on moving forward with corrective actions and overall risk discussion
- I-69 and I-475 CIF discussion on various details that may be susceptible to fracture and suggested retrofit strategies as needed
- I-96 Ramp G beam web delamination issue. Web was split open due to corrosion pack-out within the web. Provided input on how to move forward with retrofitting.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

N/A

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

S-BRITE continues to have tremendous impact and benefit for owners, designers, and fabricators of steel bridges. MDOT plans to continue participation in the next pooled fund TPF-5(486) Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)

Michigan Department
Of Transportation
5307 (9/13)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Aurora Program

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(290)		MDOT START DATE	8/1/2014
PROJECT NO.			MDOT COMPLETION DATE (Original)	5/31/2019
OR NO.	OR14-057		COMPLETION DATE (Revised)	OPEN
MDOT TECHNICAL CONTACT	Justin Droste, 517-636-0518 DrosteJ@michigan.gov			
LEAD AGENCY:	Iowa Department of Transportation			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$150,000.00
FYs 2014-2019 (only)	(Revised)	$0.00			(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

AK, AZ, CA, CO, DE, IA, IL, KS, MI, MN, MO, ND, NY, OH, PA, UT, VA, WA, WI, and Ontario Ministry of Transportation – Total Commitment Level: $2,250,000.00

PURPOSE AND SCOPE

The purpose of this project is to:

1. Improve dissemination of road weather information to transportation providers and end users, ultimately increasing safety by reducing potential weather-related incidents and improving transportation safety, reliability, and mobility in both urban and rural areas.
2. Improve the efficiency of maintenance operations.
3. Aid in the development of technologies that seamlessly integrate to facilitate the formation of partnerships between maintenance and operations and facilitate the dissemination of road weather information.
4. Develop initiatives that assist public agencies in deploying Road Weather Information System (RWIS) technologies and methodologies.
5. Encourage greater cooperation and information exchange between transportation agencies and the other agencies and groups.
6. Support development of expanded uses of RWIS technologies.

The program's mission is to support cooperative research, evaluation, and deployment of innovative technologies that advance road weather monitoring and forecasting in highway design, construction, maintenance and operations and to serve as an international advocate for expanded uses of these technologies.

FISCAL YEAR 2014 ACCOMPLISHMENTS

Completion of project 2009-01: Summary and Comparison of Agency Experience with Sensors.
This project was funded to compile a summary of various environmental sensors and the experience agencies have had with each sensor. This information will be utilized by MDOT when selecting sensor types and models.
Completion of project 2007-05: Multiple Use ITS Data Collection Practices.
This project was funded to summarize the previous experience of other states when combining Intelligent Transportation Systems (ITS), traffic devices, etc., at one location. MDOT participated in this survey and continues to strive to combine as many of these devices at one location as possible.
Completion of project 2013-01: National Winter Maintenance Peer Exchange.
This project was completed and finalized a gathering to allow agencies to network and share ideas and innovations. MDOT is an active participant in this meeting.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Completion of project 2015-02 2015: National Winter Maintenance Peer Exchange.
This conference had excellent attendance. State best practices were again well received.
Completion of project 2012-03: Cameras and Operational Impact of Remote Road Condition Monitoring
This study in Utah evaluates the benefit of cameras in winter weather remote monitoring.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Completion of project 2010-04: RWIS Sensor Density and Location
MDOT is looking to expand their RWIS system and this information will be distributed to the areas within MDOT that will be placing new installations in 2017.
Completion of project 2012-05: Seasonal Weight Restrictions Demonstration, Phase 1. MDOT participated to develop a project to evaluate existing data available, collect additional data, and determine models that can be analyzed to predict spring thaw.

Arizona and Delaware have joined the Aurora group.

FISCAL YEAR 2017 ACCOMPLISHMENTS

2017 National Winter Maintenance Peer Exchange – Completed September 2017. The National Winter Maintenance Peer Exchange (NWMPE) is the premier forum for winter maintenance professionals to learn about the state of the practice and state of the art in winter maintenance. The forum is held every other year and is co-sponsored by Aurora, Clear Roads, and AASHTO's SICOP. Participants benefit in learning what the best practices are from over 30 state DOTs who showcase their work in winter maintenance. Breakout sessions provided the opportunity to contribute to the national winter maintenance dialogue and research agenda. The 6th National Winter Maintenance Peer Exchange was held September 12-13, 2017, in Pittsburgh, Pennsylvania.

Improving Estimations of Real-Time Traffic Speeds during Weather for Winter Performance Measurement – Completed April 2017. This project developed a model based on traffic, weather, and maintenance activity data to produce real time predictions of weather influenced traffic speed drops with uncertainty measures.

An Analysis of the PWD Precipitation Rate Estimates as Compared to a Hotplate Snow Gauge – Completed April 2017. The objectives of this project were to 1) assess sensor performance for measuring LWE under various precipitation type and temperature scenarios, 2) provide an analysis on the observed differences between the base-elevation and mid-elevation LWE, 3) develop recommendations on alternate sensors, i.e., snow depth sensor, or operational changes in determining LWE using the PWD suite of sensors.

Review Synthesis of Alternative Power Supply – Completed August 2017. This project provided a comprehensive review, investigation, and analysis of alternative power sources and power budgets of sensors and associated components for remote RWIS applications.

RWIS Training Tool – Completed September 2017. The Aurora Storm Simulator training module mimics the decisions a maintenance supervisor makes during winter storm situations. The simulator provides information about typical maintenance resources (routes, staff, equipment, materials) available at a maintenance facility and then follows how a student manages the resources during a winter event. The simulator monitors a student's level of performance over the storm scenario in three ways: costs, time (usage and regain), and an index of mobility.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Meetings and Conference Calls

- Held Spring Board Meeting in Seattle, Washington (April 10 – 12, 2018)
- Held Fall Board Meeting in Columbus, Ohio (October 16 – 18, 2018). This meeting included Friends of Aurora.
- Host(ed) monthly Aurora Board conference calls to generate research ideas and discuss important issues.

Research

- Tracked progress on three existing Aurora projects.
  - Seasonal Weight Restrictions Demonstration, Phase 2
  - RWIS Sensor Density and Location, Phase 2
  - Winter Severity Index (Support to Clear Roads)
- Developed scopes of work and tasks for two prospective Aurora projects. It is anticipated that these projects will be awarded late this quarter or early next quarter.
  - Guidelines on the use of Invasive and Non-Invasive Sensors, Phase I Existing Capabilities and Limitations
  - RWIS Life Cycle Costing
- Develop additional scopes of work for prospective research projects, based on Aurora Fall Board Meeting discussion.
- Finalized three research project reports.
  - Seasonal Weight Restrictions Demonstration, Phase 1
  - Quantifying Salt Concentration on Pavement, Phase 2
  - Survey of Best Practices in Data Storage
- Developed a relationship with the National Severe Storm Laboratory regarding advanced radar capabilities. Aurora now receives regular updates from technical staff.
- Shared research opportunities with the National Center for Atmospheric Research (NCAR).
- Investigated integration of weather, ITS and connected and autonomous vehicles with FHWA.
- Supported Pathfinder and IMO participation by Aurora members.
- Provide access to, and support of, the Aurora Storm Simulation Training Program (http://aurorabase.iteris.com/login/?destination=/). This tool provides customized snowplow training based on actual weather and storm simulation, including organizing labor and equipment. A grade is provided to each student.

Outreach and Membership

- New membership: State of Washington, State of Missouri (anticipated)
- Provide Aurora Pooled Fund updates at various meetings.
- Aurora members completed multiple SICOP Talks Winter Ops podcasts.
- Presented at FHWA National Road Weather Stakeholders meeting.
- Presented at Transportation Research Board (TRB) AH010 Surface Transportation Weather Committee and AHD65 Winter Maintenance Committee.
- Engaged with industry, i.e., probe data providers, considering weather research opportunities and understanding the capabilities of new technologies.

- Engaged with weather research industry (vendors and manufactures) to understand new trends, technology and solving equipment limitations and issues. This is accomplished through the Friends of Aurora event. Engagement with industry provides the opportunity to understand state issues and discuss trends and new capabilities within industry. Aurora provides this opportunity every other year.
- Roemer Alfelor is the FHWA liaison to Aurora. He is actively engaged with Aurora members, providing members with the latest FHWA resources, programs and committee membership opportunities. This keeps Aurora members aware of federal road weather management direction and opportunities, including integration with connected and autonomous vehicles.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Meetings and Conference Calls

- Held Spring Board Meeting in San Diego, California (March 26-28)
- Held Fall Board Meeting in Tampa, Florida (October 8-10, 2018)
- Host(ed) monthly Aurora Board conference calls to generate research ideas and discuss important issues.

Research Completed/In Progress:

Optimal RWIS Sensor Density and Location - Phase III

- Utilize select interstate highways of Iowa since applicants have already archived stationary RWIS datasets and imagery, and other remote sensing and GIS data in previous projects. In addition, the key variables of interest in this project will be road surface index (RSI) and road surface temperature (RST). RSI is considered one of the most important performance indicators as it measures the effect of various winter maintenance operations on road users (i.e., level of service). RST has been selected for investigation as it is required to generate accurate road weather forecasts and predicting black-ice potential.
- Using knowledge gained and methods developed from this project, additional efforts can be made via an extended research opportunity to implement larger case-studies and provide winter maintenance personnel with a visualization tool that they need to help make more informed decisions on optimizing the use of existing infrastructures and available resources while improving mobility and safety of motorists.

Invasive and Non-Invasive Sensing: Assessing Agreement between Measurement Systems (To be completed by Fall 2021)

- The objectives of this effort are to: 1) Develop location and density optimization models and solutions for all other members of AURORA that were not covered in our previous project; 2) Extend the methodology to account both spatial and temporal attributes of road weather and surface conditions; 3) Develop an empirical optimal density model and related guidelines based on results for all topographic-climate zones in central North America; 4) Evaluate the effects of spatial demarcation on RWIS planning, and examine the implications of RWIS deployment at different geographical/jurisdictional levels (e.g., leveraging the RWIS stations in neighbor states/provinces); and 5) Integrate the developed solutions into LORWIS (www.lorwis.com) – a prototype web-based RWIS location visualization platform for demonstrating the proposed models and the resulting solutions.

Road Authority Practices in Data Storage Survey(Completed)

- Road authorities across the United States of America, Canada, and some European organizations regarding their data collection practices for road weather information systems (RWIS), automated vehicle location (AVL) / global positioning systems (GPS), camera images, and traffic data. The results of this survey can be used by Aurora members to assess their data collection practices with respect to other road authorities.

Seasonal Weight Restrictions Demonstrations, Phase 2 (In Progress until Spring 2021)

- The major task of Phase 2 was to implement the suite of models recommended from Phase 1 at the demonstration sites, and to calibrate those models, if required. Output from those models was then compared with validation data. Validation data, provided by the DOTs, consisted of subsurface temperature data (which was reduced by the research team to compute frost and thaw depths), and in some cases, deflection and/or stiffness data from LWD and FWD tests. The following SLR protocols and models were originally planned for implementation during the 2014-2015 and 2015-2016 winter/spring: 1) Degree Day threshold models; 2) Frost & Thaw Depth Prediction Models (freeze thaw index); 3) Frost & Thaw Depth Prediction: Numerical Model.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Meetings and Conference Calls

- Held Virtual Board Meetings for the Spring and the Fall
- Monthly Board Conference calls to generate research ideas and discuss important issues.

RWIS Life Cycle Cost Analysis

- The objectives of this research were to develop guidelines to do the following:
    - Help quantify the costs and benefits associated with RWIS sites
    - Better assess costs arising from RWIS assets over the life cycle
    - Provide a framework for calculating net present worth
    - Assess alternatives and associated cost implications
    - Determine long-term RWIS life-cycle costs and the optimal point to replace RWIS equipment
    - Support decisions on repair versus replacement based on projected expenses
    - Assist in planning and funding the replacement or repair of RWIS infrastructure

RWIS Sensor Density and Location, Phase 2

- The objectives of this effort are to: 1) Develop location and density optimization models and solutions for all other members of AURORA that were not covered in our previous project; 2) Extend the methodology to account both spatial and temporal attributes of road weather and surface conditions; 3) Develop an empirical optimal density model and related guidelines based on results for all topographic-climate zones in central North America; 4) Evaluate the effects of spatial demarcation on RWIS planning, and examine the implications of RWIS deployment at different geographical/jurisdictional levels (e.g., leveraging the RWIS stations in neighbor states/provinces); and 5) Integrate the developed solutions into LORWIS (www.lorwis.com) – a prototype web-based RWIS location visualization platform for demonstrating the proposed models and the resulting solutions.

FISCAL YEAR 2021 ACCOMPLISHMENTS

A virtual Board meeting was held Spring 2021, and In-person board meeting in Fall of 2021.

The following are current projects with the pooled fund: https://aurora-program.org/research/in-progress/

- Invasive and Non Invasive Sensing: Assessing Agreement between Measurement Systems
- Roadway Ice/Snow Detection Using a Novel Infrared Thermography Technology
- Roadway Friction Modeling
- RWIS Life Cycle Cost Analysis Tool

The following projects were completed in FY 21: https://aurora-program.org/research/completed/
AUG 2021 Optimal RWIS Sensor Density and Location – Phase 3

MAY 2021 Impacts of Atmospheric Rivers in the Transportation Sector

MAR 2021 Ongoing Issues with Winter Weather Severity Indices

DEC 2020 Demonstration and Inter-Comparison of Seasonal Weight Restriction Models, Phase II

FISCAL YEAR 2022 ACCOMPLISHMENTS

-Note that both phases, TPF-5 (290) and TPF-5 (435), are active

-Project- Non-Invasive Sensor Deployment in Aurora Member States
-Continue monthly Board meeting calls.
-Continue to communicate with new Aurora representatives.
-Seek additional project ideas from members.
-Gather and distribute project ideas to members.
-Continue to hold project-related meetings.
-Collaborate and facilitate addressing project needs, relating to scope and/or budget changes, that may arise.

Meetings and Conferences:

Board member monthly conference calls
 Financials
 Membership
 Submitted ideas
 Additional solicitation

May 2022 meeting was held in Portland, OR.
2022 Aurora Spring Meeting
• Coordinated presentations from FHWA, SICOP and researchers.
• Prepared financial details, including commitment, encumbrances and available funds.
• Solicited project ideas for the 2022 Aurora Spring Meeting. A total of 19 ideas were received.
• Prepared spreadsheet for project voting.
• Organized and distributed project ideas and voting spreadsheet to Aurora Board.
• Obtained and integrated voting results for discussion during the spring meeting.
• Prepared and distributed questions to the proposers of the five highest rated project ideas.

October 2022 Meeting Held in Minneapolis, MN

- Friends of Aurora Presentations
- Final Project decisions
- Projects and Invoices
- State Commitments
- Management and Board Meeting Costs
- Overall Funds Available for Projects
- Discussion regarding 2023 Spring Meeting

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

TPF-5(290) will remain active until all project deliverables are completed and available funds are expended.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Aurora is an international partnership of public road agencies working together to perform joint road weather research. By participating MDOT **can** help set the agenda for collaborative research, development, and deployment of road weather information systems (RWIS). The Department would be better positioned to multiply its financial resources to address ~~its most~~ pressing RWIS-related challenges, and to develop relationships with national/international and public/private leaders in RWIS equipment, decision support systems, standards, and training. TPF-5(290) is still active and TPF5-(435) is the continuation project for the Aurora Program. MDOT has joined TPF-5(435) and has pledged commitments in FY's 2020-2024 @ $25k each fiscal year.

For FY23:
-Continue monthly Board meeting calls.
-Friction Modeling Project continued.
-Application for network-level Integration of Connected Vehicle and RWIS Technologies for statewide usage
Proposer: NIRA Dynamics & Local US-based University
-Automating Variable Speed Limits (VSL) Using Weather, Traffic, and Friction Data
Proposer: NCAR, Rutgers, WTI
-Continue to communicate with new Aurora representatives.
-Seek additional project ideas from members.
-Gather and distribute project ideas to members.
-Continue to hold project-related meetings.
-Collaborate and facilitate addressing project needs, relating to scope and/or budget changes, that may arise.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Regional and National Implementation and Coordination of Mechanistic-Empirical (ME) Design

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(305)		MDOT START DATE	10/1/2016
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2018
OR NO.	OR18-006		MDOT COMPLETION DATE (Revised)	9/30/2023
MDOT TECHNICAL CONTACT	Justin Schenkel, 517-242-2788 SchenkelJ@michigan.gov			
LEAD AGENCY:	FHWA			
PROJECT MANAGER	Chris Wagner, 404-562-3693 christopher.wagner@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL COST	(Original)	$20,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		Total Committed Funds Available		$0.00

PARTICIPATING STATES

Manitoba Transportation, AL, AZDOT, CA, CO, FHWA, FL, GADOT, IADOT, IL, KS, KY, MDOT SHA, MI, MO, MS, NC, ND, NV, Ontario MOT, PADOT, SC, VA, WI. Partner's Total Commitments: $980,000.00 MDOT Pledge Commitment FY2017-2018.

PURPOSE AND SCOPE

The purpose of the peer exchanges and the AASHTO National Users Group meeting is to support State DOT and Canadian province implementation of ME Design procedures by (1) sharing information between, (2) identifying issues at the local/regional level regarding implementation, (3) identifying needs or areas that still need to be researched relative to the MEPDG, and (4) organizing implementation efforts on a regional and National basis.

The four peer exchanges will be limited to participation by governmental agencies, while the AASHTO Users group meeting will be open to industry representatives, academics, consultants, and others interested in ME Design. Funds from this pooled fund will only be used to support contributing agency travel and development activities. The peer exchanges and AASHTO National Users Group meeting will focus primarily on the efforts related to the AASHTO MEPDG and related Pavement ME Design™ software. However, all agencies are welcome to participate in the pooled fund as most topics covered are fundamental and applicable to all ME design procedures and pavement design in general.

This pooled fund will include the following tasks:

- Conduct 4 regional peer exchanges in each of the 4 AASHTO regions each year.
- Conduct 1 National AASHTO Users Group meeting each year.
- Provide funding for travel for 2 representatives from each participating agency to one regional meeting and the National AASHTO Users Group meeting.
- Provide contract support for meeting logistics and documentation of outcomes.
- Develop regionally and nationally significant products that aid MEPDG implementation including technical briefs, synthesis of best practices, updates of MEPDG documentation.
- Formation of TAC to select and approve topics to be funded.
- Develop a charter to define the governance structure of the regional groups and AASHTO Users Group and expenditures from the pooled fund.

FISCAL YEAR 2021 ACCOMPLISHMENTS

As reported in the Fifth Annual National Meeting of the AASHTO Pavement ME User Group (PMEUG) Technical Report, dated December 8-10, 2020 (Virtual Meeting), the planned 2021 events included a couple of training webinars, the RoadMap workshop, and an annual User Group meeting late in 2021.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The 2022 events included training webinars, a RoadMap workshop, and an annual User Group meeting to be conducted in November. Accordingly, webinar videos and slides were made available via https://me-design.com/MEDesign/Webinars.html and meeting minutes/reports were made available via https://www.pooledfund.org/details/study/549.

PROPOSED FISCAL YEAR 2023 ACTIVITIES

It is anticipated the study will maintain it's usually annual activities in 2023.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This TPF study is still in an "active status" and is pending all final deliverables and closeout memo.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
MDOT will remain as an active state partner until all project objectives/major tasks activities are completed and final deliverables are submitted/approved**.** MDOT technical contact continues to service as a Technical Advisory Committee member. Issued the FHWA MEPDG- Implementation Roadmap (Final Report) September 2022.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Technology Transfer Concrete Consortium (TTCC) [Old: TPF-5(159)]

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(313)		MDOT START DATE	4/10/2015
PROJECT NO.			MDOT COMPLETION DATE (Original)	5/31/2022
OR NO.	OR15-002		COMPLETION DATE	
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@michigan.gov			
LEAD AGENCY:	Iowa Department of Transportation			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us			
CONTRACTOR	Iowa State University (PI-Tom Cackler)			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$60,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		TOTAL COMMITTED FUNDS AVAILABLE		$0.00

PARTICIPATING STATES

AL, CA, CO, FHWA, FL, GA, IA, ID, IL, IN, KS, KY, LA, MA, MI, MN, MO, MT, NC, ND, NE, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, WA, WI, and WV. Total pledge commitments from partners- $1,732,000.00 MDOT Pledge Commitment FYs 2015-2019

PURPOSE AND SCOPE

The purpose of this pooled fund project is to identify, support, facilitate, and fund concrete research and technology transfer initiatives. This pooled fund project allows for state representatives to continue the collaborative efforts of TPF-5(159) that originally began in TPF-5(066) Materials and Construction Optimization. The Technology Transfer Concrete Consortium (TTCC) is open to any state agency desiring to be a part of new developments in concrete. TTCC will meet in conjunction with the National Concrete Consortium (NCC), twice a year. NCC Bylaws and the Executive Committee membership can be found at http://www.cptechcenter.org/ncc/TTCC-NCCMeetings.cfm.

FISCAL YEAR 2015 ACCOMPLISHMENTS

The Spring 2015 meeting was held in Reno, NV on April 21-24. Topics included state reports on concrete curing, internal curing, performance-based durability specifications, and others. The Fall 2015 meeting will be held in Milwaukee, WI on September 15-17. Topics include state report on concrete pavement joint sealing practices, there were also sessions on the Super Air Meter, Formation Factor, performance engineered mixes, FHWA Update, and others.

FISCAL YEAR 2016 ACCOMPLISHMENTS

The Spring 2016 meeting was held in Columbus, OH on April 21-24. Topics included performance engineered mixes, recycled concrete aggregate, FHWA update, roller compacted concrete, self-powered sensors for concrete, UHPC, Bridge deck cracking, and internal curing. The Fall 2016 meeting was held in San Antonio, TX on August 28 - September 1. This meeting was held in conjunction with the 11th International Conference on Concrete Pavements. Topics include an update on the CP Tech Center technical products, performance engineered mix update, and state reports. In addition, each attending state DOT representative participated in the international conference by either moderating a session, presented a topic in a technical session, or presented a poster in the poster session. MDOT presented two posters; concrete surface sealers and the US-23 Aggregate Test Road.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Spring 2017 meeting was held in Salt Lake City, April 25-27. The Fall meeting was held in Minneapolis, September 19-21. Highlights of the meeting and all presentations can be found at: http://www.cptechcenter.org/ncc/TTCC-NCC-2017.cfm and http://www.cptechcenter.org/ncc/TTCC-NCCMeetings.cfm

FISCAL YEAR 2018 ACCOMPLISHMENTS

The spring meeting was held in Coeur d' Alene, Idaho April 24-26, 2018. The general session consisted of 23 topics presented by representatives from 5 state agencies, 3 from FHWA, 3 from academia, and 4 from the industry sector.

Fiber Reinforcement for Concrete Overlays and Bridges update:

- Completion date of December 31, 2018
- Project TAC conference calls are held to review progress
- Software tool for calculating fiber performance for concrete overlays is in progress.
- Tech Brief for FRC for concrete overlays is in progress
- Overview of FRC for bridge decks is in progress.

Meeting presentation highlights include:

• Performance Engineered Mixtures: o Updates from the National Concrete Pavement Technology Center,

- TPF-5(368) Pooled fund update
- FHWA Mobile Concrete Lab
- Turner Fairbanks Research Center program update

- Michigan and Idaho implementation initiatives and experiences

• Latex Modified Bridge Deck Overlays: o North Carolina and Missouri experiences
• Alternatives to the Traditional Way: o Alternate cementitious materials
- Reclaiming coal ash from legacy ponds by a burn-out process to increase quality and quantity
- The evolution of new test methods for transport properties of concrete and resistance to freezing and thawing. Using the bucket test to determine the formation factor.
- Research on a new method to measure water-cement ratio of concrete and on factors to consider for formwork removal.

• NCC States report on:
- Types of reinforcement
- Mass concrete
- Self-Consolidating Concrete

• Reinforcement – which one to choose
• ACI – fiber reinforced polymer specification.

Ongoing Research:
• New method to measure w/c ratio in fresh concrete
• New method to measure w/c ratio in fresh concrete
• ODOT/MnDOT formwork removal research
• Concrete in an aggressive salt environment

The fall meeting was held in Saratoga Springs, New York September 18-20, 2018. Topics included Quality Control/Quality Assurance, Balancing Risk, NCC State Reports, Pooled Fund Update, Training Opportunities for NCC, SPS-2 Update, Determination of optimized opening using NDT, Accelerated precast concrete Pavements, etc.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The spring meeting was held in Denver, Colorado April 2-4, 2019
Meeting presentation highlights include:
FHWA Updates, SAM PWL Analysis, Concrete PRS Shadow Project, and TFHRC Update, PEM Update, Hot topics in bridges, Drilled shafts and mass concrete, States experiences with mass concrete, Accelerated bridge construction, Materials, Role of minimum cement content, Formation factor, Rapid repair and early loading, Joint activation efforts in FRC and fibers in concrete, and SAM testing update.

The fall meeting was held in Kalispell, Montana September 10-12, 2019
Meeting presentation highlights include: FHWA Updates, SAM PWL Analysis, Concrete PRS Shadow Project, and TFHRC Update, PEM Update, Early Opening to Traffic Technologies, Precast concrete materials, Precast bridge and pavement elements, Topical treatments and repair technologies, Dowel bars in PCC, and Innovation updates.

FISCAL YEAR 2020 ACCOMPLISHMENTS

This TPF project will closeout (estimated completion date 03/31/2021) after all deliverables, final report, and the accounting closeout spreadsheet is approved by FHWA. The collaborative efforts of this project that originally began in TPF-5(066) Materials and Construction Optimization will continue under the new TPF-5(437) federal project. Member states have pledged their contributions to the new project on the TPF website.

The Spring 2020 meeting, which was planned to be held in Nashville, TN on March 31-April 2, was cancelled due to Covid 19.

The Fall 2020 meeting, which was planned to be held in Minneapolis, MN on August 30 to September 3, was held virtually over a three-day period from September 1-3. Topics presented were Alkali- Silica Reactivity, Lightweight Cellular Concrete, PEM Tests State Experiences, Dowel/Tie Bars, NTPEP, Air Loss, NRRA Update, et. al.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Continued work on the five (5) Syntheses. Pending final report. Upon receipt of all final deliverables, TPF-5(313) will be closed out. The studies scope and planned objectives are now funded under the newly reauthorized TPF-5(437).

FISCAL YEAR 2022 ACCOMPLISHMENTS

The pooled fund is complete. Results of each of the syntheses were on the agenda for the Spring NCC meeting in Nashville. PowerPoints from the researcher's presentations and final reports are available on the pooled fund website.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT has fulfilled its total pledge commitment under this study. The lead agency updated the TPF website with a revised project end date of May 31, 2022. Project deliverables have been completed.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Results of each of the syntheses were on the agenda for the Spring NCC meeting in Nashville. PowerPoints from the researcher's presentations and various research project's final reports are available on the pooled fund website. This pooled fund has been completed.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Evaluation of Low-Cost Safety Improvements

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(317)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-209		MDOT COMPLETION DATE (Original)	9/30/2022
			COMPLETION DATE (Revised)	9/30/2023
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov			
LEAD AGENCY:	Nevada DOT			
PROJECT MANAGER	Roya Amjadi roya.amjadi@fhwa.dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$25,000.00
	(Revised)				(Revised)	$40,000.00
TOTAL FY 2022 EXPENDITURES		$10,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

AL, AR, AZDOT, CA, CO, CT, DC, FL, GADOT, IADOT, IL, IN, KS, KY, LA, MA, MDOT SHA, ME, MI, MN, MO, MS, MT, NC, ND, NE, NHDOT, NV, NY, OH, OK, OR, PADOT, RI, SC, SD, TN, TX, UT, VA, WA, WI, WY. Partners Total Commitments: $977,500.00
MDOT Pledge Commitment FY's: 2016-2022.

PURPOSE AND SCOPE

FHWA has initiated the Low-Cost Safety Improvements study to encompass safety-effectiveness evaluations of priority strategies from the NCHRP Report 500. The goal of the proposed research is to develop reliable estimates of the safety effectiveness of safety improvements identified as strategies in the NCHRP Report 500 and guidebooks through scientifically rigorous "Before"-"After" (B/A) evaluations of sites within the U.S. where these strategies are being implemented. The data for the study will be gathered from those states that implement the strategies throughout the US. The methodology utilized will typically be an Empirical Bayes evaluation or other appropriate method, using B/A data to help determine their effectiveness in reducing the number and severity of crashes. The data will be collected, evaluation studies will be performed as strategies are implemented over the course of several years.

Originally a target of 20 strategies totaling $4.38 million over 5 years was planned for ELCSI–PFS studies in four phases. Currently, this study has outperformed its original goals, and has added four extra phases for a total of eight phases. The original budget of $4.38 million remains the same. To provide much needed reliable measures for effectiveness of various low-cost safety improvements, this study's performance period has been extended beyond the initial date of 2017. This pooled fund study has contributed over 800 CMFs to the CMF Clearinghouse. This effort is on-going.

FISCAL YEAR 2020 ACCOMPLISHMENTS (Benefits to MDOT)

- Safety Evaluation of Flashing Yellow Arrows at Signalized Intersections
- Development of Crash Modification Factors for High Friction Surface Treatments (HFST)
- HFST Quick Reference
- Safety Evaluation of Pedestrian Countdown Signals

All of these provide useful information for MDOT to further define our approach to safety. HFST is an area MDOT wants to expand use of and with this information we can make efficient decisions.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The annual meeting was held June 28, 2021. ELCSI-PFS, PHASE X COMPLETED

- This phase was modified for no-cost POP extension to accommodate publication needs and completed July 2021.
- Variable speed limits (VSL).
- Safety Evaluation of Roadside for: Light Poles, Guardrails, and Side Slope Flattening.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The 2022 Annual Technical Advisory Committee (TAC) meeting was conducted virtually on May 25-26, 2022. All presentations and documents were shared with the TAC members by emails and on the Contractor (TTI) website after the meeting.

ELCSI-PFS, PHASE XIII
The FHWA awarded the PHASE XIII task order to the Texas A&M, Transportation Institute (TTI) in July of 2022.
This task order will study:

- Curve Enhanced Delineation (CED),
- Alternative Rumble Strip (ARS), and
- Fixed Objects Delineation of (FOD).

This task order's kickoff meeting is on August 17, 2022.
The Phase XIII is funded by the FHWA and the ELCSI-PFS.

ELCSI-PFS, PHASE XII
Innovative Intersection Design for Pedestrian and Bicycle Safety completion Date is October 30, 2022.
This phase is active. The highlights for this quarter progress are:

- Continued reducing the video data at the three sites in Washington DC.
- Continued to reduce the aerial video data. □
- Explored the possibility of obtaining right-turn speed from the sites with before and after data.
- Received bids for drone video for the Silver Spring, MD site. Selected vendor.
- Met with Montgomery County and the drone vendor to discuss data collection in Silver Spring, MD.

ELCSI-PFS, PHASE XI
This task is in progress (completion on 08/30/22). All deliverables were received, and publication process has started for following studies:

- Safety Evaluation of Mini-Roundabouts.
- Safety Evaluation of Bike Lane Configurations at Intersections.
- Safety Evaluation of Wrong Way Driving (WWD) Low-Cost Safety Improvements.
- Wrong-Way Driving Research and Technical Resources' Workshop (virtual) was conducted on March 9-10, 2022.

The ELCSI-PFS, Phase XI is mostly funded by the FHWA, DCMF program, and Intersection Road map.

PUBLICATIONS
Publications for Phase XI are in progress and expected to be completed by October 2022.
Please see list of all ELCSI-PFS with links at; https://highways.dot.gov/research/safety/evaluations-low-cost-safety-improvements-pooled-fund-study/publications

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Continue to manage Phases XI, XII, and XIII studies.

Begin the process for closing out the ELCSI-PFS' old number (TPF-05(317)) and start paperwork to create a new pooled fund project number and comply with all FHWA financial management requirements.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This project is active pending deliverables and initiation of new TPF number to continue activities.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The Evaluation of Low-Cost Safety Improvements pooled fund study has been invaluable to both MDOT and the staff in the Safety Programs area. The annual meeting allows various staff members to attend to learn new and improved low-cost safety improvements and more importantly to network with fellow DOTs and researchers. From these meetings MDOT has expanded on its research of Crash Reduction Factors for our roadways, piloted wrong way electronic devices, developed mini roundabout criteria, established signing standards for all way and two way stops on high-speed non-freeways, increased delineation and sought further safety tools for pedestrians and bicyclists, a heightened awareness area for the department. We have also shared our successes with rumble strips, wider edge lines and reflective strips on signposts with other DOTs. We will continue to review the results of the various studies and support all future research as they can shape the safety program in Michigan.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Transportation Management Center (TMC) Pooled Fund Study

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(319) [Old SPR-2(207)]		MDOT START DATE	4/17/2015
PROJECT NO.			MDOT COMPLETION DATE (Original)	4/16/2020
OR NO.	OR15-534		COMPLETION DATE (Revised)	4/16/2022
MDOT TECHNICAL CONTACT	Suzette Peplinski, 616-262-0059. PeplinskiS@michigan.gov			
LEAD AGENCY:	Federal Highway Administration (FHWA)			
PROJECT MANAGER	Jon Obenberger, 202-493-3265 Jon.Obenberger@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)			Amendment 2	(Revised)	$200,000.00
TOTAL FY 2022 EXPENDITURES		$25,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

AL, CA, FL, GADOT, IADOT, IL, KS, MDOT SHA, MI, MN, MO, NC, NJ, NV, NY, OH, PADOT, RTC Southern Nevada (FAST), TN, TX, UT, VA, WA, WI. Total partner commitments received: $3,525,569.00.

PURPOSE AND SCOPE

The purpose of the Transportation Management Center (TMC) Pooled Fund Study is to assemble regional, state, and local transportation management agencies and the Federal Highway Administration (FHWA) to (1) identify human-centered and operational issues that are common among TMC operators and managers; (2) suggest approaches to addressing identified issues; (3) initiate and monitor projects intended to address identified issues; (4) provide guidance and recommendations and disseminate results; (5) provide leadership and coordinate with others with TMC interests; and (6) promote and facilitate technology transfer related to TMC issues nationally.

FISCAL YEAR 2014 ACCOMPLISHMENTS

- Studies included: Best Practice for Road Condition Reporting Systems, Guidebook for Developing Virtual TMCs, Effectiveness of Safety and Public Service Announcement (PSA) messages on Dynamic Message Signs (DMS), Roles of Transportation Management Centers in Incident Management on Managed Lanes, and Travel Time Displays prior to Freeway Entrances.
- A webinar was also held: Effectiveness of Disseminating Traffic Messages on Dynamic Message Signs.

FISCAL YEAR 2015 ACCOMPLISHMENTS

- Several webinars were held on current, relevant TMC topics that MDOT staff attended.
- Studies included: Human Factors Guidelines for TMCs, Next Generation Traveler Information System - A 5-Year Outlook Project, and Public Perception of PSA on DMS in Rural Areas.

FISCAL YEAR 2016 ACCOMPLISHMENTS

- TMC PFS group held quarterly conference calls to share information and update on studies.
- Several webinars were held (which are generally done through USDOT's T3 program to share with a wider audience) on current topics.
- Studies completed this year include: TMC Video Recording and Archiving Best General Practice, Freeway Service Patrol Prioritization and Best Practice, and Travel Time Displays at Freeway Entrance Approaches. All three of these topics are of current relevance in Michigan and have been shared with MDOT operations stakeholders.
- MDOT hosted the group's Annual Meeting this year at the Southeast Michigan TOC in Detroit.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Quarterly conference calls were held with members to review progress of studies and share information.
- Reports were issued for: Safety Service Patrol Prioritization and Best Practices, Synthesis of Variable Speed Limit Sign Operations, Public Perception of Public Safety Messages on DMS.
- Ongoing studies were initiated for the Effects of ITS Planning and Deployment in a CV Environment.

FISCAL YEAR 2018 ACCOMPLISHMENTS

- Quarterly conference calls were held with members to review progress of studies and share information.
- Reports were issued for: Effects of ITS Planning and Deployment in a CV Environment and Travel Time Displays at Freeway Entrance
- Approaches. Ongoing work: Capability and Usage Guidelines for Color CMSs, Consideration of Current and Emerging TMC Data, IT

- Security Guidance for TMCs, Streaming Video Sharing and Distribution.

FISCAL YEAR 2019 ACCOMPLISHMENTS

- Studies completed: Consideration of Current and Emerging TMC Data and Streaming Video Sharing and Distribution
- Studies continued: Capability and Usage Guidelines for Color Changeable Message Signs and IT Security Guidance for Transportation Management Centers.
- Projects that were started and kick-off meetings held in 2019: Use of TMC Performance Dashboards for Communicating the Benefits of Traffic Operations, Info & Analysis of TMC Staff and Staffing Contracts and Performance Measures & Health Index of ITS Assets
- The TMC Pooled Fund Study Annual Meeting was held on May 14th & 15th of 2019 in Denver, Colorado. Members from 17 agencies
- participated in the meeting to share their knowledge and experience, exchange information, and select projects to advance in 2020.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Reports were completed for TMC Information Technology Security; Capability and Usage Guidelines for Color Changeable Message Signs, TMC Performance Dashboards (also webinar), and Performance Measures and Health Index of ITS Assets (also webinar).
- Projects were kicked off for: Transportation Management Systems (TMS) Asset Management Planning for TMSs and LCCA; Integrating Predictive Analytics into Real-Time Operations.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- The last annual meeting was held virtually in November & December 2020. The next annual meeting will be May 2022.
- Projects completed in 2021: Analysis of TMC Staff and Staffing Contracts, Performance Measures and Health Index of ITS Assets.
- Projects underway: Inventory Document and Configure TMS Assets, Predictive Analytics for Real-time TMS Operations, TMS Asset Management Planning and LCCA.
- Five additional projects were selected to kick-off in FY2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Reports completed include Capability and Usage Guidelines for Color Changeable Message Signs, and Performance Measures & Health Index of ITS Assets.
- Projects initiated and ongoing include: Planning to Frame Traffic Management Systems (TMS)s Strategic Direction and Future Investments, Using Information from Social Media to Improve the Operations of TMSs. Applying Predictive Analytics into the Real-time Operations of TMS, and TMS Asset Management Planning.
- The annual meeting was held in May 2022 to select new projects, provide presentations on current projects, hear member state initiatives, and tour the Ohio DOT facilities.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

TPF website revised project completion date to April 16, 2022. Project continuation TPF-5(487) FHWA approved FY 2023-FY 2027.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

- MDOT staff have attended the PFS webinars (which are used to help disseminate information from each of the completed studies) and use information discussed, along with the related studies, for developing statewide guidelines and projects.
- Multiple MDOT staff are involved on the advisory teams for the ongoing projects to provide input and guide studies to benefit MDOT's data management, traffic operations initiatives, and asset management efforts.
- Links to completed studies are distributed to the ITS Stakeholder group as they are released.
- Since MDOT is currently procuring and integrating color DMS/CMS into our traffic operations, the Guidelines for Color CMS report will be valuable in developing the new operating procedures in line with FHWA guidelines.
- Analysis of TMC Staff and Staffing Contracts continues to aid MDOT Transportation Operations Center (TOC) managers in updating contract documents and managing TOC operations at MDOT's 4 TOC's.
- Performance Measures and Health Index of ITS Assets provides useful input for the ITS program's Device Modernization Plan efforts.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2021

STUDY TITLE: Base Funding for the North Central Superpave Center

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(320)		MDOT START DATE	2/3/2015
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR15-521		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@michigan.gov			
LEAD AGENCY:	Indiana Department of Transportation			
PROJECT MANAGER	Tommy Nantung, 765-463-1521 ext. 248 tnantung@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2021 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$150,000.00
	(Revised)				(Revised)	
TOTAL FY 2021 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

IA, IL, IN, KS, MI, MO, and WI. Total Participating Commitments Received $300,000. MDOT Pledge FYs 2015-2020

PURPOSE AND SCOPE

This pooled fund project will provide for continued operation of the North Central Superpave Center (NCSC) to assist agencies and industry with Superpave implementation and hot mix asphalt issues. The NCSC will provide technical assistance, training, communication, and research and development to meet the needs of the region.

FISCAL YEAR 2015 ACCOMPLISHMENTS

- There was a conference held in 2015 prior to MDOT committing funds. Planning for the 2016 conference is ongoing.
- A teleconference was held to discuss states' experience with premature cracking on Hot Mix Asphalt (HMA).
- Additional technical conference calls will be held throughout the coming year.

FISCAL YEAR 2016 ACCOMPLISHMENTS

- A teleconference was held in February to discuss asphalt performance testing/balanced mix design.
- The 2016 technical conference was held in March in Indianapolis. Topics discussed include fundamentals of recycled shingles, rejuvenators, softening agents, REOB, durability, construction related items, verification of specific gravity, and various Federal Highway Administration (FHWA) policies (current and future).
- Learning the state of the practice will help MDOT remain current with specifications and compliant with federal regulations.
- The NCSC will provide technical assistance, training, communication, and research and development work to meet the needs of the region.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Work continued on the study Tack Coat Installation Performance Guidelines.
- Testing continued on an industry-supported project- Determining the Fiber Content in Crack Sealing. A presentation on the proposed method was given to the American Society for Testing and Materials (ASTM) Subcommittee on Formed In-Place Sealants and Cracks in Pavements. The subcommittee expressed interest in seeing more results and will consider adopting the test as a new ASTM standard. Continued the study Development of a Friction Performance Test for Compacted Asphalt Mixtures. Proof of concept testing is underway and looks promising. A Study Advisory Committee meeting was held in early July.
- Testing of Reclaimed Asphalt Pavement (RAP) samples for the study Investigation of Delta Tc for Implementation in Indiana is underway along with a comprehensive literature review. Seven virgin binders have been tested after 20-hr and 40-hr Pressure Aging Vessel (PAV) aging. One source of shingles has been obtained for testing. A Study Advisory Committee (SAC) meeting was held in early July to get input on which blends to continue testing.
- Survey responses are being analyzed and the literature review is continuing for the study Best Practices for Patching Composite Pavements. A SAC meeting was held in early July.
- Technology Transfer-The Technical Director participated in the Transportation Research Board (TRB) workshop on implementation of Warm Mix Asphalt. Concerns exist on why some states are lagging in May 2017. She attended the FHWA Asphalt Mix and Binder Expert Task Group meetings in May as well. She also participated in the ASTM Road and Paving Material committee week as Vice Chair.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Communication:
Information requests were processed as they arrived. Approximately 20-25 requests were received per month. Published reports have now been downloaded from the Joint Transportation Research Program website. During this calendar year there have been over 10,700 occurrences.

Third Party Lab and Testing Services:
Proficiency testing continued along with maintenance of the American Association of State Highway Transportation Officials (AASHTO) Materials Reference Laboratory (AMRL) accreditation records. The AASHTO resource lab inspection was completed. Samples for third party tack coat bond strength and Indiana Test Method (ITM) 221 (friction) testing were received and testing completed. Samples for dynamic modulus testing were received from Penn State University; their equipment broke near the end of a research project. The Nova Scotia Transportation ministry requested a review of their Superpave asphalt specifications and tests.

Research:
- Continue to work on the study *Tack Coat Installation Performance Guidelines*. Testing has been completed and the data analysis is underway. A draft final report is anticipated in July 2019.
- Continue to work on the *Development of a Friction Performance Test for Compacted Asphalt Mixtures*. Testing has been completed and a draft final report will be submitted next quarter.
- Testing continued for *Investigation of Delta Tc for Implementation in Indiana* and data analysis is underway. The draft final report will be completed next quarter or early in the following quarter.
- A time extension was requested for *Best Practices for Patching Composite Pavements* to allow time to collaborate with an INDOT engineer who will be working on this issue. The Study Advisory Committee approved the request, which was forwarded through the appropriate channels.
- Work on *Real Life Experiences with Major Pavement Types* was initiated. A literature review to identify possible analysis techniques, data elements needed for life cycle cost analysis and other background information began. Past Joint Transportation Research Program (JTRP) research reports and the Indiana Long-Term Pavement Program (LTPP) sites were reviewed to see if any previously studied test sites could be used in this study.
- Continue to work on a National Cooperative Highway Research Program (NCHRP) Synthesis study on asphalt pavement lift thicknesses. Survey responses were received from 45 states, five provinces and 62 industry representatives. The first draft report was submitted. A panel meeting to review the report will be held early next quarter.

Technology Transfer:
The Technical Director participated in the meeting of the Transportation Research Board (TRB) committee on Critical and Emerging Issues in Asphalt Technology. She gave a presentation on research at the NCSC at American Society of Civil Engineers (ASCE) Indiana Section Annual Meeting and represented the region at the American Society for Testing and Materials (ASTM) International's Committee on Road and Paving Materials.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Training:
The technical director provided a Perpetual Pavements webinar over the Upper Great Plains Transportation Institute's (North Dakota State University) distance learning system to participants in three states. She also gave a shorter presentation at the ND Asphalt Conference. She provided over one day of training on asphalt materials, construction and Superpave5 to approximately 20 engineers and managers from INDOT.

Communication:
Information requests are processed as they arrive; about 20-25 per month are received. Minutes and presentations from the last Multi-Regional Training and Certification Group (M-TRAC) meeting were posted, and NCSC staff is exploring ways to facilitate asking questions and sharing responses for the group. Published reports have now been downloaded from the Joint Transportation Research Program website over 11,930 times.

Third Party Lab and Testing Services:
The research engineer continued her work on proficiency testing and maintenance of AMRL accreditation records. The internal lab audit was completed. Lab usage fees were established for third-party testing and are included in the new lease agreement between Purdue and INDOT.

Research:
- The draft and final reports for *Investigation of Delta Tc for Implementation in Indiana* were completed this quarter and the close-out meeting was held. A draft implementation plan was provided to the business owner; implementation of the parameter is not recommended at this time. It could possibly be used as a forensics tool or could be implemented in the future after some remaining issues are resolved nationally. Publication of the final report is expected next quarter.
- Work on *Real Life Experiences with Major Pavement Types* continued. A literature review to identify possible analysis techniques, data elements needed for life cycle cost analysis and other background information continued.
- The final report on an NCHRP Synthesis study on asphalt pavement lift thicknesses was published by TRB.

Technology Transfer:
The Technical Director and Jusang Lee gave a presentation about the Superpave Center and partnership with INDOT and other states to a delegation of Korean engineers who were visiting ASTM Headquarters. The technical director participated in her first ASTM Board of Directors' Meeting of her three-year appointment. She also chaired the meeting of ASTM Committee D04 on Road and Paving Materials. She delivered the Gene Skok lecture at the National Road Research Alliance meeting in May. She also participated in the

meeting of TRB Committee AFK10, Critical and Emerging Technologies in Asphalt, as Asphalt Section chair. This two-day meeting was held in Indianapolis and included invited guests from Indiana, Illinois, Michigan and Ohio industry and agencies in addition to the committee members. Negotiations began to partner with the Asphalt Pavement Alliance to co-host the North Central Asphalt User Producer Group (NCAUPG) meeting.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Training:
None provided due to passing of the Technical Director and the global pandemic. Discussion took place on whether the NCSC would still be interested in training the foreign delegates for ASTM International. Due to the worsening pandemic situation globally, the training would be delayed to 2021. The NCSC expressed their continued interest in conducting the training after the COVID situation improved.

Communication:
Major updates were made to the M-TRAC website. Published reports have now been downloaded from the Joint Transportation Research Program website over 15000 times.

Third Party Lab and Testing Services:
Determined the specific gravities for the PRA samples received. Estimate for ITM 221 testing was sent to the contractor. The research engineer continued her work on proficiency testing and maintenance of AMRL accreditation records.

Research:
- SAC meeting was held for *Real Life Experiences with Major Pavement Types* to discuss the lack of access to old project data files and direction forward. The proposed alternative direction was approved by the SAC along with no-cost time extension.
- Five new resins were obtained but testing was limited for the study titled *Developing Lower Modulus Polymer Resin Binder Systems Specifications for High Friction Surface Treatments (HFST) on Asphalt Pavements in Nevada,* due to closure of Purdue research labs campus-wide and COVID-16 safety procedures are being developed for the labs.
- Report writing continued for the NCHRP synthesis project titled *Practices for Assessing and Mitigating the Moisture Susceptibility of Asphalt Pavements*.

Technology Transfer:
Co-authored a paper presented at Association of Asphalt Paving Technologists (AAPT) conference held online.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Communication: Combined State Binder Group (CSBG) website is being updated. Shah is working with A. Gallistel (CSBG liaison) and implementing the changes.

Third Party Lab and Testing Services: The research engineer continued work on proficiency testing and maintenance of AMRL accreditation records. Peckham Industries contacted NCSC for repeat testing of two RAP samples next quarter. Received the go-ahead from US Aggregate to test four friction aggregate using ITM221.

Research:
- Based on the proposed new direction for the project titled Real Life Experiences with Major Pavement Types data from LTPP website is being extracted.
- Testing of the resins continues after Purdue labs partially reopened with social distancing measures in place, for the study titled Developing Lower Modulus Polymer Resin Binder Systems Specifications for High Friction Surface Treatments (HFST) on Asphalt Pavements in Nevada.
- Submitted Draft Report to NCHRP Panel for the synthesis project titled Practices for Assessing and Mitigating the Moisture Susceptibility of Asphalt Pavements.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT commitments for fiscal years 2015 and 2016 [$25k each] were transferred during FY 2016 to the lead state. As such, the original FY 2015 commitment was changed to $0.00, and the FY 2016 was revised from $25,000.00 to $50,000.00 on the TPF website.

The revised completion date on the TPF website is September 30, 2022, and no additional funds have been requested.

MDOT has fulfilled its total pledge contribution amount of $150,000.00.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Research: Continue testing aged field cores samples obtained from Nevada will be used for freeze/thaw cycling and pull-out testing. Prepare HMA slab samples for testing other HFST resins under temperature.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: National Road Research Alliance (NRRA)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(341)		MDOT START DATE	2/22/2016
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2018
OR NO.	OR15-531		COMPLETION DATE (Revised)	9/30/2022
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@Michigan.gov			
LEAD AGENCY:	Minnesota DOT			
PROJECT MANAGER	Glenn Engstrom, 651-366-5531 glenn.engstrom@state.mn.us			
CONTRACTOR	University of Minnesota			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$450,000.00
	(Revised)			FY 2021 *	(Revised)	$750,000.00
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

CA, IADOT, IL, MI, MN, MO, ND, and WI. Total Partner Commitment Level: $4,850,000.00
MDOT Pledge Commitment FYs 2016-2021

PURPOSE AND SCOPE

Primary objectives of the National Road Research Alliance (NRRA) are:
- Conduct structured construction, field testing and evaluation using the Minnesota Road Research Facility (MnROAD).
- Evaluate pavement materials, equipment, and methods under real-world conditions.
- Establish industry standards and develop performance measure for improving pavement performance.
- Develop and/or revise specifications and recommendations.
- Studying and promoting innovative techniques and technologies that will save agencies money, improve safety, and increase efficiency.
- Supporting technology transfer by developing practical field guides, best practices, and training curriculum to promote the results of research projects.
- Conduct cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiencies.
- Support the exchange of information and ideas through collaborative research efforts that provide opportunities for public agencies to share experiences.
- Identify and prioritize common road related research needs to address regional and national issues that are built on existing efforts such as Federal Highway Administration's (FHWA's) Portland Cement Concrete (PCC) and Hot Mix Asphalt (HMA) Roadmaps as well as the Foundation for Pavement Preservation Roadmap.
- Fund high priority, readily implementable research projects though research contracts and university partnerships.
- Leverage knowledge, skills, and resources from participating partners to advances pavement research and implementation efforts while developing the workforce of the future.
- Support technology transfer that highlights the implementation of research results and the associated benefits.

The scope of work for this pooled fund project is:
- Members provide the prioritized research needs, project development and design by way of the research project teams.
- Through the pooled fund members provide funding for high priority, readily implementable research projects.
- Participate in the planning of the reconstruction of MnROAD test sections in 2017 based on the established research needs developed. MnDOT will provide $2.5 million of funding support to assist in the effort.
- Members receive timely results on NRRA research projects through communication products that emphasize lessons learned and implementation.
- Assistance in putting research results into practice through technology transfer events.
- Membership in the Technology Transfer and Communication Teams.
- NRRA members support committees that meet periodically throughout the year to determine priorities, develop strategies to address the priorities, and execute action plans.
- Sponsor students to work on specific prioritized research needs through academic contracts/grants.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Long Term Research Construction- finalized special provisions. MnDOT let the construction project (delayed) for 2017 construction at MnROAD. The long-term research construction effort is being funded with 2.5 million of MnDOT funds for NRRA members to use.
- NRRA Team Meetings were held monthly [w/ a few exceptions] and as needed to accomplish its tasks.
- Held the May 2017 NRRA Pavement Conference and workshop on May 23-24, 2017.
- Significant Results - NRRA Agencies and Associates members make up five (5) teams that play an important technical role in setting both the technology transfer and long-term research needs. Each team was active this summer meeting every two weeks to develop and prioritize ideas that fall into identified categories that meet local, state, regional and national research needs.
- Monitoring of various test cells. Continued material testing and analysis of the preliminary data collected to date.
- Completed construction of various test cells to be included in various studies. Actively continue development of long-term research needs in the various technical areas including Request for Proposal (RFP) development. Promotion of the NRRA seeking new members.

FISCAL YEAR 2018 ACCOMPLISHMENTS

- Continued monitoring and reporting on the various test cells.
- Continued identification of technology transfer needs with webinars
- being offered on the many subjects.
- Continued public relations outreach for additional members. Continued work and reporting out by the individual technical committees.

FISCAL YEAR 2019 ACCOMPLISHMENTS

- Continued Public Relations (PR) outreach for new members including Transportation Research Board (TRB) booth and MnROAD's 25th Anniversary Open House.
- Phase (PH) II TPF-5(375) has been approved with research projects being solicited and scored for priority. Phase II extends this research venture an additional 5 years. In addition to new research projects PH II will also be used for additional monitoring and analyzation of PH I data from the low/high-volume pavement preservation sections built both in Alabama and Minnesota.
- With many of the test sections built in 2016, there was not ample time to identify the rates of deterioration that will be realized on the test sections. MnDOT is leading this portion of the pooled fund study and will again partner with NCAT for data collection in Alabama and most of the data analysis.
- Technical transfer efforts continue with presentation to various DOT's and organizations on current best practices and latest technologies. Continual efforts of data gathering, analyzation and reporting of findings from the various research aspects.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Continued PR outreach for new members and to inform everyone on research efforts being conducted by the NRRA.
- Completed research topic selection for PH II projects, TRB presence and innovation solicitation for technical transfer topics. Construction of some of the PH II research projects are time and weather dependent.
- Provided additional technical webinars on a variety of subjects and continued data collection analysis and research reports from the findings of the various research aspect.

FISCAL YEAR 2021 ACCOMPLISHMENTS

To date ten (10) government agencies and over fifty-five (65+) industry, associations, consultants, and academic institutions have become NRRA members to share their expertise and are learning about new tools and methods to improve and expand upon transportation systems nationally.

Phase-I Projects:

• Tech Transfer - 100% of the 13/13 projects complete.
• 2017 Long Term Research – 50% of the 4/8 projects complete.
• 2019 Long Term Research – 8% of the 1/11 projects complete.
• 2019 Call for Innovation Research – 0% of the 0/5 projects complete.
• 2020 Call for Innovation Research – 0% of the 0/7 projects complete.

Phase-2 Projects:

• 2021 Long Term Research – 0% of the 0/13 projects complete.

General:

• NRRA members/Teams have met monthly again this quarter which also acts as TAP meetings for each team's short- and long-term research efforts also focusing on development of 2021 projects with inputs on MnROAD 2022 construction.
• Executive Committee meetings: Two meetings held this quarter and one expected in the next quarter to help establish Phase-II efforts in February 2021.
• Call for Construction sent out and ideas are being submitted – one formal idea so far and other potential ideas – Construction in 2022.
• Monthly Research pays off webinars have been completed and a plan for end of 2021 topics are developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

This pooled fund ended in 2021. The next phase is TPF 5(466). Please reference that pooled fund for 2022 accomplishments. Several projects are still active and less than 100% complete. Remaining unspent funds will be expended on these projects under the new TPF number.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
Revised project completion date is February 22, 2021. MDOT fulfilled its original total pledge contribution amount of $450,000.00 and increased their FY 2021 pledge commitment to $300,000.00. MDOT's pledge increase in FY 2021 makes us par with other partners in the study. FY16-18 at $150K and FY 21 at $300K (covers FY's 19 & 20 pledge shortage). Project activities will be continued under new TPF project TPF-5(466) which began in FY22.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
See the NRRA team pages for implementation topics that are being developed. TAP members of each of the contracts and teams will be asked to help the development of implementation for the technology transfer team to push with its members. This is a focus area that is probably the hardest part of successful research. The technology transfer team will be focused on this topic in the upcoming months.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Roadside Safety Research for Mash Implementation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(343)		MDOT START DATE	10/1/2016
TPF- SOLICITATION NO.	1424		MDOT COMPLETION DATE (Original/ Revised)	12/31/2018/ 09/30/2021
OR NO.	OR15-528		COMPLETION DATE (Pending Revision) *	12/31/2023
MDOT TECHNICAL CONTACT	Carlos Torres, 517-355-2852 TorresC@michigan.gov			
LEAD AGENCY:	Washington DOT			
PROJECT MANAGER	Mustafa Mohamedali 360-704-6307 MOHAMEM@wsdot.wa.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$220,000.00
	(Revised)	$50,000.00			**(Revised)**	$320,000.00
TOTAL FY 2022 EXPENDITURES		$50,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$50,000.00

PARTICIPATING STATES

AK, AL, CA, CO, CT, DE, FL, IADOT, ID, IL, LA, MA, MDOT SHA, MI, MN, MO, MS, NM, OH, OK, OR, PADOT, TN, TX, UT, WA, WI, WV. Partners Total Commitments: $7,190,363.00 MDOT pledge commitments: $320,000.00 [FY's 2017-2018 @$50K each and FY 2020 @$100K, FY 2021 @ $20K, FY2022 @$50,000 and anticipated $50,000 in FY2023.

PURPOSE AND SCOPE

The objective of the Roadside Safety Pooled Fund Program is to provide a cooperative, cost-effective, and efficient approach to conducting research on roadside safety hardware meeting the functional needs of participating states. Emphasis will be placed on assisting state DOTs with their implementation of the Manual for Assessing Safety Hardware (MASH), transition to the use of MASH-compliant roadside safety devices in lieu of current National Cooperative Highway Research Program (NCHRP) 350-compliant devices as mandated in the revised Federal Highway Administration (FHWA) - American Association of State Highway Transportation

Officials (AASHTO) Joint Implementation Plan and addressing other roadside safety needs of common interest. Another objective of this pooled fund research is to provide each participating state an opportunity to send a representative to an annual meeting to collaborate with other state DOT safety engineers to assess best practices, new regulatory issues, risk management strategies, and other matters pertaining to roadside safety. Roadside Safety Pooled Fund members will meet, review potential projects for inclusion as part of future MASH crash testing projects, develop a work plan that involves selecting projects for future MASH crash testing, and designate individuals that will serve as team leaders for overseeing these projects.

Specific research activities expected to be addressed within the program include the design, analysis, testing, and evaluation of crashworthy structures, and the development of guidelines for the use, selection and placement of these structures. Crashworthy structures include bridge railings, guardrails, transitions, median barriers, cable barriers, temporary concrete barriers, end treatments, crash cushions (impact attenuators), culverts, breakaway support structures (e.g. sign supports, luminaire supports, mailboxes), and work zone traffic control devices. In addition, research is expected to address the influence of highway features such as driveways, slopes, ditches, shoulders, medians, and curbs on single vehicle collisions.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Completed Projects

1. MASH Transition from F-Shape Temporary Concrete Barrier Pinned on Asphalt to Rigid Single-Slope Concrete Barrier
   - Test Report No. 605641-1; Test Report Date: January 2016
   - Benefit: Provides insight on methods to anchor temporary concrete barrier to permanent concrete barrier.
2. Guidebook for Use of Pinned-Down Temporary Concrete Barriers in Limited Space Applications
   - Test Report No. 605071-1; Test Report Date: April 2016
   - Benefit: Provides insight on an alternative limited deflection temporary concrete barrier system that meets MASH.
3. MASH Finite Element Analysis and Full-Scale Crash testing of Stacked W-Beam Transition for 31-inch Guardrail
   - Test Report No. 604581-1; Test Report Date: May 2016
   - Benefit: Provides information on a MASH-compliant guardrail anchorage that MDOT could use if desired.

The Michigan Department of Transportation (MDOT) joined the Roadside Pooled Fund in mid-2016 and the first Roadside Safety Pooled Fund meeting with MDOT participation is slated to take place in late October 2016. As a result, there was no input or involvement from MDOT in the three completed projects identified above.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed Projects

1. Barrier Deflection Characteristics of 31-inch W-Beam Guardrail Systems with 8-inch Blockouts.
   - Test Report No. 603481; Test Report Date: February 2017.
     Benefit: Provides some insight on impact deflection characteristics for Type MGS-8 guardrail.
2. Guidance for Raising Beam Guardrail Composite Blockout for Rail Height Adjustment.
   - Test Report No. TM-605311; Test Report Date: February 15, 2017.
     Benefit: Provides additional insight regarding guardrail height adjustments.

Pooled Fund Scorecard Development

The pooled fund, in conjunction with TTI, is in the process of developing scorecards for prioritizing MASH testing and evaluation of roadside safety devices. A scorecard (scorecard #1) was completed for guardrail and cast-in-place, permanent concrete barrier systems.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Pooled Fund Scorecards

The pooled fund, in conjunction with TTI, developed and completed a series of scorecards for prioritizing MASH testing and evaluation of roadside safety devices. The following scorecards were completed:

- #2: Guardrail terminals, cable barrier systems, and impact attenuators
- #3a: Transitions
- #3b: Portable barriers
- #3c: Other longitudinal barriers
- #3d: All other terminals
- #3e: Bridge railings

Completed Projects

1. Keyed-In, Segmented, Single Slope Reinforced Permanent Concrete Barrier
   - Objective: Perform a MASH, TL-4 (Test 4-12) crash test on a 120-foot long installation (consisting of three 40-foot segments with no connections between adjacent segments) of 42" tall, Texas DOT (TxDOT), reinforced single slope permanent concrete barrier keyed into 1" thick asphalt pavement.
   - Results: The barrier successfully passed MASH Test 4-12. MASH Tests 4-10 (small car) and 4-11 (pickup truck) were not performed due to successful past testing.
2. MASH Testing of Oregon DOT, F-Shape Temporary Concrete Barrier (TCB) Pinned to Concrete Pavement
   - Objectives: Determine a suitable offset between the TCB and the edge of the concrete pavement, and perform a MASH, TL-3 (Test 3-11) crash test on the pinned TCB with the selected offset from the edge of pavement. The F-shape TCB design used on this project was the Oregon DOT, F-shape TCB design.
   - Results: A 9-inch (minimum) offset was determined to be suitable for the design to meet MASH, TL-3 requirements when pinned to an 8-inch thick (minimum) concrete pavement. The barrier successfully passed MASH Test 3-11 with a 9-inch offset from the edge of pavement and pinned to an 8-inch thick concrete pavement.
3. 31-inch Tall Buried-in-Backslope (BIB) Terminal Compatible with MGS Guardrail
   - Objective: Develop a 31" tall buried-in-backslope that is compatible with MGS guardrail, MASH, TL-3 compliant, and suitable for installation on a V-ditch with a 1:4 or flatter foreslope, and a 1:2 or flatter backslope.
   - Results: The BIB terminal successfully passed MASH Tests 3-34 and 3-35.
4. MASH TL-3 T-Intersection (Short Radius) System Design Variations (Project Ended on 8/31/18)

A meeting was held in September 2018 in Denver, Colorado with the pooled fund member states and TTI to discuss ongoing projects and select and prioritize future projects.

FISCAL YEAR 2019 ACCOMPLISHMENTS

MASH Testing of W-beam Guardrail in Concrete Mow-Strip

- Objectives: Determine MASH, TL-3 compliance of Type MGS-8 guardrail, with wood and steel posts, as installed in a concrete mow strip.
- Results: Both MASH, TL-3 tests (i.e., tests 3-10 and 3-11) involving the steel post version of Type MGS-8 guardrail passed. However, with the wood post version of Type MGS-8 guardrail, only test 3-10 (i.e., small car test) passed. Test 3-11 (i.e., pickup truck test) failed. A subsequent test (3-11) was performed using a shorter (36" long) wood post, and this test also resulted in a failure. Therefore, additional research is needed to determine if Type MGS-8 guardrail with wood posts can meet MASH, TL-3 criteria when placed in a concrete mow strip.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Completed Projects

1. T4541-DA: Administrative Support
2. T4541-DI: Determination of Pedestrian Rail Offset Requirements to Eliminate Vehicle Interaction
3. T4541-DS: 2019 Travel and Meeting Assistance
4. T4541-CU: 2018 MASH Coordination Effort

Ongoing Projects

1. Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
2. Testing of MGS System with Reduced Post Spacing for MASH Compliance
3. Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
4. Thrie-Beam/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
5. Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
6. MASH TL-3 Transition Design with a Storm Drain Inlet
7. MASH Coordination Effort
8. Testing and Evaluation of Large Sign Slipbase Support on Slope at MASH Test Level 3 Impact Conditions

9. MASH TL-4 Investigation and Testing of the Critical Flare Rate for Cast-in-Place Single Slope 42" Concrete Barrier Flaring around a Fixed Object
10. Review and Investigation of W-Beam Guardrail Terminals with Curbs

Approved Projects

1. Shorter TL-3 MASH W-Beam Transition
2. MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top of Barrier
3. MASH TL-3 Testing of Guardrail on 6H:1V Slope
4. Length of Need (LON) for Guardrail without Anchorage: Phase 1

FISCAL YEAR 2021 ACCOMPLISHMENTS

Completed Projects

1. 2020 MASH Implementation Support
2. 2020 Administrative Support
3. Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
4. Testing of Midwest Guardrail Systems with Reduced Post Spacing for MASH Compliance
5. MASH TL-4 Investigation and Testing of the Critical Flare Rate for Cast-in-Place Single Slope 42” Concrete barrier Flaring Around a Fixed Object
6. MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top
7. T4541-CR: Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
8. T4541-DT: Determination of the Length-of-Need for Guardrail Without Anchorage: Phase 1

Ongoing Projects

1. 2021 MASH Implementation Support
2. 2021 Administrative Support
3. T4541-CV: Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
4. T4541-CW: Testing of Midwest Guardrail Systems with Reduced Post Spacing for MASH Compliance
5. T4541-CZ: Thrie/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
6. T4541-DB: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
7. T4541-DJ: Testing and Evaluation of Large Signs Slipbase Support on Slope at MASH TL-3 Impact Conditions
8. T4541-DL: A Study of Guardrail Placement on 6:1 Slope
9. T4541-DN: MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top
10. T4541-DO: Shorter TL-3 MASH W-Beam Transition
11. T4541-DQ: 2019 MASH Coordination Effort
12. T4541-DV: Study of Acceptable Sidewalk Heights and Widths
13. T4541-DW: Design and Testing of a Thrie-Beam Guardrail System at a Fixed Object
14. T4541-DX: Design and Testing of a MASH TL-3 Thrie-Beam System for Roadside and Median Applications
15. T4541-DY: MASH TL-3 Transition Design with a Storm Drain Inlet
16. T4541-DZ: Determination of the Length-of-Need for Guardrail without Anchorage: Phase 2
17. T4541-EA: Development of a Thrie-Beam Retrofit for Upgrading Obsolete Bridge Railings
18. T4541-EB: 2021 Administrative Support
19. T4541-EC: Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems
20. T4541-ED: Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
21. T4541-EE: Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
22. T4541-EF: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
23. T4541-EG: 2021 Program Development and MASH Coordination Effort

Approved Projects

1. Continued Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
2. Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems
3. Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
4. Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
5. Testing Type III Barricades with Aluminum Panels and Mounted Signs (proposal in development)
6. Transition Between Guardrail and Tangent Anchored Portable Concrete Barriers
7. Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports
8. Proposal 2021-04-BR: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete
9. Proposal 2021-06-LSRB (CONT): MASH TL-3 Transition Design with a storm drain inlet (continuation)
10. Proposal 2020-02-BD: Multi-directional base design for steel beam non-proprietary large sign supports—Phase II
11. Proposal 2021-02-LSRB: Crash testing a Guardrail on 1TO1 slope
12. Proposal 2021-01-BD: Crashworthy Pedestrian and Small Traffic Signals

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed Projects

1. T4541-CR: Placement of Guardrail on Slopes Phase IV: MASH TL-3 Testing of Guardrail
2. T4541-DT: Determination of the Length-of-Need for Guardrail Without Anchorage: Phase 1
3. T4541-EQ: 2022 Program Development and MASH Coordination Effort
4. T4541-ER: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
5. T4541-ES: MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete Bridge Barrier
6. T4541-ET: MASH Testing of a Guardrail System on 1H:1V Slope
7. T4541-EV: MASH Crashworthy Pedestrian and Small Traffic Signals
8. T4541-EW: 2022 Administrative Support

9. T4541-EX: Buried-in-Backslope Terminal Variations in Foreslope, Backslope, and Ditch Configurations
10. T4541-EO: Washington State I-90 Snoqualmie Pass Barrier Gap Design, Drafting, and Detailing

Ongoing Projects

1. T4541-CV: Testing and Evaluation of the MGS System with Maximum Flare at MASH Test
2. T4541-CW: Testing of Midwest Guardrail Systems with Reduced Post Spacing for MASH Compliance
3. T4541-CZ: Thrie/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
4. T4541-DB: Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
5. T4541-DG: MASH TL-4 Investigation and Testing of the Critical Flare Rate for Cast-in-Place Single Slope 42" Concrete barrier Flaring Around a Fixed Object
6. T4541-DJ: Testing and Evaluation of Large Signs Slipbase Support on Slope at MASH TL-3 Impact Conditions
7. T4541-DL: A Study of Guardrail Placement on 6:1 Slope
8. T4541-DN: MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top
9. T4541-DO: Shorter TL-3 MASH W-Beam Transition
10. T4541-DQ: 2019 MASH Coordination Effort
11. T4541-DV: Study of Acceptable Sidewalk Heights and Widths
12. T4541-DW: Design and Testing of a Thrie-Beam Guardrail System at a Fixed Object
13. T4541-DX: Design and Testing of a MASH TL-3 Thrie-Beam System for Roadside and Median Applications
14. T4541-DY: MASH TL-3 Transition Design with a Storm Drain Inlet
15. T4541-DZ: Determination of the Length-of-Need for Guardrail without Anchorage: Phase 2
16. T4541-EA: Development of a Thrie-Beam Retrofit for Upgrading Obsolete Bridge Railings
17. T4541-EI: Crashworthy Enhanced Highway Sign Assemblies
18. T4541-EJ: Design and Evaluation of a MASH TL-2 Compliant Permanent Concrete Low Profile Barrier
19. T4541-EN: Development of a MASH TL-3 Compliant Portable Concrete Barrier System
20. T4541-EO: Washington State I-90 Snoqualmie Pass Barrier Gap Design, Drafting, and Detailing
21. T4541-EP: Evaluation of Long-Span W-Beam Guardrail in Front of Fall-Protection Rail on Concrete Culverts
22. T4541-EB: 2021 Administrative Support
23. T4541-EC: Develop Non-Proprietary MASH-Compliant Three-Pound and Four-Pound Post Systems
24. T4541-ED: Develop Guidelines for Attaching MASH-Compliant Thrie-Beam Transitions to Rigid Concrete Barriers Other than the Rigid Barrier Tested when Evaluating the Thrie-Beam Transition
25. T4541-EE: Exploration into Variations in Beam Guard Approach Transitions to Rigid Barrier
26. T4541-EG: 2021 Program Development and MASH Coordination Effort
27. T4541-EK: Transition Between Guardrail and Tangent Anchored Portable Concrete Barriers
28. T4541-EL: Testing Type III Barricades with Aluminum Panels and Mounted Signs
29. T4541-EM: Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports: Phase I

Approved Projects

1. T4541-EH: MASH TL-4 Crash Testing of Bicycle Railing on Constant Slope Parapet

Continue work on ongoing projects identified under Fiscal Year 2021 accomplishments and begin working on the approved projects identified under Fiscal Year 2022.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The current pooed fund group is nearing its end and expected to officially end on 12/31/23. Amount of Remaining Excess Funds for the TPF 5(343) MASH Pooled Fund Program is $713,000. All ongoing and approved projects must be completed by December 2023. The FY 2022 prioritized project list is as follows:

FFY2022 TPF 5(343) Prioritized Project List

Rank	ID	Title	Cost	Notes
1	2021-04-BR	MASH 4-12 Evaluation of a Fence Mounted System for Attachments to Concrete Bridge Barrier	$175,000	Previously Funded
2	2021-06-LSRB	MASH TL-3 Transition Design with a Storm Drain Inlet (continuation)	$94,000	Previously Funded
3	2020-02-BD	Multi-Directional Base Design for Steel Beam Non-Proprietary Large Sign Supports – Phase II	$262,000	Previously Funded
4	2021-02-LSRB	Crash Testing a Guardrail on 1-To-1 Slope	$173,000	Previously Funded
5	2021-01-BD	Crashworthy Pedestrian and Small Traffic Signals	$215,000	Previously Funded
6	2021-04-WZ	Portable Sign Supports for Aluminum Signs with Variation on Mounting Height	$210,000	Funded with Excess Funds Project Duration: 14-Months Lead Tech Reps: Shawn Debenham (UT), Justin Wilstead (UT) Lead Researcher: Jim Kovar (TTI)
7	2021-02-BD	Evaluation of Four Bolt Slip Base for Breakaway Luminaire Supports for Various Pole Configurations	$220,000	Funded with Excess Funds Project Duration: 14-Months Lead Tech Reps: Shawn Debenham (UT),Justin Wilstead (UT),Brian Crossley (PA), Michelle Moser (MN) Lead Researcher: Jim Kovar (TTI)
8	2020-04-LCB	MASH TL-3 Compliance for Median Guide Rail Transition to F-Shape Barrier	$175,000	Funded with Excess Funds Project Duration: 12-Months (work plan modified by reducing number of barrier configurations evaluated by computer sim.) Lead Tech Rep: Evan Pursel (PA) Lead Researcher: Nathan Schulz (TTI)
~~9~~	~~2021-04-LCB~~	~~MASH TL-3 Evaluation of Flared Portable Concrete Barrier Installations for Work Zones Deployments~~	~~$189,000~~	Not Funded with Excess Funds Similar Project has been funded through TXDOT program
~~10~~	~~2021-04-LSRB~~	~~MASH TL-3 Testing of a Short Radius Design with TL-3 Primary Road and TL-2 Secondary Road~~	~~$200,000~~	Not Funded with Excess Funds Cost too high – costs of funding projects 6, 7, 8, 10 is $805,000 ($920K more than $713K)
11	2021-07-LSRB (Cont)	MASH TL-3 Evaluation of Shorter Thrie Beam Approach Transition (Continutation)	$130,000	Funded with Excess Funds Project Duration: 12-Months Lead/Tech Rep: Was Joe Hall (WV). Maybe Donna Hardy (WV)? Lead Researcher: Maysam Kiani

The spending package selected FFY22 prioritized projects 6, 7, 8, and 11 totaling $735K which is $22K more than excess funds. TTI/WSDOT will monitor funding throughout the year and can adjust scope of projects if needed. However, other projects often close under budget which can make up difference.

A new pooled fund is expected to begin once the current pooled fund ends on 12/31/23. The new pooled fund group will be TPF-5(501), Roadside Safety Pooled Fund – Phase 3. The proposed charter for the new pooled fund was reviewed and put to a vote at the 2022 Pooled Fund annual meeting. The majority voted in favor of the proposed charter. It is expected that MDOT will join TPF-5(501), Roadside Safety Pooled Fund – Phase 3.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The contract end date for this transportation pooled fund was extended until December 31, 2023. This was approved by FHWA. It is anticipated that MDOT will continue participation in this transportation pooled fund until the 12/31/23 contract end date. Also, it is anticipated that MDOT will contribute $50,000 in FY2022 and $50,000 in FY 2023 to continue its participation in this pooled fund.

On 9/23/21, MDOT RAC Chair Brad Wieferich approved moving forward with continued MDOT participation in this pooled and the financial contributions for FY2022 and FY2023.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Reports published by the Texas A&M University Transportation Institute (TTI) as part of the Roadside Safety Pooled Fund will be reviewed by MDOT's Barrier Advisory Committee (BAC). Reports will be reviewed individually by BAC, prioritized based on relevance of topics contained in each report based on MDOT's roadside safety needs.

BAC will then propose recommendations, as deemed appropriate, concerning the results and recommendations from these reports. BAC recommendations involving the development of new MDOT guidelines, standards, etc. or modifications to existing MDOT guidelines, standards, etc. may need to be submitted to others within MDOT (e.g., MDOT's Engineering Operations Committee (EOC)) for further consideration and approval before implementation. These decisions will be evaluated on a case-by-case basis.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Development of Maintenance Decision Support System

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(347)		MDOT START DATE	10/01/2016
PROJECT NO.			MDOT COMPLETION DATE (Original)	09/30/2022
OR NO.	OR14-034		COMPLETION DATE (Revised)*	9/30/2023
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 RoathJ1@michigan.gov			
LEAD AGENCY:	South Dakota Department of Transportation			
PROJECT MANAGER	David Huft, 605-773-3358 Dave.huft@state.sd.us			
CONTRACTOR	Iteris, Inc.			

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$30,000.00		TOTAL COST	(Original)	$125,000.00
	(Revised)			FY 2021 *	(Revised)	$170,000.00
TOTAL FY 2022 EXPENDITURES		$30,000.00		**Total Committed Funds Available***		$0.00

PARTICIPATING STATES

CA, CO, CT, IN, KY, MD, MI, MN, ND, NE, PA, SD, VA, and WI. Total commitment level: $2,105,149.00 MDOT Pledge Commitment FYs 2017-2022.

PURPOSE AND SCOPE

Develop a Maintenance Decision Support System (MDSS) winter maintenance operations forecasting tool (computer web-based) that helps reduce winter maintenance costs, increases level of service based on recommendations, and helps provide a reduction in damage to infrastructure and the environment. Under TPF-5(054) pilot the MDSS winter maintenance forecasting tool in the Southwest Region during the 2012 & 2013 winter seasons. Implement the forecasting tool statewide beginning in the 2014 winter season for use in seasons to come. Implementation deployment and enhancements continue under new TPF-5(347).

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed tasks:

- Incorporated MDSS Graphic User Interface (GUI) functionality into WebMDSS.
- Refined and evaluated the capability and performance of MDSS software components, including surface condition prediction models and MDSS GUI.
- Recommend, developed, and evaluated methods for enhancing highway agencies' management through interfaces between MDSS and other management systems.
- Provided weather forecast support, MDSS configuration support, live MDSS operations, and necessary training for continuing limited deployment field trials.
- Prepared a final report summarizing methodology, findings in performance, conclusions, and recommendations.
- Made an executive presentation to the project's Technical Panel and provide electronic copies of the presentation material to participating states.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Completed tasks:

- Investigated ways to incorporate mobile road weather information system (RWIS) data into MDSS. Developed ways to display the data.
- Performed enhancements & adjustments to existing MDSS module.
- Continued efforts associated with Assessment of Recommendations (AoR) and reported out results to the project's Technical Panel.
- Designed & developed & released an updated mobile application for MDSS.
- Continued to fine tune the WebMDSS interface.
- Explored additional route configuration capabilities to MDSS that will enhance route recommendations.
- Improved understanding of traffic in MDSS.
- Prepared report summarizing research and made an executive presentation to the project's Technical Panel.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Completed tasks:

- New Version of WebMDSS, improved Data Display, added overlay options to maps, favoriting capabilities and new lists views
- Ended the MDSS GUI and transitioned every user over to WebMDSS
- Provided trainings on the new MDSS App and WebMDSS

- Created a new Dashboard feature to improve the sites user ability
- Continued efforts to improve Automatic Vehicle Location (AVL) integration. More agencies will be integrating AVL / Mobile Digital Computer (MDC) data.
- Continued to perform enhancements and adjustments to existing MDSS modules (on-going task).
- Continued MDSS Assessment of Recommendations (AoR) with the addition of AoR capabilities in WebMDSS.
- Assess Version 1 of mobile App. Add new features and fix user issues.
- Redesigned MDSS dashboard.
- Added any modules not yet complete from MDSS GUI into WebMDSS and address any user encountered bugs.
- Added additional routes to MDSS with the additional configurations. Receive more feedback from users on additional configurations.
- Completed two initial studies into traffic/MDSS relationships and identify potential next steps.
- Wrapped up documentation for MDSS-to-Automatic Terminal Information Service (ATIS) data feed.
- Made updates to the MDSS documentation based on activities during Phase 10.
- Prepared report summarizing research and make executive presentation to the project's Technical Panel.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Completed tasks:

- Continued design and development of web-based version of MDSS
- Performed enhancements and adjustments to existing MDSS module
- Developed a method to Collect and Provide Detailed Usage Statistics
- Continued design and development of a Mobile Friendly MDSS Application
- Developed a Route Configuration Optimization Process
- Assessed recommendations based on user feedback in real-time with post-recommendation analysis to improve MDSS modeling
- Conducted an analysis of traffic information within the MDSS modules and the impact of traffic on the MDSS recommendations

FISCAL YEAR 2021 ACCOMPLISHMENTS

Primary research areas selected by the technical panel for Phase XII of the project work plan are:

- Understand how MDSS can better support the use of Tow Plows, which are becoming more prevalent in member state winter operations (Task 14.5)
- Perform enhancements and adjustments to existing MDSS modules (Task 15.10)
- Assess recommendations based on user feedback in real-time with post-recommendation analysis to improve MDSS modeling. (15.13)
- Continue design and develop a mobile friendly MDSS application (15.18)
- Continue design and development of a web-based version of MDSS (Task 15.20)
- Integrate mobile RWIS data into MDSS (Task 15.23)
- Analyze the use of Level of Service in DOT operations and understand how this functionality can be improved within MDSS (Task 15.26)
- Develop MDSS screens to facilitate objective analysis of user acceptance or rejection of recommendations to understand the MDSS factors affecting each situation (Task 15.27)
- Integration of ESS friction into MDSS model (Task 15.28) – Year 2
- Improved forecast verification tools (Task 15.29) – Year 2

FISCAL YEAR 2022 ACCOMPLISHMENTS

Primary research areas selected by the technical panel for Phase XII of the project work plan are:

- Understand how MDSS can better support the use of Tow Plows, which are becoming more prevalent in member state winter operations (Task 14.5)
- Task 14.2: In-Vehicle MDSS Update
- Perform enhancements and adjustments to existing MDSS modules (Task 15.10)
- Assess recommendations based on user feedback in real-time with post-recommendation analysis to improve MDSS modeling. (15.13)
- Continue design and develop a mobile friendly MDSS application (15.18)
- Continue design and development of a web-based version of MDSS (Task 15.20)
- Integrate mobile RWIS data into MDSS (Task 15.23)
- Task 15.24 Develop a Method to Collect and Provide detailed use statistics
- Analyze the use of Level of Service in DOT operations and understand how this functionality can be improved within MDSS (Task 15.26)
- Develop MDSS screens to facilitate objective analysis of user acceptance or rejection of recommendations to understand the MDSS factors affecting each situation (Task 15.27) Including Task 15.29 Improved Forecast Verification Tools
- Integration of ESS friction into MDSS model (Task 15.28) – Year 3
- Improved forecast verification tools (Task 15.29) – Year 3

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The Michigan Department of Transportation's (MDOT's) original funding commitment was allocated over FYs 2012, 2013, and 2015-2017 under TPF-5(054). However, the lead agency requested all partner states to transfer future funds beyond FY 2016 to TPF-5(347), which is a new continuation study with an effective start in FY 2017.

TAC members assess future research needs on an annual basis. New projects identified/approved are incorporated in the annual work plan, which may extend the overall study an additional year. The new TPF-5(347) pooled fund study's duration must not exceed five years (FYs 2017- 2021). As such, MDOT has posted its FY 2021 pledge amount to the TPF website, [which includes the additional $5,000 in contributions for FYs 2019- 2021.

This TPF project has been extended and MDOT will continue as a state partner until all project deliverables are completed. The solicitation 1562 fiscal year 2022 pledge commitment was transferred to TPF-5(347) in 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Discussions of potential change in Intellectual Property Agreement between DTN/MDSS/Pooled Fund Study has been brought up by DTN. Depending on the changes that occur, this could impact the participation of MDOT and other States.

1. MDOT implemented AVL and MDSS at its maintenance facilities in 2013. Continued involvement with the MDSS pooled fund gives MDOT additional opportunity to advance and improve MDSS services to our users.
2. The success of the pooled fund study is a direct result of strong collaboration between the participating states and the contractor. MDSS continues to grow and evolve, new interfaces and functionality are being added that will increase the benefits of the system.

   Continued participation in this pooled fund will enable MDOT to have:
   - Winter weather information from a single, user-friendly source (website & mobile application).
   - Improved anticipation of storm events and road conditions.
   - More consistent winter maintenance by all maintenance units.
   - Reduced environmental exposure to deicing chemicals.
   - Powerful reporting and analytical tools for managers.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Self De-Icing LED Signals

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(351)		MDOT START DATE	3/25/2016
PROJECT NO.			MDOT COMPLETION DATE (Original)	8/14/2019
OR NO.	OR15-530		COMPLETION DATE (Prev. Est.)	06/30/2022
MDOT TECHNICAL CONTACT	Erik Smalley, 517-636-6108 SmalleyE@michigan.gov			
LEAD AGENCY:	Kansas DOT			
PROJECT MANAGER	**David Behzadpour,** 785-291-3847 David.Behzadpour@ks.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$60,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

Seven (7) Participating Agencies:

CA, KS, MD, MI, NJ, PA, and WI. Total Commitment Level: $360,000.00 MDOT Pledge Commitment FY's: 2016-2018

PURPOSE AND SCOPE

This proposed research project will develop and test different types of prototype self- deicing Light-Emitting Diode (LED) signals over a project period of three years. Project objectives are to develop multiple prototypes of a new type of self-deicing LED signals for highway signalized intersections and railroad signaling applications and validate them using field tests.

FISCAL YEAR 2016 ACCOMPLISHMENTS

The Technical Advisory Committee (TAC) members approved the project scope. Devices were constructed for use during the 2016/2017 winter. Deliverables that might benefit MDOT if implemented include LED lens devices that will de-ice automatically when necessary and improve safety.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Developed 3 prototype signals and began testing.

This project was launched in Aug 2016 with six participating states (Kansas, California, Michigan, New Jersey, Wisconsin and Pennsylvania) and an initial budget of $240,000. Maryland is expected to officially join the study by the end of this year with additional contribution of three years funding.

An expert panel meeting was held in early March. Discussions were held on desired specifications of the prototype signals and possible field tests sites as well as the field evaluation of the prototypes.

Necessary equipment, components and insulation materials are being procured to develop and build the fully working prototypes of the finalized design and test for their thermal and lighting performance. We will continue to order LED drivers, electricity monitors, waterproof security video cameras, other mounting accessories and materials, etc. for monitoring the performance of the prototypes in the field tests in the upcoming winter season.

Appropriate color LED modules, which are not available in the market, were designed in-house and custom-made with the aid of the industrial partner.

Three preliminary prototype signals (Red, Yellow, and Green) of Type 1 have been developed in-house, each deploying 26 custom-made colors LEDs mounted in an array vis "Heat Arrangement of LED Arrays in Low Profile". They are under laboratory testing for improvements.

Tested the lighting and thermal performance of the preliminary prototypes of the Type 1 signal lights. Based on the result, new design with a lot of changes and improvements has been finalized for final products.

Finalized the design of Type 1 self-de-icing LED signals using 96 custom-made mediate-power color LED mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". Designed in- house and custom-made our own color LED modules (for each color R, G, Y) for making the fully working prototype signals for the first type with the aid of our industrial partner.

Worked with the factories to optimize the mounting method of the custom-made LED modules on the 3-5 mm thick aluminum MPCB back plate serving as the passive heat exchange if aluminum alloy for assembly.

Custom-made three prototypes of the LED signals of Type 1 using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile", with regular paint coating, and finished laboratory for improvements and optimizations to finalize the design.

Improved and custom-made three new signal light engines using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile" but with TIN coating and tested them to improve the heating performance (to make faster heat transfer).

Finalized the design of the signal lens that adopts a whole piece design with smooth and flat outside surface and integrated with 96 additional custom-made Fresnel lenses sitting inside the signal lens over each MED on the inside surface to focus the light serving as a collimator lens. Based on the testing results, the signal light engines with TIN coating may have superior thermal performance, however, further testing in the laboratory and filed is necessary to validate the final choice.

Identified and started custom-making the Fresnel Lens from HongXuan Optoelectronic with diameter 15 mm and focal length 6 mm.

Developed the new whole-piece signal housing, new Fresnel lenses, LED drivers, and other accessories for the Type 1 self-de-icing LED signal lights, with the aid of the industrial partner.

Found and selected a qualified plastic molding company to custom make the three parts of the plastic housing of fully working prototypes of Type 1 signals that deploy 96 mediate-power LEDs vis the architecture of "Heat Arrangement of LED Arrays in Low Profile". The new housing will be used for the new LED signal lights.

Started custom-making and modeling of the signal housing, which takes time to complete.

Started custom-making the LED drivers with desired specifications based on our test results.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Develop and make whole piece housings, test prototypes in closed settings; stage 2 to begin.

This project was launched in Aug 2016 with six participating states (Kansas, California, Michigan, New Jersey, Wisconsin, and Pennsylvania) and an initial budget of $240,000. Maryland is expected to officially join the study by the end of this year with additional contribution of three years funding.

An expert panel meeting was held in early March. Discussions were held on desired specifications of the prototype signals and possible field test sites as well as the field evaluation of the prototypes.

Necessary equipment, components and insulation materials are being procured to develop and build the fully working prototypes of the finalized design and test for their thermal and lighting performance. We will continue to order LED drivers, electricity monitors, waterproof security video cameras, other mounting accessories and materials, etc., for monitoring the performance of the prototypes in the field tests in the upcoming winter season.

Appropriate color LED modules, which are not available in the market, were designed in-house and custom-made with the aid of the industrial partner.

Three preliminary prototype signals (Red, Yellow, and Green) of Type 1 have been developed in house, each deploying 26 custom-made color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". They are under laboratory testing for improvements.

Tested the lighting and thermal performance of the preliminary prototypes of the Type 1 signal lights (Figure 1). Based on the test results, new design with a lot of changes and improvements has been finalized for final products.
Finalized the design of Type 1 self-de-icing LED signals using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". Designed in house and custom-made our own color LED modules (for each color R, G, Y) for making the fully working prototype signals of the first type with the aid of our industrial partner.

Worked with the factories to optimize the mounting method of the custom-made LED modules on the 3-5 mm thick aluminum MPCB back plate serving as the passive heat exchangers of aluminum alloy for assembly.

Custom-made three prototypes of the LED signals of Type 1 using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile", with regular paint coating, and finished laboratory testing for improvements and optimizations to finalize the design.

Improved and custom-made three new signal light engines using 96 medium-power LEDs (0.25 Watt each) mounted in an array via "Heat Arrangement of LED Arrays in Low Profile" but with Tin coating (Figure 3) and tested them to improve the heating performance (to make faster heat transfer).

Finalized the design of the signal lens that adopts a whole piece design with smooth and flat outside surface and integrated with 96 additional custom-made Fresnel lenses sitting inside the signal lens over each LED on the inside surface to focus the light serving as a collimator lens. Based on the testing results, the signal light engines with TIN coating may have superior thermal performance, however, further testing in the laboratory and field is necessary to validate the final choice.

Identified and started custom-making the Fresnel Lens from HongXuan Optoelectronic company with diameter 15 mm and focal length 6 mm (model # HX-F015006).

Developed the new whole-piece signal housing, new Fresnel lenses, LED drivers, and other accessories for the Type 1 self-de-icing LED signal lights, with the aid of the industrial partner.

Found and selected a qualified plastic molding company to custom make the three parts of the plastic housing of fully working prototypes of Type 1 signals that deploy 96 mediate-power LEDs via the architecture of “Heat Arrangement of LED Arrays in Low Profile”. The new housing will be used for the new LED signal lights.

The non-provisional patent application for the invention of Type 2 self-de-icing signal light was officially approved by the USPTO and issued on Dec 26, 2017, patent No. US 9,851,086 B2.

Started custom-making and modeling of the signal housing. Three samples were delivered for examinations and laboratory tests for necessary calibrations and further improvements.

Started custom-making the LED drivers with desired specifications based on our test results. Seven LED drivers were delivered for sample testing.

The custom-made signal housing is ready for production of products with possible minor adjustments for field tests in different states. Six improved samples have been delivered and thoroughly tested in laboratory and closed-setting tests on the roof.

New type of screws for uses in the signal housing are self-designed and will be custom-made with Fastenal company.

A company is custom making two improved and finalized types of LED driver, one for YELLOW and GREEN signal lights (output 0.8 A, maximum 30 Watts), the other for RED signal light (output 1.1 A, maximum 30 Watts). The new LED drivers have temperature Sensor control, when the temperature is above 4 degrees Celsius, the LED driver output will be derated (For Yellow + Green LED lights, output current 0.5 A, approximately 17- 18 Watts; For Red LED light, output current min 0.6 A, approximately 15-16 Watts.) When the temperature sensor is turned off or failed for any reasons, the power output will be restored to 100% as default.

The self-deicing signal lights have higher light output than the codes and standards required in all viewing angles from 0 deg to 70 deg as measured, even at the derated power output.

We have been conducting a closed-course performance and reliability tests of the fully working prototypes mounted on the roof of the University of Kansas engineering complex - M2SEC building, in preparation for field tests.

Seven states have officially participated in this project, including Kansas, California, Michigan, New Jersey, Wisconsin, Pennsylvania, and Maryland to provide support.

A project addendum is proposed to conduct two additional field tests, one in Wisconsin and another one in a test site among Maryland, Pennsylvania, and New Jersey. A budget of $80,000 for the addendum is proposed to be spent starting on 5/18/2018 until the end of the project.

We have been continuously testing the closed-course performance and reliability of the prototypes previously mounted on the roof of M2SEC building (Figure 1). All signal lights were powered by the signal controller cabinet with real signaling time cycles (in a cycle length of 90 seconds, Red signal light ON for 50 seconds, Green signal light ON for 35 seconds, and Yellow signal light ON for five seconds. The temperature data were recorded every 10 seconds continuously over the entire test period, which will be continuously conducted over both winter and summer seasons in 2019.

We have designed and custom-made new types of screws (Figure 3, the bottom pictures) to improve the connection strength of the screws integrated with the plastic housing. These screws are finalized products to be used in all finalized plastic housing.

We have designed and custom made two types of LED drivers, as shown in Figure 4, including one type of custom-made LED driver for red signal light (input: 100-240 VAC, output: 0.6-1.1 A, max 30 W), and a second type custom made LED driver for green/yellow signal light (input: 100-240 VAC, output: 0.5-0.8 A, max 30 W). Both types of LED drivers are now integrated with a remote temperature sensor (see Figure 4) for controlling the power output considering the ambient air temperature. An on/off switch is designed for temperature controls in winter and summer modes which could override the operation of the temperature sensor.

We have accordingly improved and finalized the plastic housing of the fully working prototype signals of Type 1 with changes/improvements listed below, with assist of the plastic molding company Eco Molding. Eco Molding company has custom made seven samples (Figure 5) of the finalized new plastic housing for validations tests before actual product production.

We have produced 60 pcs of the finalized LED engines with the aid of the industrial partner (Figure 6a), ready for the upcoming field tests.

We have also updated and custom made 60 pcs of glass disc (Figure 6b) which have four small mounting holes removed on the edge (the original glass disc had 8 mounting holes).

We also custom-made plastic mounting bars (Figure 6b) for mounting the glass disc to the LED light engine.

We are working on getting improvement on custom-made Fresnal lens model number HX-F0150115 (diameter 15 mm, thickness 2.0 mm, focal length 11.5 mm) to increase tolerance of the thickness (approximately 1.8 – 2.1 mm) while reducing the unit cost.

FISCAL YEAR 2019 ACCOMPLISHMENTS

As of June 30, 2019, we have achieved the following significant results.

This project was launched in Aug 2016 with six participating states (Kansas, California, Michigan, New Jersey, Wisconsin, and Pennsylvania) and an initial budget of $240,000. Maryland is expected to officially join the study by the end of this year with additional contribution of three years funding.

An expert panel meeting was held in early March. Discussions were held on desired specifications of the prototype signals and possible field test sites as well as the field evaluation of the prototypes. Necessary equipment, components and insulation materials are being procured to develop and build the fully working prototypes of the finalized design and test for their thermal and lighting performance. We will continue to order LED drivers, electricity monitors, waterproof security video cameras, other mounting accessories and materials, etc., for monitoring the performance of the prototypes in the field tests in the upcoming winter season.

Appropriate color LED modules, which are not available in the market, were designed in-house and custom-made with the aid of the industrial partner.

Three preliminary prototype signals (Red, Yellow, and Green) of Type 1 have been developed in house, each deploying 26 custom-made color LEDs mounted in an array via “Heat Arrangement of LED Arrays in Low Profile”. They are under laboratory testing for improvements.

Tested the lighting and thermal performance of the preliminary prototypes of the Type 1 signal lights (Figure 1). Based on the test results, new design with a lot of changes and improvements has been finalized for final products.

Finalized the design of Type 1 self-de-icing LED signals using 96 custom-made mediate-power color LEDs mounted in an array via “Heat Arrangement of LED Arrays in Low Profile”. Designed in house and custom-made our own color LED modules (for each color R, G, Y) for making the fully working prototype signals of the first type with the aid of our industrial partner.

Worked with the factories to optimize the mounting method of the custom-made LED modules on the 3-5 mm thick aluminum MPCB back plate serving as the passive heat exchangers of aluminum alloy for assembly.

Custom-made three prototypes of the LED signals of Type 1 using 96 custom-made mediate-power color LEDs mounted in an array via “Heat Arrangement of LED Arrays in Low Profile”, with regular paint coating, and finished laboratory testing for improvements and optimizations to finalize the design.

Improved and custom-made three new signal light engines using 96 medium-power LEDs (0.25 Watt each) mounted in an array via “Heat Arrangement of LED Arrays in Low Profile” but with Tin coating (Figure 3) and tested them to improve the heating performance (to make faster heat transfer).

Finalized the design of the signal lens that adopts a whole piece design with smooth and flat outside surface and integrated with 96 additional custom-made Fresnel lenses sitting inside the signal lens over each LED on the inside surface to focus the light serving as a collimator lens. Based on the testing results, the signal light engines with TIN coating may have superior thermal performance, however, further testing in the laboratory and field is necessary to validate the final choice.

Identified and started custom-making the Fresnel Lens from HongXuan Optoelectronic company with diameter 15 mm and focal length 6 mm (model # HX-F015006).

Developed the new whole-piece signal housing, new Fresnel lenses, LED drivers, and other accessories for the Type 1 self-de-icing LED signal lights, with the aid of the industrial partner.

Found and selected a qualified plastic molding company to custom make the three parts of the plastic housing of fully working prototypes of Type 1 signals that deploy 96 mediate-power LEDs via the architecture of “Heat Arrangement of LED Arrays in Low Profile”. The new housing will be used for the new LED signal lights.

The non-provisional patent application for the invention of Type 2 self-de-icing signal light was officially approved by the USPTO and issued on Dec 26, 2017, patent No. US 9,851,086 B2.

Started custom-making and modeling of the signal housing. Three samples were delivered for examinations and laboratory tests for necessary calibrations and further improvements.

Started custom-making the LED drivers with desired specifications based on our test results. Seven LED drivers were delivered for sample testing.

The custom-made signal housing is ready for production of products with possible minor adjustments for field tests in different states. Six improved samples have been delivered and thoroughly tested in laboratory and closed-setting tests on the roof.

New type of screws for uses in the signal housing are self-designed and will be custom-made with Fastenal company.

A company is custom making two improved and finalized types of LED driver, one for YELLOW and GREEN signal lights (output 0.8 A, maximum 30 Watts), the other for RED signal light (output 1.1 A, maximum 30 Watts). The new LED drivers have temperature Sensor control, when the temperature is above 4 degree Celsius, the LED driver output will be derated (For Yellow + Green LED lights, output current 0.5 A, approximately 17- 18 Watts; For Red LED light, output current min 0.6 A, approximately 15-16 Watts.) When the temperature sensor is turned off or failed for any reasons, the power output will be restored to 100% as default.

The self-deicing signal lights have higher light output than the codes and standards required in all viewing angles from 0 deg to 70 deg as measured, even at the derated power output.

We have been conducting a closed-course performance and reliability tests of the fully working prototypes mounted on the roof of the University of Kansas engineering complex - M2SEC building, in preparation for field tests.

Seven states have officially participated in this project, including Kansas, California, Michigan, New Jersey, Wisconsin, Pennsylvania, and Maryland to provide support.

A project addendum is proposed to conduct two additional field tests, one in Wisconsin and another one in a test site among Maryland, Pennsylvania, and New Jersey. A budget of $80,000 for the addendum is proposed to be spent starting on 5/18/2018 until the end of the project.

We have been continuously testing the closed-course performance and reliability of the prototypes previously mounted on the roof of M2SEC building. All signal lights were powered by the signal controller cabinet with real signaling time cycles (in a cycle length of 90 seconds, Red signal light ON for 50 seconds, Green signal light ON for 35 seconds, and Yellow signal light ON for 5 seconds. The temperature data were recorded every 10 seconds continuously over the entire test period, which will be continuously conducted over both winter and summer seasons in 2019.

We have designed and custom-made new types of screws to improve the connection strength of the screws integrated with the plastic housing. These screws are finalized products to be used in all finalized plastic housing.

We have designed and custom made two types of LED drivers, including one type of custom-made LED driver for red signal light (input: 100-240 VAC, output: 0.6-1.1 A, max 30 W), and a second type custom made LED driver for green/yellow signal light (input: 100-240 VAC, output: 0.5-0.8 A, max 30 W). Both types of LED drivers are now integrated with a remote temperature sensor for controlling the power output considering the ambient air temperature. An on/off switch is designed for temperature controls in winter and summer modes which could override the operation of the temperature sensor.

We have accordingly improved and finalized the plastic housing of the fully working prototype signals of Type 1 with changes/improvements listed below, with assist of the plastic molding company Eco Molding. Eco Molding company has custom made seven samples of the finalized new plastic housing for validations tests before actual product production.

We have produced 60 pcs of the finalized LED engines with the aid of the industrial partner, ready for the upcoming field tests.

We have also updated and custom made 60 pcs of glass disc which have four small mounting holes removed on the edge (the original glass disc had 8 mounting holes).

We also custom-made plastic mounting bars for mounting the glass disc to the LED light engine.

We are working on getting improvement on custom-made Fresnal lens model number HX-F0150115 (diameter 15 mm, thickness 2.0 mm, focal length 11.5 mm) to increase tolerance of the thickness (approximately 1.8 – 2.1 mm) while reducing the unit cost.

We are in preparation for field tests. Three fully functional prototypes of the fourth generation were mounted on a signal pole on the roof of an engineering building, powered by a traffic control cabinet for closed-course performance and reliability tests.

Three more fully functional prototypes of the fourth generation were also tested in a well-controlled cold room for the performance of the ambient temperature sensor connected to the LED driver for switching full/derated power output. Based on the test results, we are adjusting the power output of the LED drivers. We are also making minor adjustments of the signal housing for quick assembly of the real products. Results have been used to evaluate the readiness of the prototypes for field tests starting in next quarter.

Corrected some problems and resolved issues of the custom-made LED drivers, including (1) decreased the size of the power connector of the temperature sensor, (2) decreased the length to 6 mm, (3) changed to more reliable single switch, (4) enlarged the inside size of the installation hole to 6mm x 4.5 mm, (5) changed the final designed output current of Yellow/Green LED drivers to 0.40 A (derated) /0.84 A(full output), (6) changed the final designed output current of Red LED drivers to 0.60 A (derated) /1.1 A(full output), (7) improvements on temperature measurement accuracy, redesigned logic circuits, and changes of electronic parts used on the LED PCB boards.

The signal housing of the fourth generation LED signal lights was revised for quick assembly. We have received the new prototypes of the housing with desired changes, which were tested in the laboratory with satisfactory performance.

Other parts like glass mounting discs have also been improved in house for enlarging the installation holes to fit the new housing.

Additional vendors for Fresnel lenses were contacted for lower unit price with higher quality control than the current lens vendor. Based on the lab test results, a total of 5000 PCS of new Fresnel lenses (Model #1511) were ordered from the new vendor for field tests.

Based on the lab test results on the second generation of LED drivers, a total of 21 pcs of the third generation of LED drivers were ordered for lab tests, in preparation for the field tests.

Monitoring cameras – Raspberry 3 B+ motherboard and accessories – have been designed and are currently being custom built in house, which will be mounted at each field test site for year-around real-time monitoring and data recording of the new signals to be tested in the field.

A new proposal was approved on extended work with increased total project cost of $360K and new end date of June 30, 2021.

FISCAL YEAR 2020 ACCOMPLISHMENTS

We have been continuously preparing new fully functional prototypes of the signal lights for field tests in other states (California, Michigan, New Jersey, Wisconsin, Pennsylvania, and Maryland), as well as conducting necessary updates on the equipment installed in the first field in Kansas.

First, we have been continuously working with the plastic molding company to solve the problem of the concaved lens surface of the signal housing came out of the production line to meet with future assembling requirements.

Second, we have been talking with the Fresnel lens company to modify the design and form factor of the currently adopted 96 individual lenses mounted in the housing to a whole piece of disc embedded with a total of 96 Fresnel lenses on it, as an alternative solution to the problem of the concaved housing lens surface in case the molding company cannot solve it.

Third, negotiation continues with the LED driver company for improving and producing the fourth-generation drivers compatible with UL certificate.

Fourth, the field monitoring system has added mobile communication information device with data plan to remotely send the data of the signal performance back to the laboratory on daily basis for real-time performance monitoring, which is under testing on the roof. Moreover, the ongoing roof test and the field test in Kansas have continuously recorded data over the past spring and summer sessions.

More details are listed as follows:

Firstly, to solve the defective signal light housing with concave lens surface made during the production process (problem: the concave lens surface made the assembly of the final signal light products difficulty, and could easily crack the inside glass disc used to support the 96 Fresnel lenses. The maximum tolerance of the error is 1.5-2 mm in depth.), we proposed to the factory the laboratory-based remedying method (Figure 1) developed for flattening the defective plastic housing produced with concaved lens surface using supplemental heat beneath the lens and added weight on the inside of the top surface.

Figure 1 A remedying method in the laboratory for flattening the concaved lens surface, using supplemental heat beneath the lens and added weight on the top inside surface, a thermal lamp was installed inside a box below the glass on which the lens sits, the lens surface was monitored with four temperature sensors connected to a HOBO data logger.

However, this method was deemed too costly to be adopted in the production line for mass production. Rather, the factory has been revising the molding technique to solve the problem. After consulting many experts inside and outside of the molding industry, the molding company came out with a possible solution by increasing the runner size from 4 mm to 6 mm, to solve the problem. The factory has tried the new TPF Program Standard Quarterly Reporting Format- 7-2011

A new problem was found with the runner in the injection molding. The runner could not be released (Figure 2, the runner was sticking to cavity side) after they made the runner bigger, so the factory has been improving it by using a bigger machine for trial. As of today, we are still waiting for the bigger machine to be available. The mold is ready to make new trials which is still in progress.

Figure 2 The runner could not be released from the machine, sticking to cavity side, after the factory made the runner bigger from 4 mm to 6 mm

Secondly, we are considering changing the design and construction of the Fresnel lens, as an alternative solution to the defective signal light housing with concave lens surface made during the production, in case the molding company cannot totally solve that problem. We have been talking with the Fresnel lens company to modify the design and form factor of the currently adopted 96 individual lenses mounted in the housing to a whole piece of disc embedded with a total of 96 Fresnel lenses on it, as shown in Figure 3.

New design of the single lens disc with Example of similar product 96 Fresnel lenses embedded on it Figure 3 New design and form factor of the currently adopted 96 individual lenses mounted in the housing to a whole piece of disc embedded with a total of 96 Fresnel lenses on it

TPF Program Standard Quarterly Reporting Format- 7-2011

Based on the feedback from the Fresnel lens, the new design is doable of a whole piece of disc embedded with a total of 96 Fresnel lenses on it, yet new molding fee is incurred. We are still communicating with the factory about the costs and seeking quotes from other similar Fresnel lens companies.

Thirdly, we have been continuously negotiating with the LED driver company for improving and producing the fourth-generation drivers with desired solutions on the following two issues and for control of the yield rate in production. The key issues under communication include costs and compatibility with UL certificate of the fourth generation of LED drivers.

1) Light power-up delay (the time delay between power on and signal light on) for about 0.5-1 second, especially for green signal light. ---- Proposed Solution: adjustment of MCU chips used in the driver to decrease the delay to only mini-seconds.
2) Unstable output performance of the drivers, due to unsecured soldering of wire connections by hands. ---- Proposed Solution: new products will be made on the automatic production line instead of hand-making (all previous samples due to small quantity were made by hands, not by machines). The unreliable soldering connection will be resolved, all new products will be aged by the standard procedure before shipping. This can largely improve the quality and reliability of new drivers, increasing the yield rate in production.

Fourthly, we considered the existing field monitoring system for continuous data recording over time and storing data on USB drive is reliable but not convenient for remote monitoring of the signal performance and real-time data extraction. Because the data retrieval requires on site visitation by personnel and manually unplugging the USB drive and copying the data to a computer, therefore, it is impossible for us to know the field performance of signals without physically visiting the test sites in different states, which is deemed extremely inconvenient for us, and even impossible during the COV1D 19 pandemic. To solve this problem, we have added the existing field monitoring system with new mobile communication information device and monthly data plan to remotely send the data of the signal performance back to the laboratory on daily basis for real-time performance monitoring. The new system is under testing on the roof and working perfectly. Through the mobile data plan (2 GB/month), now we can freely access the computer and its stored data of the field monitoring system at each test site, in addition to the temperature data in text file format emailed to us automatically by the computer on daily basis.

Figure 4 illustrates the new real-time data retrieval from the computer of the monitoring system at test sites (on the roof top, as an example), which we can remotely extract from any computers in the lab, out of campus, or on travel. Figure 5 illustrates the temperature record emailed to us on daily basis.

Moreover, the ongoing roof test and the field test on south of Lawrence, Kansas have continuously recorded data over the past spring and summer sessions. However, due to the outbreak of coronavirus and the need to keep social distance, we did not contact the Lawrence signal crews to retrieve the data from the field test site, which will be done at a later time when the virus situation is controlled and safe to do so. We are planning to schedule a visitation to the field test site with the Lawrence signal crew in July or August to retrieve the data accumulated in the past 7 months, and also install the new mobile data equipment and plan for remote data monitoring and retrieval in the future.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Continue working with the housing manufacturer to solve the problem of concaved lens with new trials. A total of 100 new samples will be made with tolerable concave error of 1-2 mm in depth.
- Ask the driver manufacturer to improve the fourth generation of LED drivers, to solve those two problems and provide compatibility with LTL certificate.
- Schedule a visitation to the field test site in Kansas with the Lawrence signal crew to retrieve the data accumulated in the past 7 months, and also install the new mobile data equipment and plan for remote data monitoring and retrieval in the future.
- Communicate with other states (in addition to Kansas) to locate the other 5 field test sites and the detailed plan on field installations. Depending on the time when the coronavirus is contained, field installation will be resumed. Field installation might need to be postponed due to the outbreak of the coronavirus.

In the present quarter (April 1, 2021 – June 30, 2021) forty (40) samples of the improved second generation fresnel lens disc were tested with satisfactory thermal performance, but the lighting performance was not optimized due to increased focal length of 12.5-13.0 mm (> 11.5 mm). Then, with improvements on the mold injection technology in the factory, one sample of third generation fresnel lens disc was tested with shortened focal length of 11.9 mm, but still > 11.5 mm. Continuous revisions on the mold is being considered for making fourth generation fresnel lens disc with optimized focal length of 11.5 mm or less in mass production. Meanwhile, twenty (20) new samples of the third generation fresnel lens disc were produced and delivered for assembly of the fifth generation of the prototypes of the final product for field tests this summer.

Fifth generation prototypes and associated field remote monitoring systems have been fully prepared and tested for other field test sites to be conducted in Michigan, Wisconsin, Maryland, and New Jersey & Pennsylvania, which are participating in field testing and evaluation of the prototypes.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Proceed with an introduction to field test of the self-de-icing signal to be used by signal crews of different states, for test site selection and mounting the new self-de-icing signals and the corresponding data recording and remote monitoring system for the upcoming field test site use.

Continue to communicate with each participating state to select the field test sites, to install the 5th generation of prototypes deployed with the 3rd generation fresnel lens disc in test sites in Michigan, New Jersey, Wisconsin, Pennsylvania, and Maryland.

Complete the final report deliverable.

FISCAL YEAR 2023 ANTICIPATED ACTIVITIES

N/A

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The final report was completed May 2022.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Clear Roads Winter Highway Operations Pooled Fund (Phase II)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(353)		MDOT START DATE	10/1/2016
PROJECT NO.			MDOT COMPLETION DATE (Original)	12/30/2021
OR NO.	OR13-015		COMPLETION DATE (Revised)	6/30/2023
MDOT TECHNICAL CONTACT	Justin Droste, 517-636-0518 DrosteJ@michigan.gov			
LEAD AGENCY:	Minnesota Department of Transportation			
PROJECT MANAGER	Debbie Sinclair, 651-366-3746 debbie.sinclair@state.mn.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

AK, AZDOT, CA, CO, CT, DE, IADOT, ID, IL, IN, KS, MA, MDOT SHA, ME, MI, MN, MO, MT, ND, NE, NHDOT, NV, NY, OH, OR, PADOT, RI, SD, TX, UT, VA, VT, WA, WI, WV, WY. Total Partner Commitment Level: $4,075,000.00
MDOT Pledge Commitment FYs 2017-2021

PURPOSE AND SCOPE

This pooled fund project will maintain its focus on advancing winter highway operations nationally, but it will include a more pronounced emphasis on state agency needs, technology transfer, and implementation. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility. This pooled fund is needed to evaluate these new tools and practices in both lab and field settings, to develop industry standards and performance measures, to provide technology transfer and cost benefit analysis, and to support winter highway safety. This project responds to research and technology transfer needs not currently met by other pooled fund projects. Existing partners make every effort to coordinate with other agencies to avoid duplication of efforts and to encourage implementation of results.

Objectives of this ongoing pooled fund project will include:

- Conducting structured field testing and evaluation across a range of winter conditions and different highway maintenance organizational structures to assess the practical effectiveness, ease of use, optimum application rates, barriers to use, durability, safety, environmental impact and cost-effectiveness of innovative materials, equipment, and methods for improved winter highway maintenance.
- Establishing industry standards and developing performance measures for evaluating and utilizing new materials and technologies. • Supporting technology transfer by developing practical field guides and a training curriculum that will promote the results of research projects.
- Conducting cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiency.
- Supporting the exchange of information and ideas via peer exchanges and collaborative research efforts that provide opportunities for maintenance specialists to share experiences related to winter maintenance.
- Promoting public education and outreach related to winter maintenance and winter driving safety.
- Conducting state of the practice surveys to share best practices on current operational issues. (For example: Salt shortages, level of service requirements, or other hot button issues).
- Included in the Scope of work: Research reports, technical briefs, synthesis reports, field guides, specifications, PowerPoint presentations, video documentation, training materials, public safety messages, and software programs.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and several other projects commenced during the 2017 FY.

- 12-04 Snowplow Operator and Supervisor Training.
- 14-04 Plug and Play, Phase 2.
- 14-05 Snow Removal Performance Metrics – Phase I: Synthesis.
- 14-07 Snowplow Route Optimization.
- 15-03 North American Study on Contracting Snow and Ice Response.

Two of the five completed projects and their respective deliverables are described below.

2- 2017 Completed Projects/Respective Deliverables:

- 12-04 Snowplow Operator and Supervisor Training

- The key outcomes of the project are presentations, course guides, exams, and other training support materials for winter maintenance operations. MDOT can use the information to help train staff during winter operations schools, region trainings, and other training events.

14-04 Plug and Play, Phase 2

- Clear Roads has been leading a collaborative effort called the Plug-and-Play Initiative to develop a universal bi-directional
- communications protocol for in-cab electronics, regardless of the manufacturer or service provider. This project identified the most
- appropriate standard protocols and made recommendations regarding the method of transmission. MDOT will use this research to assist
- with the development of an RFP for our automated vehicle location and maintenance decision support system.

Five new research projects and five new synthesis projects were also authorized for solicitation.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects, two synthesis projects and several other projects commenced during the 2018 FY.

- 14-02: Quantifying the Impact That New Capital Projects Will Have on Roadway Snow and Ice Control Operations (November 2017)
- 15-02: Identification and Recommendations for Correction of Equipment Factors Causing Fatigue in Snowplow Operators (November 2017)
- 12-03: Understanding the Chemical and Mechanical Performance of Snow and Ice Control Agents on Porous or Permeable Pavements (January 2018)
- 16-04: Emergency Operations Methodology for Extreme Winter Storm Events (May 2018)
- 16-06: Training Video for the Implementation of Liquid-Only Plow Routes (June 2018)
- 16-S3: Maintenance Vehicle Conspicuity (February 2018)
- 17-S1: Accuracy of Deicer and Abrasive Material Application Equipment (September 2018)

Two of the five completed projects and their respective deliverables are described below.

12-03 Understanding the Chemical and Mechanical Performance of S&I Control Agents on Porous or Permeable Pavements

This project provided better information and guidelines to help determine the optimum maintenance strategies for porous or permeable asphalt pavements, including:

- Dense graded pavements.
- Open graded pavements.
- Ultrathin Friction Course.

14-02 Quantifying the Impact that New Capital Projects Will Have on Roadway Snow and Ice Control (RSIC) Operations

The project developed an automated method of quantifying the anticipated impact that new capital projects will have on costs for RSIC. This method could be used in the early stages of project development to determine if an agency will need additional resources, such as trucks, salt, fuel, and manpower, to accomplish winter maintenance tasks after the project is completed. This methodology could also be used by maintenance managers to justify requests for additional resources after projects are complete.

Eight new research projects were also authorized for solicitation. Clear Roads also elected to form a subcommittee to manage the Clear Roads QPL (formally known has Pacific Northwest Snow fighters QPL).

FISCAL YEAR 2019 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed six research projects and continued several other projects during the 2019 FY. These projects and their respective deliverables are described below.

13-05 Developing Test Bed Software to Qualify Plug and Play Technology

The goal of this project is to develop a software suite that will be used to validate and certify candidate spreader controllers and AVL equipment for compliance with the current Clear Roads Universal In-Cab Performance Specification and Communications Protocol.

14-03 Developing a Training Video and Manual for Best Practices and Techniques in Clearing Different Interchange Configurations and Other Geometric Layouts

This project was extended into FY 18. It will be a 15-20-minute video that showcases the most efficient pass sequences to properly clear various interchange and intersection layouts. MDOT plans to use this to instruct operators on the best way(s) to safely clear various intersection geometries.

15-01 Synthesis of Material Application Methodologies for Winter Operations

The goal of this project is to create a synthesis of best management practices for application rates, material application methodologies and material usage, including chloride brines applied directly or as additives to abrasives and rock salts.

16-01 Utilization of AVL/GPS Technology: Case Studies

The goal of this project is to help state DOTs make more informed decisions with respect to implementation of winter maintenance AVL/GPS. MDOT was one of the case studies highlighted in this report.

16-02 AWSSI Enhancements in Support of Winter Road Maintenance

The objective of this project is to expand on the current AWSSI Tool to add more stations and provide features to allow for winter severity projections and connect winter severity to winter maintenance costs.

16-05 Weather Event Reconstruction and Analysis Tool

The goal of this project is to allow transportation agencies to reconstruct winter weather events quickly and easily, with a focus on drawing from data sources that cover the entire United States or large regions.

16-03: Standards and Guidance for Using Mobile Sensor Technology to Access Winter Road Conditions

Through rigorous testing of sensor equipment, development of standardized scales, and creation of guidance for using an array of measurements in concert for decision-making, Clear Roads will make better use of road sensor data than is now currently available.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and continued several other projects during the 2020 FY. Completed projects and their respective deliverables are described below (click link for more detail).

PROJECT NUMBER	TITLE	COMPLETION DATE	STATUS
18-S1	Mechanic/Operator Training and Training Needs for Winter Maintenance Equipment	09/2020	Completed
18-01	Defensive Driving for Snowplow Operators	08/2020	Completed
18-05	Alternative Methods for Deicing	07/2020	Completed
17-02	Standard Specifications for Plow Blades with Carbide Inserts	04/2020	Completed
16-05	Weather Event Reconstruction and Analysis Tool	12/2019	Complete

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Clear Roads pooled fund study plans to commence and continue several projects during the 2021 FY. These projects are listed below.

- 21-01 Grip Sensor Technology and Salt Application
- 21-02 Update to CR 13-04 Best Practices for Protecting DOT Equipment from Corrosive Effect of Chemical Deicers
- 21-03 The Efficacy and Environmental Impact of Non-Chloride Deicers
- 21-04 Training Module Development for CR 18-03 Evaluation of SSI/WSI Variables
- 21-05 Synthesis Evaluation of Electric Vehicle Technologies and Alternate Fuels for Winter Operations
- 21-06 Calculated Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types Adjacent to Chloride-treated Roadways
- 20-06 Salt Shed Design Template
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-04 Expanded Use of AVL/GPS Technology
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-02 Understanding the NaCl Phase Diagram
- 20-01 Entry-Level Driver Training (CDL) for Maintenance Equipment Operators
- 19-04 Synthesis of Technical Requirements and Considerations for an Automated Snowplow Route Optimization RFP Template
- 19-03 Measuring the Efficiencies of Tow Plows and Wing Plows
- 19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 18-02 High Performance Blade Evaluation

FISCAL YEAR 2022 ACCOMPLISHMENTS

Project selected for FY2022

- 22-01 Comprehensive Guide to Prewet [A comprehensive guide that will provide optimal application rates for meeting pre-wetting goals and will quantify the benefits of different rates, speeds, and other delivery factors. The guide will also present the findings of using two to four salt spreader configurations and delivery systems (e.g., auger, Monroe hopper, zero-velocity spreader). The evaluation will include a discussion of the advantages and disadvantages of each in meeting pre-wetting goals.]
- 22-02 Liquid Chloride Storage and Pump System Best Management Practices [This project will develop a guidance manual that explores the issues transportation agencies should consider when choosing or replacing deicing liquid storage systems. There are several areas of interest associated with operating a reliable system including safety, environment, and cost-effectiveness. A review of the systems different agencies use, including system benefits and challenges, will help agencies better understand their options when procuring a new system or updating an existing one.]
- 22-03 Effects of Additives in Lowering the Freezing Point [While manufacturers of deicing salt products claim that additives enhance product performance, there is no definitive evidence to substantiate these claims. Evaluating these products in the lab and in the field will establish the effectiveness of additives to lower eutectic temperatures and will indicate whether additives increase the performance of deicing salts. Research recommendations can be used to inform the decision-making of state departments of transportation (DOTs), municipalities and other winter maintenance practitioners when choosing a deicing salt for winter maintenance operations.]
- 22-04 Evaluation of DLA of Salt Brine vs Granular Salt as Measured through Various Performance and Safety Metrics [Many of the studies conducted to date focus on cost savings and environmental impacts of the DLA of salt brine while not addressing the efficacy and safety impacts of its use. Without performance comparison data to support DLA practices, the traveling public may conclude that while the advantages of DLA in cost savings and environmental impacts are clear, granular salt treatments are still the more effective way to treat winter roadways. This study aims to provide DOTs with the information they need to defend the use of DLA treatments where appropriate.]
- 22-05 Synthesis: Use of Dashboards for Winter Operations [Advances in information technology offer agencies the capability to capture and track data obtained from winter maintenance equipment. A review of which agencies are using dashboards in winter maintenance operations, including necessary resources and best practices for developing and implementing this tool, will give Clear Roads an understanding of how this data is obtained and displayed through these dashboards. Then, how is

the information displayed used to gain efficiencies related to Level of Service, material use, resource allocation, and the cost of winter maintenance operations.]

- 22-S1 Synthesis: Corrosion and Connectors Don't Mix [The goal of this synthesis is to identify the various setups / connectors used by Clear Roads members. Determine if anyone is experiencing success in keeping the lights operating for an entire winter season. Identify a setup / connector that is most likely to operate for an entire snow season.]
- Project completed in FY 2022
- 19-02 Recruitment and Retention of Highway Maintenance Workers [This project developed a concise guide of innovative but practical ways for DOTs to recruit and retain a highly proficient, productive, versatile, and committed roadway maintenance workforce. The final report includes case studies in several categories, including recruitment programs, retention strategies, recruitment and retention for underserved communities, recruitment and retention of the next generation, and capturing information to inform program improvements.]
- 20-07 AWSSI Enhancements, Phase 2 [This project continued the process of improving the tool developed by the MRCC. This iteration added additional locations to the AWSSI tool; updated the average AWSSI seasonal total map through the 2019-2020 season; added the ability to download the daily seasonal data for any given station during the current season; and provided the user with the ability to add up to five specific historical seasons to be included in any station's current year chart.]
- 20-01: Entry-Level Driver Training (CDL) for Maintenance Equipment Operators [This project developed the following materials: (1) complete curriculum to meet the FMCSA requirements for the instructor-led classroom and behind-the-wheel components of the entry-level driver training rule, focusing on obtaining an initial Class B CDL, upgrading from a Class B CDL to a Class A CDL, and obtaining the hazardous materials endorsement for the first time; (2) all training materials and resources necessary for states to execute the training program; (3) train-the-trainer materials to assist agencies in implementing the training program; and (4) fact sheet and timeline to help agencies ensure that all of their training locations are added to the TPR before February 7, 2022. To date, there have been 750 requests for this material from agencies all over the U.S.]
- 19-04 Synthesis of Technical Requirements and Considerations for Automated Snowplow Route Optimization [Through a survey and follow-up interviews with agencies and vendors, this project captured the technical requirements and considerations involved in selecting an automated snowplow route optimization program. The project produced two complementary documents as appendices to the final report: 1) Decision Support Guidance: An accessible and in-depth discussion of the technical requirements for route optimization and the key decisions DOTs should consider when developing the project scope and managing a provider. 2) Contracting Language Template: A flexible template to assist DOTs with developing a scope of work for an RFP for automated snowplow route optimization services. The language in the template is intended to ensure that DOTs and service providers have a shared understanding of the scope of work that the DOT requires and to maximize the likelihood that the project will result in safe, feasible, implementation-ready routes.]
- 19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing [Through a survey of practice and subsequent field testing, researchers gathered a robust set of data on how agencies apply various liquid deicers across a broad range of field conditions, particularly at lower temperatures. The test results, along with the survey results and information gathered through a literature review, were used to create a set of application rate tables for brine and brine blend usage for DLA and anti-icing.]
- 19-03 Measuring the Efficiencies of Tow Plows and Wing Plows [Through a practitioner survey, testing/simulation, and analysis, this project created a spreadsheet-based Decision Support Tool to help agencies more accurately assess the efficiencies, costs of ownership, and return on investment for tow plows and wing plows and determine the best locations to deploy it. A companion Best Practices Guide will help agencies understand the considerations for purchasing, deploying and operating specific plow types.]
- 20-02 Understanding the NaCl Phase Diagram [Project deliverables include the development of training materials (a fact sheet and a video) to help provide winter maintenance practitioners with a better understanding of the phase diagram for sodium chloride and how to apply it to yield the best results in roadway deicing. This knowledge will help winter maintenance agencies apply salt and salt brines effectively for the best performance on winter roadways.]

Ongoing Projects for FY 2023

- 18-02 High Performance Blade Evaluation
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-04 Expanded Use of AVL/GPS Technology
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-06 Salt Shed Design Template
- 21-01 Grip Sensor Technology and Salt Applications
- 21-02 Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers
- 21-03 Efficacy, Cost, and Impacts of Non-Chloride Deicers
- 21-04 Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables
- 21-05 Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations
- 21-06 Calculating Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This continuation project will maintain its focus on advancing winter highway operations nationally through practical, practice-ready research related to materials, equipment, and methods. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility.
Project will continue with existing funds to complete all tasks/deliverables.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Thirty-Six (36) state partner's leveraged funds provide support for investigator work on research projects, implementation and technology transfer activities, administrative management of the pooled fund, and travel expenses for member representatives to attend 2 Technical Advisory Committee meetings per year.

As a participating state MDOT can:

- Inform the research agenda for Clear Roads by proposing topics for future projects.
- Help prioritize and select projects for funding.
- Evaluate technical proposals to conduct the research from academic and private-sector investigators.
- Serve on subcommittees that oversee research projects.
- Meet with experts from around the country on winter maintenance issues.
- Travel to TAC meetings with expenses paid by the pooled fund.

One of the most important aspects of Clear Roads membership is access to the Clear Roads members themselves and their expertise. Members often send inquiries to their member peers for quick turnaround information. They can then report back to their management within days and provide information based on actual experiences of member states. Those inquiries and the summary of the information they receive back from the states is posted on a members-only page on the Clear Roads website.

Regarding the above list of projects 21-05 was proposed by MDOT and the project-subcommittee formed was championed by a Michigan Rep. Also, a Michigan Rep serve on several other project subcommittees, including 21-01 and 21-04.

Michigan Department
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5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Wildlife Vehicle Collision Reduction and Habitat Connectivity

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(358)		MDOT START DATE	10/1/2019
PROJECT NO.	OR21-213		MDOT COMPLETION DATE (Original)	9/30/2021
			COMPLETION DATE (Revised)	9/30/2022
MDOT TECHNICAL CONTACT	Amanda Novak 989-233-3687 NovakA2@michigan.gov			
LEAD AGENCY:	Nevada DOT			
PROJECT MANAGER	Ken Chambers kchambers@dot.state.nv.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$20,000.00		TOTAL BUDGET	(Original)	$60,000.00
	(Revised)				(Revised)	$80,000.00
TOTAL FY 2022 EXPENDITURES		$20,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

Parks Canada / Government of Canada, AK, AZDOT, CA, CO, IADOT, MI, MN, NM, NV, Ontario MOT, OR, WA.
Partners Total Commitments: $1,275,000.00 MDOT Pledge Commitment FYs 2020-2021

PURPOSE AND SCOPE

Wildlife Vehicle Collisions (WVCs) have become an increasingly larger component of overall crashes nationally, while at the same time local populations of wildlife, both large and small, have suffered restrictions to their safe movement across roads. This study pooled fund study seeks to identify cost-effective solutions that integrate highway safety and mobility with wildlife conservation and habitat connectivity.

MAJOR TASKS:

1. Explore the effectiveness of new mitigation measures intended to increase driver awareness and decrease collisions with large mammals such as deer, elk, and moose. There have been many developments in animal detection-driver warning systems. These are ideal at-grade solutions and are most often deployed on 2-lane rural highways. Other technologies that could be evaluated are on-board animal detection and vehicle-to-vehicle (V2V) systems; another emerging technology is radar speed guns linked to variable message signs.
2. Evaluate improvements to traditional mitigation measures and quantify the effectiveness of those improvements in reducing WVCs. Signage and messaging, reflectors, noise makers, educational campaigns, citizen involvement, structural solutions such as under- and overpasses and associated fencing and escape ramps (a.k.a. jump-outs), along with other mitigation measures that have received modernization and/or improvements in recent years should be re-evaluated. For example, the Illumination of roadways has been a traditional measure to increase driver visibility but has not necessarily been aimed at reducing WVCs. With new lighting techniques available, lighting systems may be evaluated for effectiveness at reducing WVCs. Similarly, new innovations in overpass technologies, such as the use of geo-synthetically reinforced soil technologies and alternative fill materials like geofoam; may result in increased effectiveness because of improved sound attenuation. Researchers will select mitigation measures in these categories to evaluate as well.
3. Assess the mitigation needs and measures for a particular species of conservation interest.
   Often there is little known about species of conservation concern and their interaction with roads and when and how to create safe passage for these species. This project will select those species of conservation concern for which information is most urgently needed by transportation agencies and its partners, particularly for species of regional or national importance.

SCOPE:

To be guided by the Technical Advisory Committee (TAC)

1. Develop, select, and provide support for priority research of new wildlife mitigation solutions.
2. Explore and encourage collaboration for research and implementation of wildlife mitigation measures by state DOTs, land management agencies, wildlife agencies and their partners.
3. Convene an annual meeting of the Pooled Fund's Technical Advisory Committee and invited guests.

FISCAL YEAR 2020 ACCOMPLISHMENTS (Benefits to MDOT)

The wildlife vehicle crash reduction study team has reviewed many study documents provided by the two research teams: Western Transportation Institute and US Geological Survey. In these documents there has been very useful information provided regarding field studies and chapters for strategic integration of wildlife mitigation into transportation procedures. Some of the field study information sent included updates on overpass design, electrified barriers, quarterly reports on progress, etc. Chapter information provided included partnerships, data requirements, and case studies. See following link: https://www.pooledfund.org/Document/Download/9151

All the information provided by the research teams is incredibly helpful to the States that are not as far advanced in this work. The information provided by the study and research teams has helped to identify next steps needed for MDOT and provided us with a clear starting point.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Active Research Modules- Continued in 2021:

(1) Design of fiber-reinforced polymer wildlife overpass structures
- This project is ongoing-upcoming deliverables include ARC co-labs and guidebook, FRP wildlife crossing drawings using AIT designs, the completion of the cost-benefit analysis.

(2) Identification of the patterns and processes that result in highway accidents involving elk-informing design of effective mitigation strategies in areas where elk is a dominant species
- Completed Elk-Vehicle Collision Mitigation Strategies Report.

(3) Wildlife community and species factors affecting crossing structure use-A continental meta-analysis and a 16-yr old perspective
- Still completing the report and data analysis for the Long-term Responses of an Ecological Community to Highway Mitigation Measures.

(4) Jump-out design and measures at fence ends and at access roads
- Field work and data collection is still ongoing.

(5) Efficacy and cost-savings of fence and wildlife crossings to reduce wildlife-vehicle collisions in the Bow River Valley, Alberta
- Work has been completed to review the roadkill database to ensure accuracy. This project is still ongoing.

(6) Economic value select species based on biological conservation.
- Draft report completed on Bio-economics.
- Report completed for Incorporating Deer & Turtle Total Value in Collision Mitigation Benefit-Cost Calculations.

Completed Literature Reviews in 2021.
An update of costs and benefits of mitigation measures.
Built upon previous work by Nevada DOT and Partners: Added Feral Horses, Donkeys, and Free Roaming Livestock Section, Small Animal Species Section was rewritten.
Continued active work on the “Strategic Integration of Wildlife Mitigation into Transportation procedures” project.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Dr. Cramer’s final meeting was held June 6, 2022 (virtually) with all the partners. She presented on her manual to integrate wildlife mitigation into transportation procedures. She used a PowerPoint that she had developed to be used in an upcoming webinar that is also a requirement of her work task assignment. She fulfilled the webinar requirement on June 23, 2022. All partners were invited to attend and were asked to distribute the invite to members of their own state. Various areas of MDOT were invited to attend.

The TAC Annual Meeting was held on September 26-29, in Missoula, MT. It was a two-day meeting organized by the Western Transportation Institute (WTI).

Missoula Meeting-Day 1

The first day included presentations on various sections of their Best Practices Manual to Reduce Animal-Vehicle Collisions and Provide Habitat Connectivity for Wildlife

1. Animal vehicle collision reduction and habitat connectivity. Pooled Fund Study – Literature Review.
   - WTI gave an update on the findings of the literature review and showed how effective/ineffective different measures are. They also presented on potential future focus areas where information was lacking for certain measures.
2. Fiber-reinforced polymer wildlife crossing infrastructure.
   - WTI gave a final update on these structures and showed some that were constructed internationally. The team discussed different options and uses for these. The team also discussed engineering feedback regarding inspections and maintenance for these structures.
3. Before after control impact study of wildlife fencing along a highway in the Canadian Rocky Mountains.
   - WTI went through the results of their modeling effort utilizing existing data for the project site. They outlined potential options for enhancing this type of modeling in the future.
4. Wildlife barriers at fence ends and at access roads.
   - WTI outlined the current project locations and the field research findings related to fence ends. They discussed how critical it is to know what your target species is and to ensure your fence ends are secure and in working condition.
5. Permeability of large underpasses to wildlife.
   - This project was completed by USGS. They presented to us virtually on their findings. They outlined the need for design changes of underpasses to ensure smaller animals can use these too.
6. Wildlife jump-out designs.
   - WTI discussed the various jump-out designs that were studied for this project. They outlined which designs were effective/ineffective. They also outlined how these worked for whitetail deer vs. mule deer.
7. Long-term responses of an ecological community to highway mitigation measures.
   - This presentation looked at different types of mitigation measures used in different areas and how likely certain species were to utilize them.
8. Update and expansion of the WVC mitigation cost-benefit model.
   - WTI presented on the use of mitigation measures for different species and the cost savings related to WVC reduction.
9. The effectiveness of an elevated road segment to reduce road mortality and maintain connectivity between wetlands and uplands.

- This presentation was completed by USGS. They studied a section of roadway that is raised to allow for the migration of amphibians. The roadway is constructed to let light and natural precipitation through. The project overall successful. They recently developed some designs that would allow a raised road sections to be incorporated into high-speed roadways.

10. Manual of best practices.
    - WTI presented on the final manual.
11. Final report and website.
    - WTI presented on their final report document and let the partners know how it was organized and condensed for easier reading. Links to the full final reports for each research module are included in the condensed final report. They also showed us where all this information will be housed on their webpage for use by the DOTs.

Missoula Meeting-Day 2

Day 2 was a field day to look at jump-out designs, wildlife crossing structures, fencing, and electrified barriers. We stopped at various sites and had in depth discussions related to successes/failures of the different designs. This was an all-day excursion of all different study locations.

Final reports were submitted, and work is 100% complete. Pending project closeout.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The contract end date is September 30, 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Data collection has been identified as a key starting point to identifying where these types of mitigation measures would be most useful and functional in the MDOT right-of-way. Bay Region has created the ArcGIS collector map for carcass collection. We utilized a student assistant this summer to complete data collections and demo the project. We will work this fall to do additional data collections and share with other Regions.

Bay Region has continued the effort of data collection utilizing the carcass location map. We are also seeking funding to complete a hotspot analysis which will greatly enhance our carcass collection information, by providing some additional habitat modeling.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) - Phase II

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(359)		MDOT START DATE	1/2/2018
PROJECT NO.	200188 / 204724 / 200858		MDOT COMPLETION DATE (Original)	11/30/2020
OR NO.	OR17-101 (a and b)		COMPLETION DATE (Revised)	2/28/2022
MDOT TECHNICAL CONTACT	Elise Feldpausch			
LEAD AGENCY:	Michigan Department of Transportation			
PROJECT MANAGER	Elise Feldpausch			
CONTRACTOR	CTC & Associates (Administrative Services), Athey Creek Consultants LLC (Researcher)			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY 2022 BUDGET	(Original)	$0.00		TOTAL BUDGET	(Original-Incl. non-SPR)	$424,420.00
Non-SPR	(Revised)	$0.00		**MDOT (only)**	(Revised)	$145,000.00
TOTAL FY 2021 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

Year	Total MDOT Contributions	Project Total Expenditures
2017	$35,000.00	$0.00
2018	$45,000.00	$37,008.53
2019	$35,000.00	$261,671.45
2020	$30,000.00	$331,663.44
2021	$267,467.00	$308,419.53
2022	$0.00	$119,824.35
Project Budget and Expenditure Totals		
SPR	$989,343.29	$789,124.26
Non-SPR	$267,467.00	$267,467.00
Total	$1,256,810.29	$1,056,591.26

PARTICIPATING STATES

SPR-II Funds: IADOT, IL, KS, MI, MN, PADOT, TX, WI Total Commitments Received: **$1,442,976.00**
Non-SPR-II Funds: IA, Dutch Ministry of Transport, and Ontario**. The FY 2021 MDOT pledge amount represent non-SPR funds to this project.**

PURPOSE AND SCOPE

This new Transportation Pooled Fund (TPF) project is a continuation of TPF-5(231), titled, "ENERPRISE Group," that was established in 1991. ENTERPRISE's main purpose is to develop and carry out a joint research program to develop, evaluate, and deploy Intelligent Transportation System (ITS) technologies. Each year, members contribute funds in support of ITS projects of mutual interest and develop an annual work plan. These projects typically involve private sector partners working with designated member agencies. Over time, ENTERPRISE has grown into a multi-national consortium dedicated to the advancement of ITS and provides a focus for coordinating ITS developments and for sharing results within and outside the program.
The Technical Advisory Committee (TAC) voted unanimously to perform future research activities, starting in 2017, under this new TPF project to be led administratively by MDOT. The tasks to be completed as part of the program vary from year to year and are reevaluated through an annual project selection process as established by the ENTERPRISE member agencies. Requests for proposals will be posted for contracts based on approved work plans and it is expected that several contracts may be authorized throughout the life of the pooled fund project.

Research objectives may include but are not limited to the following:
1. Investigate and promote ITS approaches and technologies that are compatible with other national and international ITS initiatives.
2. Support the individual ITS program plans of ENTERPRISE participants.
3. Provide a mechanism to support multi-state and international project cooperation and technical information interchange.
4. Facilitate the formation of public-private partnerships for appropriate program activities.
5. Pursue emerging ITS project opportunities in areas of interest to the group.
6. Provide test beds in a variety of environments and locations for emerging ITS technologies.
7. Identify common needs within the group and proceed with appropriate technical activities.

Administration Contract (OR17-101b): This sub project is for administrative services and technical advisement. Primary services required will be management of related research projects including tasks such as project tracking, organization of monthly meetings, completion of FHWA quarterly reports and closeout funding spreadsheet, and preliminary scope and estimates.
Research Contract (OR17-101a): The overall goal of this project is to carry out joint research to develop, evaluation and deploy ITS.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed solicitation for partners and determined priorities for starting the project. Developed problem statements, posted Requests for Proposals (RFPs) and scored proposals received for the following contract authorization: Administrative Services and Technical Advisement [OR17-101b].

FISCAL YEAR 2018 ACCOMPLISHMENTS

OR17-101b:
Announced selection for the administrative contract authorization of the ENTERPRISE Phase II project. Held the initial kick off meeting with the TAC and administrative consultant (OR17-101b) to begin developing the annual work plan. Post Requests for Proposals and scored proposals received for the following contract authorization: Research Objectives (OR17-101a).
OR17-101a:
TAC Meeting held on September 19, 2018. TAC reviewed and approved the RFP draft for posting solicitation to secure research vendor for performing initial research objectives.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The project kick-off meeting with the TAC and Athey Creek (OR17-101a) was held November 14-15, 2018. The TAC developed a plan for five primary research projects to get underway and discussed options for six secondary projects. The five primary projects began between November 2018 and February 2019. Three secondary projects were scoped in the fourth quarter of the fiscal year (FY).

FISCAL YEAR 2020 ACCOMPLISHMENTS

The five primary projects wrapped up this year and seven new secondary projects started.
Monthly teleconferences were held by the board. Due to COV-19 travel restrictions the spring and fall in person meeting was transitioned to virtual where project selection and updates were given.
The following research projects and associated tasks were worked on in 2020:
Project 6: Emerging Practices for Communications Infrastructure
- Task 1: Project Team – Conducted project team meetings approximately every 4-6 weeks to provide updates and gather input.
- Task 2: Cybersecurity Research Gap Assessment – Monitored the National Cooperative Highway Research Program (NCHRP) website for publication of the report on cybersecurity at field devices. This publication may not be available in time for synthesizing into this project, in which case the literature review published early in the NCHRP project will be referenced in the report for this project.
- Task 5: Draft technical report completed for review by project team and participating entities.
- Task 6: Completed the final report by incorporating comments received on the draft.

Project 7: Automated Classification of Winter Road Conditions-Phase 2
- Task 4. Draft Summary Report – Completed draft report and distributed to project team for review and comment.
- Task 5. Final Summary Report – Revised draft report with comments received and published the final report.

Project 9: Volumes from Probe Data
- Task 1: Research Key Topic Areas for Volume Probe Data – Completed business cases for agency use of probe volume data.
- Task 2: Gather Input from I-95 Corridor Coalition Volume & Turning Movements Phase 2 Project Participants – Completed information gathering interviews with four participating agencies.
- Task 3: Completed the draft report and final report.

Project 10: Potential Approaches for Wrong-Way Driving Applications
- Task 1: Summarize Wrong-Way Driving Issues and Challenges – Created a brief outreach document (1-page front/back) to summarize wrong-way driving (WWD) issues, as well as the proposed concept for WWD applications.
- Task 2: Describe Concept for Navigation Applications for Wrong-Way Driving – Finalized the presentation for the 2020 Society of Automotive Engineers (SAE) World Congress webinar, with input from project champions. Began identifying other private sector entities (e.g. Waze, Google) for outreach.

Project 11: Procurement Practices for Partnering with Emerging Technology Providers
- Task 3: Develop case studies – Completed case studies.
- Task 4: Draft summary report – Prepared draft report and presented results to ENTERPRISE Board for review and comment.
- Task 5: Final summary report – Revised draft report with comments received and published the final report.

Project 12: Synthesis of the Use of Speed Data from Probes for Arterial Operations
- Task 1: Identify Vendors and Agencies Using Probe Speed Data for Arterials – Finalized list of vendors and agencies.
- Task 2: Interviews, Emails, and/or Surveys – Finalized interview questions and scheduled phone interviews with vendors and agencies.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- The Board held monthly teleconferences. CTC & Associates created associated agendas, took notes, and finalized, distributed and posted meeting minutes.
- A bi-annual Board Meeting was Held as a webinar over three days in March 2021.
  - CTC & Associates was responsible for the meeting planning and agenda development and assisted with meeting facilitation and took the meeting notes.
  - Athey Creek conducted/presented two project updates and kicked off two additional projects.
  - The Board discussed, ranked and selected the next round of research projects for funding, which would be for the next iteration of the pooled fund study.
  - Each Board member provided a detailed update of their ITS-related activities.

- CTC outlined the steps for the transition to the next iteration of the pooled fund, as well as the process for the next Research RFP.
- The ENTERPRISE website Program Brochure was updated to reflect current and recently completed projects.
- CTC & Associates continued to monitor the research projects schedules and obtain TAC approval for Athey Creek's monthly invoices and continue to provide assistance to Athey Creek on individual research projects.
- CTC & Associates continued to assist MDOT on members' pooled fund commitments and transfers and keep track of the steps on the transition to a new pooled fund and assist with the closeout of the current study.
- Research projects - Athey Creek (including, but not limited to)
  - Project 10: Potential Approaches for Wrong-Way Driving Applications
    - Task 3: Technical Memorandum – Create the technical memorandum.
  - Project 13: Traveler Information Collaboration
    - Phase 1 --Task 2: Identify and Gather Practice from Other States – Finalize survey summary.
    - Task 3: Establish Initial Community of Practice
    - Prepare initial concept paper for the proposed Community of Practice.
  - Project 14: Establishing a Framework for Communication of Map Updates to Mapping Companies
    - Task 2: Outreach to Mapping Companies – Complete phone interviews.
    - Task 3: Guidance for Communicating Map Updates
    - Continue to develop draft guidance and plan for a webinar.

FISCAL YEAR 2022 ACCOMPLISHMENTS

All research projects finalized, and a Final Report completed. It has been determined by the Board that there is interest in moving forward the next iteration of the ENTERPRISE PFS. FHWA has approved the request and assigned a pooled fund study number of TPF-5(490).

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Final project/accounting closeout process.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project Continuation

Michigan Department
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5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Evaluation of .7-inch Diameter Carbon Fiber Reinforced Polymer Pretensioning Strands in Prestressed Beams

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(363)	MDOT START DATE	12/5/2017
PROJECT NO.	201029	MDOT COMPLETION DATE (Original)	9/30/2020
OR NO.	OR15-541	COMPLETION DATE (Revised)	3/31/2022
TECHNICAL CONTACT	Eric Munley Eric.Munley@dot.gov Phone: 202-493-3046		
LEAD AGENCY	Michigan Department of Transportation		
PROJECT MANAGER	Steve Kahl, 517-898-3428 kahls@michigan.gov		
CONTRACTOR	Lawrence Technological University (LTU)		

BUDGET STATUS

FY 2022 MDOT Budget			Project Budget		
Budgeted Funds	(Original Carryforward)	$136,733.00	MDOT Revised Budget		$266,639.63
Budgeted Funds	(Revised Carryforward)	**$266,639.63**	Contract Revised Budget		$488,639.25
*TOTAL FY 2022 MDOT EXPENDITURES		**$0.00**	**Total Authorized Funds**		**$553,593.33**

Year	MDOT Only Contributions	Total Partners Contributions	Project Total Expenditures
2017	$36,000.00	$96,000.00	$0.00
2018	$75,798.26	$175,798.29	$78,279.51
2019	$24,934.71	$64,934.71	$71,063.54
2020	*$129,906.66	$151,906.66	$98,943.68
2021	$0.00	$64,953.67	$84,312.88
TOTALS:	**$266,639.63**	**$553,593.33**	**$332,599.61**

*Michigan covering contributions until partner state funds are received.

PARTICIPATING STATES

ME, MI, NC, OH, and Ministry of Transportation of Ontario (MTO) Canada. Total Partner's Pledge Commitments Received: **$423,687.00**

PURPOSE AND SCOPE

The proposed research is necessary to evaluate the safe use of 0.7-inch diameter Carbon Fiber Reinforced Polymer (CFRP) strands in a beam to meet load carrying requirements. This study will evaluate material properties, details, and design criteria to use 0.7-inch diameter CFRP strands for pre-tensioning of pre-stressed AASHTO I girders, bulb-T, and box beams. The study will include a look at the performance of the strands for environmental conditions and extreme events, as well as prepare design procedures and examples. Project deliverables include construction specifications for 0.7-inch CFRP strands. The research results will identify fabrication concerns with the larger diameter strands as well.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The solicitation process for this project was completed, a vendor was selected, and a contract was awarded to Lawrence Technological University (LTU) to perform the research services.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Task #1: Literature review: The research team finalized the main sections of the literature review and summarized the main points of concern and those needing further investigation.

Task #3: High temp/freeze-thaw: The research team tested the first batch of carbon fiber composite cable (CFCC) specimens under 150 cycles of freeze and thaw. The research team is currently preparing for the second batch that will be subjected to 300. The research team also studied the effect of high temperature on the tensile strength of CFCC through heating and testing to failure multiple 6-ft long CFCC test specimens.

Task #4: Creep/relaxation/prestress loss: The test specimens for creep and relaxation are currently under continuous monitoring. In addition, the research team evaluated and presented to MDOT Engineers the loss of the prestressing force in 48-ft long CFCC strands anchored using three wedge anchors and coupler system during the construction of beam specimens for fire testing (Task #6).

Task # 5: Transfer & development length: The research team prepared and tested three batches of test specimens to evaluate the transfer and development lengths.

Task #6: Precast beams under fire/freeze-thaw: The research team completed the construction of all beams necessary for fire testing and is currently preparing and conditioning the fire chamber to conduct the fire test after the moisture in the beams drops to an acceptable testing levels to avoid concrete spalling and premature failure of the beams. In addition, the research team is currently building the formwork and the reinforcement cages for the freeze-thaw beams. After these beams are built, they will be subjected to 300 cycles of freezing and thawing and then tested to failure under flexural loading to determine the residual strength and the mode of failure.

The 2018 Technical Advisory Committee (TAC) meeting was held on September 13-14, 2018.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task #4: Test specimens for creep and relaxation have been under continuous monitoring since the start of the project. The research team evaluated the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level.

Task # 5: The research team continued to test the new set of pull-out specimens that contained diameters of steel and CFCC strands to compare the bond strength between CFCC and steel strands. Based on these test results, bond capacity between CFCC and concrete is approximately 150 percent of the capacity between steel and concrete. Bond specimens were also prepared for extreme heat and extreme cold testing. Five pull-out bond specimens will be subjected to cycles of elevated temperature, while five will be subjected to cycles of freezing and thawing. After concluding the cycles of high temperatures or freezing/thawing, the specimens will be subjected to static pull-out test to evaluate the effect of temperature increase/decrease on the bond strength between CFCC and concrete.

Task # 7: Testing of full-scale beams included fire testing of beam specimens in the fire chamber and included building two more beam specimens for a complete bridge model. During the last quarter, the fire testing continued, and two more full-scale beam specimens were tested under fire. The first beam specimen was prestressed with CFCC strands, while the second beam specimen was prestressed with steel strands. The fire endurance of a beam with CFCC strands was approximately 50 percent of that for the beam with steel strands. Failure took place due to the loss of bond between CFCC and concrete. Nevertheless, the beam with CFCC strands supported the applied load for two hours under fire conditions. In addition, the research team is currently working on constructing four half-scale beams that will be used to build a bridge model that will also be tested under flexural loading setup. The test results of the bridge model will be compared with the results obtained in 2013 from testing an identical model with 0.6-inch CFCC strands (under different MDOT research project).

Task #9 The research team performed the analysis of test results to date and started developing analytical models to compare the experimental test results with the analytical estimate. The team also performed completed thermal heating and cooling tests on the freeze-thaw beams and is preparing to start the freeze-thaw cycles.

The 2019 TAC meeting was planned for October 7 and 8; however, the Principal Investigator (PI) cancelled this meeting due to a medical emergency. The TAC meeting was held on March 5, 2020, in Raleigh, North Carolina.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Task #3: High-temp & freeze-thaw effect: The research team completed the testing of five CFCC strands under 300 cycles of freeze-thaw. This is in addition to five strands that were tested earlier under 150 cycles of freeze-thaw. A tensile test was performed after exposure to freeze-thaw cycles to evaluate residual strength. In addition, the research team is currently investigating the effect of heat generated due to concrete curing on tensile strength of CFCC strands as well as the prestress loss due to the heat relaxation effect.

Task #4: Creep/relaxation/prestress loss: The test specimens for creep and relaxation have been under continuous monitoring since the start of the project. The research team evaluated the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level.

Task # 6: Prestressed beams under extreme events: The testing of the Freeze-thaw beams was completed. After exposure to freeze-thaw cycles, the beams re being tested under 3-point-loading test setup to failure. Special attention was given to the bond strength between the CFCC and the concrete. In addition, the research team completed the fire/loading test to evaluate the residual capacity of beams prestressed with CFCC strands after exposure to 1-hour fire test according to ASTM E-119 combined with a service load. The research team is currently performing the necessary data analysis to assess the residual strength and failure mode of CFCC prestressed beams compared to those of a control beam prestressed with conventional steel strands that was tested under the same conditions.

Task #9 The research team is developing analytical models to compare the experimental test results with the analytical estimate and is currently preparing design examples for the design of highway bridge beams with large-diameter CFCC strands.

FISCAL YEAR 2021 ACCOMPLISHMENTS

LTU's research team worked on major tasks # 3, 4, 5, 7, 8 and 9 during fiscal year 2021.
Task #3: High-temp & freeze-thaw effect: Based on the test results of evaluating the heat relaxation in bonded and unbonded strands, the research team was able to evaluate prestress loss in CFCC prestressing strands during construction due to heat relaxation of the strands. This prestress loss will be considered during the design among other construction and long-term losses.
Task #4: Creep/relaxation/prestress loss: The test specimens for creep and relaxation have been under continuous monitoring since the start of the project. The research team evaluated the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level.
Task # 5: Transfer/Development/bond strength: The research team completed testing pullout specimens after exposure to 150 freeze-thaw cycles or 150 cycles of heating. Test results showed that exposure to freeze-thaw cycles impacts the bond between CFCC and concrete due to the deterioration of concrete properties. Heat cycles from ambient to 176 °F did not seem to have a significant impact on bond strength.

Task # 7: Full-scale testing: The research team completed the construction of a half-scale decked bulb T beam bridge model prestressed with 0.7 in. CFCC strands. The team also completed the testing of the bridge under service and post-cracking limit states and is currently preparing for the strength limit state testing, which is expected to take place in Aug. 2021. Engineers from MDOT as well as key figures from State and U.S. congress are expected to attend the testing of the bridge. Under an earlier pool-fund research

project, the team constructed and tested to failure an identical bridge model prestressed with 0.6 in. CFCC strands. Test results of both bridge models are being analyzed and compared.
Task # 8: The research team is currently assembling a matrix of the test results and is evaluating the performance of 0.7 in. CFCC strands to assess the applicability of different design provisions that were developed for 0.6 in. CFCC.
Task #9 The research team is reviewing and amending the design guidelines to include the design of prestressed beams with large diameter CFCC strands.

On June 22nd, 2021, the research team had a progress meeting with MDOT engineers and engineers from other participating states. During the meeting, the PI presented the results of the research project to date and discussed the ongoing activities and the activities through the remainder of the project.

FISCAL YEAR 2022 ACTIVITIES

Draft final report was issued in December 2021. A project extension to March 31,2022 was approved. This time extension will allow the team to undertake a comprehensive review on PI's final report document. After all comments were addressed in subsequent revisions, a final report was issued on March 31 2022. The design guides were forwarded to bridge design staff for future use.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

none

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

PM approved time extension request with justification.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The report and design guides; will be used for design of 0.7 in diameter CFCC strand prestressed concrete bridge in the near future.

Michigan Department
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5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Performance Engineered Concrete Paving Mixtures

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(368)		MDOT START DATE	01/01/2017
PROJECT NO.			MDOT COMPLETION DATE (Original)	12/31/2021
OR NO.	OR18-009		COMPLETION DATE (Revised)	12/31/2022
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@michigan.gov			
LEAD AGENCY:	Iowa Department of Transportation			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us			
CONTRACTOR	CP Tech Center: Iowa State University Mr. Peter Taylor 517-294-9333			

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL COST	(Original)	$75,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		Total Committed Funds Available		$0.00

PARTICIPATING STATES

Twenty (20) Participating Agencies:

AR, CA, CO, FHWA, GADOT, IADOT, ID, IL, KS, ME, MI, MN, NC, NY, OH, OK, PADOT, SD, TN, and WI.
Total Commitments Received: $2,200,000.00 MDOT Pledge Commitment FYs 2017-2021.

PURPOSE AND SCOPE

The objective of this study is to focus on the successful deployment of Performance Engineered Mixtures (PEM). This study will build upon foundational work supported by FHWA as well as states participating in this study. Emphasis will be placed on implementation, education, and training, adjusting the specification values to relate accurately to good pavement performance in the field, and continued development of relating early age concrete properties to performance.

Task 1: Implementing What We Know
This task is intended to provide support to study participants with implementation of performance engineered paving mixtures within their states.

Task 2: Performance Monitoring and Specification Refinement
With any new specification it is critical to monitor the requirements and be sure that they are optimized to consistently produce good performing pavements. As necessary, the specification values and testing limits should be adjusted to represent the optimal balance between cost and performance. This task will provide field performance data for use in making decisions on specification limits in the areas of salt damage, transport, and freeze-thaw damage.

To accomplish this successfully, an organized process of pavement monitoring and evaluation is intended in this task. It is proposed that the projects built under PEM specification requirements also continue to be monitored in the future Phase 2 of the study.

Task 3: Measuring and Relating Early Age Concrete Properties to Performance
This task will build upon the foundational work done to date in measurement technologies to design and control concrete pavement mixtures around key engineering properties.

It is planned that work under this task will address Improved testing methods for improved accuracy and reduced cost.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The following are ongoing activities for 2017 included as task 1 of this study.
Project Level Support (shadow testing and pilot projects)

- Federal Highway Administration (FHWA) Mobile Concrete Trailer (MCT) – FHWA began support of four or five projects per year with testing and training of state and contractor personnel on the projects. All states participating in the PFS will have the opportunity for the MCT support.

  The Concrete Pavement (CP) Tech will coordinate field support with the FHWA MCT and provide project assistance with running field tests and be available to work with DOTs on assistance with mixture qualification tests. Assist running test procedures and incorporating them into state specifications. Michigan was not on the list of states to be visited in 2017.
- A session at each of the spring and fall 2017 National Concrete Consortium (NCC) meetings will provide an update on the project.
- Initial PEM presentations are available at:
  - http://www.cptechcenter.org/ncc/TTCC-NCC-2017.cfm;

- http://www.cptechcenter.org/ncc/TTCC-NCC-documents/F2017NC2_Docs/2%20Cackler-NCC%20PEM%20Introduction2%20091917.pdf;
- http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/24%20PRAUL%20-%20PEM.pdf;
- http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/25%20Jones%20PEM.pdf

- A suite of prospective standard test procedures will be proposed for the new testing methods as DOTs work with the research team to validate the test procedures and incorporate them in appropriate mixture qualification and construction specifications, as follows:
  - Shrinkage Tests:
  - http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/28%20Weiss-NCC-Shrinkage.pdf
  - http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/27%20Jafar%20shrinkage.pdf
  - Super Air Meter (SAM)
  - Determination of F Factor using electrical methods and mixture constituent properties
  - Vibrating Kelly Ball (VKelly)
  - Dual Ring
  - Oxychloride methods
  - Box Test

FISCAL YEAR 2018 ACCOMPLISHMENTS

PEM Team members provided a PEM update at the National Concrete Consortium (NC2) spring meeting at Couer d'Alene, ID in April. The PEM Technical Advisory Committee (TAC) joined for a conference call on May 11, 2018. Topics discussed included PEM progress, tests/testing updates, data collection protocol and progress in preparation of PP-84-19, (Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures).

CP Tech Center staff delivered a PEM update to the American Concrete Pavement Association (ACPA) Chapter/State Paving Association Executives at their spring meeting in Skamania, WA. Participants discussed how they might work with contractor members toward implementation of the PEM tests and procedures.

On May 17, 2018, PEM Team members collaborated with the FHWA Materials and Construction Technology (MCT) Portland Cement Association (PCA) lab personnel and the CO/WY Chapter – ACPA to present an open house on a paving project near Denver. The PEM tests were demonstrated by FHWA and CP Tech Center staff. Nearly 60 people attended the event with representation from agency, engineering companies and industry.

CP Tech Center staff joined ACPA contractors and associates at the Association's Strategic Board meeting in Denver in June. They addressed the group with an overview of the PEM initiative and participated in an open forum discussion about PEM with concrete paving contractors from across the nation. A primary objective of the meeting was to identify contractor needs related to PEM.

PEM Team members worked throughout the quarter, refining, and responding to industry comments as they prepared the PP-84-19 that is due in the hands of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Materials and Pavements (COMP) technical conversations continue with state DOT participants to identify and respond to their needs, questions, and plans for PEM shadow testing. Activity is anticipated in MN, IA, PA, and SD during the 2018 construction season. Currently, NC, NY and ID are discussing events/training/shadow testing for 2019. PEM Team members continue additional outreach with the states.

The PEM Website was launched this quarter through the CP Tech Center. Users will find valuable information about PEM, test method summaries, videos, slideshows, or You Tube links, a schedule of shadow project and information pertinent to test data entry. The link is www.cptechcenter.org/pem.

FISCAL YEAR 2019 ACCOMPLISHMENTS

PEM open houses were held with the FHWA MCT lab in MN (July 18) and IA (August 1)

- Revisions to PP-84-19 were balloted in the fall 2019 AASHTO COMP Rolling Ballot.
- Shadow testing was completed in SD in September on I-90 in western SD.
- Training and open houses were completed in PA in late August.
- PEM update for the PCA at their August meeting in Minneapolis, MN.
- PEM updates and agency presentations at the National Concrete Consortium (NC2) meeting in Denver, CO (spring 2019) and Kalispell, MT (fall 2019).
- Outreach and assistance to State Highway Administrations (SHAs) and industry.
- Continued effort to expand participation in the study.

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Data are being analyzed from PEM field demo projects (shadow testing) in New York state, North Carolina, Minnesota, and Iowa. FHWA issued reports from prior field-testing demonstration projects.
- Collect, Collate, and publish field data from four states.
- Continue mining Long-Term Pavement Performance (LTPP) database.
- Provided updates at AASHTO COMP (virtual) annual meeting on August 2-6, 2020.
- Revise Provisional Test Methods (TPs) and the Provisional Standard Practice (PP) referred to as PP-84 from the Fall 2020 COMP rolling ballot for April 2021 AASHTO Materials Standard publication.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Continue technical support and specification development assistance to states. Continue performance monitoring, refining test limits, tech support through shadow testing, integrating PEM mixtures into SHA's standards. Select states are moving forward toward implementation of certain PEM initiatives, while others have reservations. MDOT is somewhere in the middle of the pack.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Iowa DOT agreed to serve as the lead state for a new pooled fund project that incorporates continued support for PEM and an extended scope of work that will continue to encourage agencies to consider specification changes and field procedures that enhance concrete pavement performance. This pooled fund project for Sustainable Performance Engineered Concrete (SPEC) is again proposed as a joint agency/industry collaboration. The CP Tech Center is working with agency and industry to define and consider needs beyond the mix, exploring operational innovations that can further advance concrete pavement reliability. Activities included calls

with agencies focusing on continued shadow testing, data collection and analysis, a construction specification incorporating PEM language, pilot projects, and state/industry PEM implementation. Calls were made to Maine and Idaho to identify and address training needs as well as Minnesota, Michigan, and Wisconsin to request shadow test data. The PEM team has continued to collaborate with FHWA's Mobile Concrete Technology Center (MCTC), providing training, assistance, and PEM Open Houses. In May, CP Tech joined FHWA in New York City for a one-day PEM event, including demonstration of tests and new technology. We will also be joining the MCTC staff in Minnesota at MnRoad. It remains the PEM Team's intent to provide all participating SHAs one opportunity for local training. Planning is in the works with Maine DOT for a PEM overview meeting. In follow-up to the Georgia DOT PEM workshop held March 8 & 9, planning is underway for the CP Tech Center to provide sampling, testing, and training on a paving project utilizing PEM methods. The DOT is also planning a pilot project with an optimized aggregate gradation mixture as a result of the workshop. Under the FHWA Cooperative agreement, members of the PEM Team will schedule a precision and bias testing event. FHWA has also approved a plan for precision and bias work on resistivity. Dr. Jason Weiss is coordinating with various laboratories for this work. Work continues on the TRB Circular focusing on the PEM experience from the following state agencies: New York, Iowa, Michigan, North Carolina, and Wisconsin.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Pooled fund ends in 2022. 2023 activities would include producing final documents and closing the project.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

As of FY 2021, MDOT has fulfilled its pledge commitment level in support of the study. Research work activities will continue until all project objectives are fulfilled. The lead agency updated the TPF website with a revised project end date of December 31, 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The FHWA is currently reviewing test methods and other best practice documents from the researchers and other stakeholders. Select implementation and piloting of these test methods are currently underway.

Michigan Department
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5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Building Information Modeling (BIM) for Bridges and Structures

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(372)		MDOT START DATE	10/1/2017
PROJECT NO.			MDOT COMPLETION DATE (Original)*	3/31/2023
OR NO.	OR18-015		COMPLETION DATE (Estimated)	1/31/2024
MDOT TECHNICAL CONTACT	Brad Wagner, 517-256-6451 WagnerB@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us			
CONTRACTOR	HDR Engineering Inc.			

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$20,000.00		TOTAL COST	(Original)	$100,000.00
	(Revised)	$0.00			(Revised)	$125,000.00
*TOTAL FY 2022 EXPENDITURES		$20,000.00		Total Committed Funds Available		$25,000.00

*MDOT pledge commitments for fiscal years 2021 and 2022 were paid in FY 2020 at lead agency's request.

PARTICIPATING STATES

AL, CA, DE, FHWA, FL, GADOT, IADOT, IL, IN, KS, MI, MN, MS, NC, NE, NJ, NY, OH, OK, PADOT, TX, UT, VT, WA, WI.
Partners Total Commitments: $2,495,000.00 MDOT Pledge Commitment FYs 2018-2023

PURPOSE AND SCOPE

The pooled fund project will provide the primary funding mechanism for AASHTO Subcommittee on Bridges and Structures (SCOBS) T-19 to perform the duties of governance and stewardship of Building Information Modeling (BIM) for Bridges and Structures.

1. Establish standards, guidelines, or manuals for bridge project stakeholders to facilitate the wide use of Industry Foundation Classes (IFC) as an exchange standard in BIM for Bridges and Structures in bridge projects. This would include recommending or mandating the use of common modeling format and IFC submittal.
2. Develop the national standard Model View Definitions (MVD), data definitions, and data requirements for the model life cycle for all data exchanges for transportation bridges and structures. This national standard will use the above governance and stewardship model to facilitate the development and future maintenance.
3. Collaborate with stakeholders to provide timely update of IFC data dictionary for common bridge elements.
4. Collaborate with building SMART and software vendors to design and offer suitable training covering BIM for Bridges and Structures model development, management, and usage.
5. Conduct Return on Investment (ROI) analysis to quantify the benefits of using a common modeling format, BIM for Bridges and Structures, in terms of time and cost savings.
6. Develop a template of BIM for Bridges and Structures-specific contractual provisions for managing, reducing, or eliminating the risks associated with IFC-BIM for Bridges and Structures. Project stakeholders/owners could use the template to conduct a risk evaluation for deploying BIM for Bridges and Structures at a project and organization level.
7. Provide recommendations to T-19 on changing existing workflows to leverage model exchanges for project delivery and asset management for transportation bridges and structures owners.
8. Provide a work plan, progression schedule, and coordination web and face to face meetings with T-19 on the development and implementation of BIM for Bridges and Structures.
9. Establish a forum/expert hub for practitioners in the bridge industry to promote the common modeling formats and share experiences.
10. Provide technical support, organize training workshops, and facilitate pilot/demonstration projects for bridge owners to encourage and accelerate the adoption of BIM for Bridges and Structures.

It is envisioned that the tasks listed above will be contracted to a consultant with proven expertise in this area.

FISCAL YEAR 2018 ACCOMPLISHMENTS

An initiation meeting was held to get input from industry and to refine the project request for proposals. The project was advertised, and a preferred vendor was selected. Currently, the first-year work plan is being negotiated to authorize the consultant. Expected authorization will be October 2018.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The researchers documented existing BIM efforts and formed working groups to carry out various activities associated with the pooled fund. Accomplishments include development of a website to support BIM education and overall engagement, submitted a draft report documenting existing BIM efforts and common terminology, updated the bridge lifecycle process map to reflect current needs, and developed an overall engagement/outreach plan.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The completed a gap analysis comparing the current MVD for Design to Construction with the international Bridge Design Transfer View MVD. A process map was developed that maps out the full design to construction process and identifies all applicable data exchanges. A focus group, consisting of all applicable software vendors was established. The communication plan was completed, an info graphic/roadmap was developed, and a recommendation for data governance was completed.

FISCAL YEAR 2021 ACCOMPLISHMENTS

An Information Delivery Manual (IDM) was developed and reviewed, and final draft will be submitted in November 2021. Significant coordination with software developers occurred, and a test suite is being developed that will allow software vendors to determine compliance with MVD. Several outreach activities were completed. will be developed and submitted. Roadmap will be widely distributed, officially kicking off communication plan. Initial data dictionary developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The final IDM was delivered, balloted through AASHTO Committee on Bridges and Structures and approved. The bridge data dictionary was completed. A software certification program was initiated. An economic analysis was started, and a literature review was delivered, which focused on the benefits of using IFC. Coordination began on a governance model with AASHTO and FHWA. Several software vendors signed a letter of intent to support IFC development.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The economic analysis will be completed. Further discussion on a governance model will be coordinated with AASHTO and FHWA. A software unit test suite will go live and will be supported by the Pooled Fund. Coordination with industry will continue.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The lead agency updated the TPF website with a revised project completion date of January 31, 2023. MDOT fulfilled its original pledge commitment in FY 2020. MDOT pledged an additional commitment of $25k for a 6th year of the pooled fund. This will allow for additional tasks to be completed in FY 23. MDOT remains an active partner until all project objectives have been fulfilled.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT identified payoff potential and implementation planned is as follows:

1. MDOT will use the study results to assist in developing standards for 3D bridge modeling
2. Manage risks associated with 3D models by utilizing developed contractual templates
3. Make changes to existing workflows to leverage model data exchanges over the life of the bridge
4. Participate in available training.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Accelerated Performance Testing on the 2018 NCAT Pavement Test Track w/ MnRoad Research Partnership

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(374)		MDOT START DATE	10/1/2020
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR21-206		COMPLETION DATE (Revised)	11/30/2022
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@Michigan.gov			
LEAD AGENCY:	FHWA			
PROJECT MANAGER	Kidada Dixon, 334-353-6940 dixonk@dot.state.al.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$300,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AL, FHWA, FL, GADOT, IL, KY, MDOT SHA, MI, MN, MS, NC, NY, OK, SC, TN, TX, VA, WI, and WV. Partners Total Commitments: $13,259,807.00 MDOT Pledge Commitment FY 2021 $300,000

PURPOSE AND SCOPE

The scope of work for the pooled fund project will include: 1. Hauling materials to the project from offsite locations. Material donations are typically secured by state sponsors, while reasonable hauling expenses are handled by the pooled fund; 2. Rebuilding sections in accordance with sponsors' directives via competitively bid subcontracts administered by NCAT. It is anticipated that aggregate hauling, liquid asphalt supply and delivery, rental of select construction equipment, plant production, and mix placement may all be procured via competitively bid subcontracts; 3. Installing both environmental (i.e., multi-depth pavement temperature probes) and response instrumentation (i.e., high speed stress and strain gages) in new experimental sections; 4. Operating a 5-truck heavy triple-trailer fleet in order to apply accelerated truck traffic on the NCAT test oval following the completion of construction. Human drivers operate NCAT vehicles in order to best induce representative vehicle wander, but it is expected that autonomous vehicles will be implemented in the future. Interstate traffic is used to load test sections at MnROAD; 5. Measuring field performance each week when the fleet is parked to fully document the changes in surface condition as a function of traffic and temperature. High-speed pavement response will also be measured on a weekly basis. Pavement deflection and surface friction will be measured on a monthly basis; 6. Conducting laboratory testing to quantify basic material and mix performance properties, which will serve as the basis of performance model development; and 7. Comparing predicted and measured pavement response as well as predicted and measured cumulative pavement damage in order to validate then calibrate prevailing M-E methodologies.

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

Pavement Preservation Experiment:
Many of the same pavement preservation treatments installed in Alabama are being investigated in Minnesota using MnDOT materials and construction methods. The northern pavement preservation experiment sections are located on U.S. Route 169, a high-volume road, and County State Aid Highway (CSAH) 8 in Mille Lacs County, a low-volume road. This study includes treatment selection, test site selection and layout, scheduling, construction, performance monitoring, and data activities to quantify the life-extending benefits of pavement preservation treatments.

Cracking Group Experiment:
The aim of the cracking group experiment is to develop and implement asphalt performance tests to predict cracking for common pavement distresses found in North America. There are several lab tests that claim to relate to one or more modes of cracking. However, most of these tests lack robust validation outside of the state where the method was developed.

Both MnROAD and NCAT have developed test sections to validate laboratory cracking tests by establishing correlations between test results and measured cracking performance in real pavement test sections within a very short timeframe. This research will provide much needed data on where to set criteria for specifications.

Test sections with differing asphalt mixtures that have a range of expected cracking susceptibilities have been constructed at MnROAD. A suite of laboratory cracking tests conducted on the mixes will identify which test results best correlate with field cracking as well as consider their variability, utility, and practicality of implementation for both mix design approval and quality control testing. A crucial component of the study is regular performance monitoring of the pavement test sections for ride quality, distresses, strength, and response.

FISCAL YEAR 2022 ACCOMPLISHMENTS

All tasks will be completed by the end of November which is the end date for this pooled fund.

FISCAL YEAR 2023 PROPOSED ACTIVITIES
Proposed activities will be to complete construction and subsequent research efforts between NCAT and MnROAD.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
TAC and FHWA approval for a no cost time extension until November 30, 2022, to complete remaining project tasks.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
No recommendations as research is ongoing.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: National Partnership to Determine the Life Extending Benefit Curves of Pavement Preservation Techniques (MnROAD/NCAT Joint Study – Phase II)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(375)	MDOT START DATE	1/2/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/30/2023
OR NO.	OR19-203	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@Michigan.gov		
LEAD AGENCY:	Minnesota Department of Transportation		
PROJECT MANAGER	Ben Worel 763-381-2130 ben.worel@state.mn.us		
CONTRACTOR	University of Minnesota [MnROAD Facility]		

BUDGET STATUS

FY 2022 Budget				Total Budget		
FY FUNDS	(Original)	$50,000.00		TOTAL COST	(Original)	$250,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$50,000.00		Total Committed Funds Available		$50,000.00

PARTICIPATING STATES

AL, AR, CO, FHWA, FP2, GADOT, IL, KS, KY, MDOT SHA, MI, MN, MO, MS, NC, NY, OK, PADOT, SC, TN, TX, WI, WV. Total partner commitment level: $4,800,000.00 MDOT Pledge Commitment FYs 2018-2023

PURPOSE AND SCOPE

Main objectives include:

1. Determining the life cycle cost of various pavement preservation alternatives in a highly controlled experiment that will provide state Departments of Transportation (DOTs) with the financial foundation to begin to build a decision tree for their own maintenance program
2. Develop Quality Assurance (QA) field testing protocols to correlate construction practices with long-term performance of pavement preservation techniques.
3. Technology transfer - Answering practical questions posed by research sponsors through formal (i.e., reports & technical papers) & informal (e.g., one-on-one responses to sponsor inquiries) technology transfer on how these life extending benefits can be best utilized in each state.

This second phase (2019-2024) will be used to continue to monitor and analyze data from the low and high-volume pavement preservation sections built both in Alabama and Minnesota since many of the test sections were built in 2016 and not had enough time to show what rate of deterioration they will have. MnDOT will lead this portion of the pooled fund study and will again partner with National Center for Asphalt Technology (NCAT) but now they will be the subcontractor doing the data collection in Alabama and most of the data analysis.

Activities that are expected include: Continue Data Collection of each of the test sections both in Alabama and Minnesota utilizing common methods and equipment between all four locations.

FISCAL YEAR 2019 ACCOMPLISHMENTS

PR outreach for new members to join the pooled fund study. Monitoring of various test sections including data collection, analyzation and reporting out of findings. Technical transfer efforts continue with presentations to various DOT's and organizations on current best practices and latest technologies.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Continued Public Relations (PR) outreach and technical transfer of findings and solicitation of national innovations for such technology transfer. Technical Webinar Presentations. Continual efforts of data gathering, analyzation and reporting of findings from the various test sections that have been constructed at the test track and off-site. Initial development of QA protocols to correlate construction practices with actual performance. Data collection and analyzation for life cycle cost analysis purposes.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Joint Activities:

- Test Track Conference held in June 2021
- Article submitted for PP Journal Summer issue
- Presented two papers at 7th Eurasphalt & Eurobitume Congress (virtual)
- Presented findings at National Pavement Preservation Conference (virtual)
- Accepted invitations to present at Public Works Expo (August 2021) and ALDOT Construction Engineers and Materials Engineers Conference (September 2021) NCAT Activities (South)
- Data collection continues on US-280 and Lee Road 159

• Continued development of the process to analyze the data
• Southern section performance data updated on NCAT's website MnDOT Activities (North)
• Field data collection on US-169 and CSAH-8
• Working to develop a process for the Pathways Autocrack to help in the research

FISCAL YEAR 2022 ACCOMPLISHMENTS

Joint Activities:

- Contract extension through December 2023 at same level of effort has been executed
- Article submitted for PP Journal Spring issue
- Paper presented at APT International Conference in April
- Spring sponsor meeting held in Auburn in May
- Two presentations given at NEPPP annual meeting in May
- Two presentations given at ETF meeting in June
- Schedule developed for bi-monthly online meetings with sponsors/stakeholders
- Fall sponsor meeting in Minnesota in September

NCAT Activities (South):

- Data collection continues on US-280 and Lee Road 159
- Continued development of the process to analyze data
- Southern section performance data updated on NCAT's website

MnDOT Activities (North):

- Field data collection on US-169 and CSAH-8
- Working to develop a process for the Pathways Autocrack to help in the research

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Joint Activities:

- Present at MPPP annual meeting
- Prepare article submission for PP Journal Summer issue
- Hold bi-monthly online meeting in July (crack sealing)
- Prepare paper(s) for submission to TRB
- Prepare paper(s) for submission to International Conference on Low Volume Roads (2023)

NCAT Activities (South):

- Data collection continues on US-280 and Lee Road 159
- Continued development of the process to analyze data

MnDOT Activities (North):

- Spring data collection on US-169 and CSAH 8

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

N/A

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Research is ongoing. No recommendations at this time.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDD's)

FUNDING SOURCE: ☒ FHWA ☒ OTHER (*PLEASE EXPLAIN*) Metro Region- Non-SPR funds in FY 2022

TPF NO.	TPF-5(385)		MDOT START DATE	3/1/2019
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR19-205		COMPLETION DATE (Revised)	10/31/2023
MDOT TECHNICAL CONTACT	Paul Shapter 517-243-7739 ShapterP@michigan.gov			
LEAD AGENCY:	Virginia Department of Transportation			
PROJECT MANAGER	Bill Kelsh Bill.Kelsh@VDOT.Virginia.gov			
CONTRACTOR	Louisiana Transportation Research Center			

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS (SPR)	(Original)	$45,000.00		TOTAL BUDGET	(Original)	$135,000.00
Non-SPR Funds	(Revised)	$35,000.00			(Revised)	$215,000.00
TOTAL FY 2022 EXPENDITURES		$80,000.00		Total Committed Funds Available		$45,000.00

PARTICIPATING STATES

LTRC, AR, CA, CO, FHWA, GADOT, ID, IL, IN, KS, KY, LA, MI, MN, MO, MS, MT, NC, NM, NV, OK, PADOT, SC, TN, TX, VA, VT, WI
Partners Total Commitments: $6,075,000.00

PURPOSE AND SCOPE

The objective of the proposed pooled-fund project is to establish a research consortium focused on providing participating agencies guidelines on how to specify collection and use data collected with TSDDs for network- and project-level (if feasible) pavement management applications. Specific tasks within this multi-year program will be developed in cooperation with the consortium participants. In addition, the consortium will also provide participating agencies with a mechanism to conduct pilot demonstration testing in their respective networks.

The work plan will be developed based on the priorities indicted by the consortium participants, during the kick-off meeting. It is anticipated that the details and scope of the objectives will be further defined to reflect the concerns of the consortium participants. However, it is proposed that the project will include the following tasks:

- Develop a list of available devices and their characteristics. This will include details about the number of devices currently in operation and what type of data they collect.
- Develop data collection guidelines and specifications for agencies. This will include reviewing best practices from around the world and will be coordinated with service providers to ensure proposed guidelines can be implemented.
- Develop guidelines on how to incorporate pavement structural condition data into agency network-level pavement business processes. This will include defining what structural indices to use and investigating how the structural condition data can complement currently collected surface condition data to make better decisions.
- Demonstrate how structural condition collected from TSDDs can be used for supporting project level decision-making based on case studies.
- Demonstrate the costs effectiveness of collecting structural condition data both, at the network and project levels, through case studies.
- Collect data on at least 100 miles of interstate or primary type pavements for each year of participation with the option to include additional testing at additional commitment levels.
- Organize and deliver workshops and training material for the consortium members.

The pooled-fund project will be led by the Virginia Department of Transportation (VDOT) through its research office, the Virginia Transportation Research Council (VTRC).

FISCAL YEAR 2019 ACCOMPLISHMENTS

- 13 states have collected data.
- Some states had additional testing performed
- The pool fund held a meeting and conference to go over data and activities
- Developed route for collection

FISCAL YEAR 2020 ACCOMPLISHMENTS

- Developed first research statement for developing guidelines and procedures to implement TSDD measurements into pavement management
- Work on incorporating structural data into network pavement management
- Developed route for additional collection
- Attended webinar "demonstration of TSD Data Extraction and Processing tool"

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Develop route for additional collection
- Continue to work on research project Guidelines and specification for TSDD data collection.
- Attended remote pool fund annual meeting
- Formed four subgroups of pooled fund member to conduct outreach and discuss implementation.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Distribute final version of Guideline for Pavement Management Implementation of TSD
- Attended remote pool fund annual meeting
- Develop route for additional collection
- Finalize report summarizing the first 6 organized webinars

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- *Attend remote pool fund annual meeting*
- *Develop route for additional collection*
- Share for review the document Guidelines and Specifications for TSDD Data Collection

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Two (2) additional years needed for more data to be collected. According to the latest quarterly report (First Q1- Calendar) posted on the TPF website the revised project end date is 10/31/2023.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT selected Option 2a) which include one day of TSDD testing on agency designated routes (approximately 100-200 miles depending on routes selected) = $45,000 per year. In FY 2022- additional non-SPR funds were provided by Metro Region ($35,000.00)

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Development of an Integrated Unmanned Aerial Systems (UAS) Validation Center

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(387)		MDOT START DATE	9/1/2018
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/1/2021
OR NO.	OR19-200		COMPLETION DATE (Revised)	12/31/2022
MDOT TECHNICAL CONTACT	Brian Zakrzewski ZakrzewskiB@michigan.gov			
LEAD AGENCY:	Indiana Department of Transportation			
PROJECT MANAGER	Anne Rearick 317-232-5152 arearick@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 Budget				Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL COST	(Original)	$75,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		Total Committed Funds Available		$0.00

* Fiscal year 2019 and 2020 contributions were paid during FY 2020.

PARTICIPATING STATES

CA, DE, GA, IL, MI, MN, PA, UT, and VA. Total partner commitments: $700,000.00 MDOT Pledge Commitment FY 2019-2021.

PURPOSE AND SCOPE

This pooled-fund study proposes to develop the standards, protocols, and testing requirements that a given Unmanned Aerial System (UAS) must meet and demonstrate for a given application.

Objectives Regarding Deployment:
- Access/address any safety concerns or issues regarding constrained locations where line of site is limited
- Research imaging system performance in poorly lit environments
- Control of the UAS while flying between large steel girders
- Address adequate resolution of the imaging system for detecting the damage of interest

The objectives of the study are two-fold:
- Development of the specific criteria a given UAS must meet for each specific application
- Determining how to validate that a given UAS meets the required criteria

The current industry is unregulated with regards to establishing the required level of performance for UAS in civil engineering applications. The results of this study will be the development of the performance measures and validation criteria that agencies can use when making decisions about deployment of UAS in the context of civil engineering.

The following project tasks are proposed:

Identify areas that need UAS validation in the context of civil engineering infrastructure. Possibilities include bridge and traffic signal inspection, accident reconstruction, construction site monitoring, site assessment and inspection of railroad way.

Conduct stakeholder workshops, including owners, engineers, pilots, and academics, to identify performance criteria which UAS must meet for a given applications.

Develop methodologies to “test” whether the UAS meets specific criteria identified in Task II for given applications.
These include, but are not limited to the following:
- The development of pilot and UAS navigation testing and validation obstacle courses, communication with the airport tower, filing of the flight-plan, as well as the required written testing criteria for the pilot.
- The development of camera and other sensor accuracy and precision requirements, such as lighting standards, contrast detection, color sensing capabilities, distance and volume measurement requirements, and image quality standards.
- The development of test methods and test equipment to objectively, and consistently measure that a given UAS is providing enough lighting (i.e., do small light optic measurement devices need to be installed at strategic locations under the bridge). Other devices will need to be developed to ensure standard contrast testing, accuracy, and precision standards, etc. required in the bullet item above can be quantitatively and repeatedly evaluated.
- The development of a test bed (e.g., full-scale bridge specimens, accident scenarios, etc.) in which navigation skills of the UAS are tested under specific conditions, such as a pre-defined wind speed.
- The development of UAS performance criteria when communication or line-of-sight is lost.
- Conduct stakeholder workshops to present results and refine, as necessary.
- Conduct a beta version roll-out of the validation criteria at Purdue University’s Center for Aging Infrastructure (CAI) and the Steel
- Bridge Research, Inspection, Training, and Engineering Center (S-BRITE).

- Based on results; further revise the validation criteria and submit a final report with detailed UAS performance measures and guidance for specific applications.
- Provide testing using the performance criteria developed and issue “certificates of performance” to UAS which satisfactorily meet the performance criteria testing for specific applications.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The project kick-off meeting was held on January 9th, 2019. Literature review continued and several owners/users of UAS have been contacted to obtain their perspective on the use of UAS. Began preliminary testing protocols for testing the capability of UAS. Efforts are underway to develop the pilot and sensing evaluation criteria.

The project is a bit behind scheduled since the graduate student who initially working on the project in the fall had to leave Purdue University for personal issues. This set the research team back a few months in searching for a new student and getting that individual up to speed on the project. Additionally, the structural engineering student who then joined the project has decided to pursue an MBA and will no longer be part of the project. This is the second student to leave the project which obviously has a negative impact on the project. Dr. Connor is seeking a new student at this time.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The initial development of evaluation criteria for UAS based on the kick-off meeting held in January of 2019 is well underway. Several specific performance tests and site specific evaluation criteria are under development. The research team had planned to have “real world” concrete deck panels obtained from a local Interstate bridge placed at the S-BRITE center in the late fall. However, the construction project from which these panels would be obtained has been delayed. In spite of the COVID-19 pandemic, some progress has been made regarding further development of the obstacle course, camera optic requirements, and pilot mission planning skill requirements. While it was planned to hold an in-person meeting in the second quarter with the project sponsors, this was obviously not possible. Due to the lack of progress, it is now planned to hold a virtual meeting in late 2020 to give sponsors a full update on progress.

FISCAL YEAR 2021 ACCOMPLISHMENTS

One of the biggest challenges has been finding a student for the project. The Project’s second student, Miranda Clark, who took the place of the first student (Martin Seneca we had who had to leave the project unexpectedly) also had to leave Purdue due to family needs. Obviously, this set the project back. The project team was not able to find a student for the main part of the project until mid-fall of 2020. The student's name is Jose Capa Salina and he has been on the project since then. He worked to get up to speed on the project during the fall and first part of 2020.
The next major hurdle was COVID 19 which shut Purdue down in mind March 2020. We closed entirely and with an experimental project like this, we were effectively out of commission through the fall of 2020 with only modest work accomplished in 2020. In early 2021 the project was able to begin to become "productive" again.
Today, in the summer of 2021, the project is basically back to 100%, albeit after a long road. However, the project is behind despite the efforts to regain ground.
As of today, the project is making good progress and has developed some very effective and meaningful performance testing strategies that will level the playing field in terms of UAS use. These tests will include a combination of evaluating pilot skills, UAV capabilities, including camera and overall flight performance. The tests have been crafted to allow repeatability and distribution to other locations.
Financially, the project is in a decent fiscal position and has tried to conserve funds as much as possible.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Things are moving well despite still digging out from 1.5 years of COVID doing its best to slow the project down. The project was scheduled to wrap up in July of this year but will need at least 9 more months to wrap things up. Thus a no-cost time extension will be requested.

- Submitted a detailed report on best practices for evaluating camera performance. This was a very long report and had a tremendous amount of information on imaging, camera optics, etc.
- Submitted the standard testing method for the Evaluation Chamber (this will be demonstrated during the on site meeting ...see below)
- Completed the proposed "pilot check" list for review. This would be filled out before each flight/inspection. A final version is pending review comments.
- The cold weather test is completed and was submitted for review. The wind turbulence test is nearly completed and should be submitted for review.
- The cold weather test is completed and will be submitted for review.
- The project is in strong financial shape fortunately as staff have been fiscally conservative for the duration of the project.
- An on-site meeting was held in September 2022.
  - The objective of the on-site meeting was to demonstrate and gain feedback on the proposed tests that have been documented in the quarterly reports. Specifically the three standardized tests that we have developed to evaluate overall UAS performance. These three tests are "objective" tests in that they would be the same for everyone and in any location. The fourth is more of a practical test. The practical testing portion is designed to evaluate a UAS on an actual in-situ inspection. S-BRITE has bridges at the Center for such practical tests, however each owner could identity such a structure in their inventory.
- At present the team has invited a few consultants who perform UAS bridge inspection to visit and beta test the proposed tests.
- The project team is aware of the NCHRP project that was recently awarded and has a very similar work scope. We have been in contact with the consultant on that project (Michael Baker) and they will be visiting our facility this summer to participate in our tests and provide feedback. While there is some overlap, there will also be some different deliverables.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Approval of a no-cost time extension to finalize the project. Continue to bring various bridge inspectors to the S-BRITE center to get real-world feedback on the test. This data will be used to finalize the scoring and test procedures for evaluating the performance of UAS within the UAS Evaluation Chamber.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
To complete all work, the project requires a No-Cost-Time Extension to December 31, 2022. The project team is confident they can complete the project in this time frame.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
For Implementation- See Accomplishments noted above.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Connected Vehicle Pooled Fund Study

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(389)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-203		MDOT COMPLETION DATE (Original)	9/30/2022
			COMPLETION DATE (Revised)	9/30/2024
MDOT TECHNICAL CONTACT	Collin Castle 517-636-0715 CastleC@michigan.gov			
LEAD AGENCY:	Virginia DOT			
PROJECT MANAGER	Michael Fontaine (**434) 293-1980** Michael.Fontaine@VDOT.Virginia.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				**MDOT Total Budget**		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

Maricopa County, AK, AL, AZDOT, CA, CT, DE, FHWA, FL, GADOT, ID, IL, MDOT SHA, MI, MN, MS, NHDOT, NJ, OH, PADOT, TC, TN, TX, UT, VA, WI. Total Commitment Level- $4,735,000.00 MDOT Pledge Commitment FYs 2020-2021

PURPOSE AND SCOPE

PURPOSE:
To provide technology transfer to state, local, and international transportation agencies as well as vehicle Original Equipment Manufacturers (OEMs) in preparing for the deployment of connected vehicle infrastructure and to provide input to the AASHTO Connected and Automated Vehicle working group, USDOT Connected Vehicle Program, and other national initiatives.

To establish a multi-phase program to facilitate research, field demonstration, evaluation, and technology transfer of connected vehicle infrastructure, vehicles, and applications.

To aid transportation agencies and OEMs in justifying and promoting the large-scale use of connected vehicle environment and applications through modeling, development, engineering, and planning activities.

SCOPE - The Pooled Fund Study will focus on the following high-level tasks:
• Research, development, and evaluation of connected vehicle applications
• Improved technology transfer to state and local agencies through:
  - Documenting and sharing deployment best practices and guidelines
  - Providing input into emerging standards
  - Identifying additional requirements within the Connected Vehicle Program to connected vehicle technology by transportation agencies and OEMs
  - Coordinating with OEMs on infrastructure and vehicle tests, application development, and standards development.

The specific program of projects to be conducted will be developed by participating states in the pooled fund study. Examples of recent projects conducted by TPF-5(206) include:
• Traffic Management Centers in a Connected Vehicle Environment
• 5.9 GHz Dedicated Short- Range Communication Vehicle-based Road and Weather Condition Application – Phase I and II
• Best Practices for Surveying and Mapping Roadways and Intersections for Connected Vehicle Applications
• Multi-Modal Intelligent Traffic Signal System – Phase I, II, and III
• Connected Traffic Control Systems

FISCAL YEAR 2020 ACCOMPLISHMENTS (Benefits to MDOT)

- Continue third phase development of the Multi-Modal Intelligent Traffic Signal System program. Including completing field tests.
- Continue the project entitled “Using Third Parties to Deliver Infrastructure to Vehicle (I2V)”
- Develop Concept of operations for project entitled “V2I Queue Advisory/Warning”
- Complete Connected Traffic Control System (CTCS): Research Planning and Concept Development.
- Completed Request for Letters of Intent (RFLI) for New Projects.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Completed project entitled “V2I Queue Advisory/Warning”
- Completed survey and complication of best practices for MAP preparation guidance document.
- Selected investigator and started development of “Connected Intersections Program” project.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- New phase of MAP preparation document to accommodate changes from SAE J2735 update in progress
- Field analysis phase of Connected Intersections Program” project underway
- Started research on third-party data sources.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Draft Guidance Materials from Connected Intersections Program research
- Begin Phase 2 of CI Message Prototype Development
- Preliminary CV Data Architecture & Create CV Data Primer Document

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Per an update from the lead agency PM (M. Fontaine) on 10/28/2021- This study’s projected long term end date is September 2029. Current pledge commitments from a few partners extend through September 2024.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT will benefit from the information developed under all projects. In particular, the “Connected Intersections Program” project aims to complement other ongoing efforts to ensure compatibility of connected signalized intersections on both a local and national scale. MDOT has a strong interest in leveraging the work from multiple development projects to be implemented in Michigan’s Connected Vehicle environment. MDOT will also benefit from an infrastructure focused guide to upcoming changes to the SAE J2735 MAP message standard.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Mid-America Freight Coalition (MAFC) Phase 3

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(396)		MDOT START DATE	2/1/2019
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2021
OR NO.	OR19-206		COMPLETION DATE (Revised)	3/31/2023
MDOT TECHNICAL CONTACT	Elisha Wulff 517-241-4778 WulffE@michigan.gov			
LEAD AGENCY:	Wisconsin Department of Transportation			
PROJECT MANAGER	Ethan Severson **608-266-1457** ethanp.severson@dot.wi.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$37,000.00		TOTAL COST	(Original)	$111,000.00
	(Revised)				(Revised)	**$**148,000.00
TOTAL FY 2022 EXPENDITURES		$37,000.00		Total Committed Funds Available		$0.00

PARTICIPATING STATES

IA, IL, IN, KS, KY, MI, MN, MO, OH, and WI. Total Commitments Received: $1,406,000.00 MDOT Pledge Commitment FY 19-22

PURPOSE AND SCOPE

The Wisconsin Department of Transportation (WisDOT) is leading a pooled fund that will:
- Produce freight-related research results
- Improve cross-state freight-related coordination and facility development
- Increase awareness of the importance of freight transportation for the nation's economy

Ultimately, the results of the Mid-America Freight Coalition (MAFC) activities will support and develop the economic well-being of the industries, businesses, farms, and the people of the ten-state region by keeping their products flowing to markets safely, reliably, and efficiently. Participation in this pooled fund presents an opportunity for agencies to support research on freight and economic development issues specific to the needs of transportation agencies, advance regional freight-related coordination, and ultimately allow for the quick implementation of research and development efforts.
Products of previous iterations of the MAFC pooled fund have included:
- High-quality research reports
- Recently published reports from TPF-5(293) have included an examination of the impact of Upper Mississippi River lock and dam
- shutdowns on state highway infrastructure, and the development of a potential regional regulatory approach to truck platooning
- Annual freight conferences attended by representatives of the ten states
- Recent conferences have run concurrent with the Ohio Conference on Freight and the Mid America Association of State Transportation Officials (MAASTO) Annual Meeting
- Educational seminars and training sessions conducted for state transportation officers
- Support to MAASTO state Freight Advisory Committees
- Direct support to MAASTO Planning and Motor Carrier Committees

Using the MAFC as a foundation, partner agencies will be able to take advantage of a wide range of expertise in truck, rail, waterway, air, and multimodal freight planning, research, management, and operations to assess and answer their regional freight research needs

The MAFC actively engages and supports freight-related activities of the MAASTO states through research projects and reports, the MAFC annual freight conference and outreach efforts, web applications, and personal communications. While specific research topics remain to be approved by the MAASTO Board of Directors (with one exception), objectives of a third iteration of MAFC efforts will generally:
- Define, conduct, and publish critical freight and economic research in coordination with the states that will support and improve freight-related facility development efforts and the related outcomes
- Identify, evaluate, and share information, technologies, and best practices between state agencies to increase awareness and speed of implementation of best practices and increase the effectiveness of freight development initiatives. This will include a "Truck Parking Information Management System" data warehousing and performance metrics development effort that was approved, but not contracted, during TPF-5(293)
- Increase the awareness and utilization of the linkages between freight transportation investments and local, regional, and national economic development
- Continue to advocate and support a regional approach to freight planning, policy, and operations
- Keep abreast of industry and commodity trends and incorporate this information into MAFC communications and efforts; strive to be a clearinghouse for freight information and research
- Maintain the MAFC website as an up-to-date resource, a source of innovative freight development ideas, and as an information-sharing hub

• Actively contribute to the development of freight policy and national freight research direction through the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board (TRB)

FISCAL YEAR 2019 ACCOMPLISHMENTS

Major accomplishments include the following:
1. Completed Identification of Urban Truck Parking Locations in the MAASTO region
2. Completed Quantification of the Value of Multimodal Freight Investments
3. Completed Assessment of Multimodal Bottlenecks in the MAASTO region
4. Completed Freight Data Inventory and Training
5. Completed Truck Parking Information System (TPIMS) Performance Metrics and Data Warehouse Preparation

In addition, the MAFC held several conference calls with its members as needed and completed planning for and held its Annual Meeting in Indianapolis August 13-14, 2019.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Proposed research by the MAFC for fiscal year 2020-2021 includes the following:

1. Review and Assessment of Rail Waybill Data
2. Develop Regional Freight Plan
3. Evaluation of Air Freight Operations in the MAASTO states
4. Region-Wide Freight Survey
5. Benefits of Weigh Station Investments on Pavement Longevity and Expense
6. Update of Freight Plan Alignment Project
7. System Failure with Automated Vehicles and Truck Platooning: What is Safe?
8. Literature Review and Bibliography of Ports and Waterway Studies

Of the studies included in the 2020 MAFC Work Program, the Review and Assessment of Rail Waybill Data is completed. The Update of Freight Plan Alignment Project is underway and has a completion date of 2/28/21. The Evaluation of Air Freight Operations in the MAASTO states is also underway with a completion date of 08/01/2021. Work continues on data management and performance reporting for Truck Parking Information Management System Performance Metrics and Data Warehousing project. Coordination and development of TPIMS web-based data repository is continuing. Dr. Perry also participated in monthly MAASTO Planning Committee and MAASTO Motor Carrier teleconferences to support upcoming projects and track other freight-related work within the agencies.

The MAFC conducted its annual meeting virtually in FY 2020. The event was broken-up into three sessions which included business meetings and virtual presentations by MAFC staff/members, industry experts and federal agencies.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The current MAFC research program was planned for FY 2020-2021. The above eight research studies were continued and/or finalized in FY 2021 with cooperation of the member states. The MAFC again conducted its annual meeting virtually in FY 2021 with presentations by member states, external partners and federal agencies.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The following projects have been completed in calendar year 2022 or are nearly completed.

1. Truck Parking Information Management Systems (TPIMS). MAFC manages the TPIMS data warehouse.
2. COVID-19 Disruptions: Freight System and Agency Operational Changes Affecting Freight Planning.
3. Characteristics and Importance of Freight Aviation in the MAASTO Region.
4. Establishing MAASTO Emergency Divisible Load Management.
5. MAASTO Regional Freight Alignment: Regional Assets for Freight Movement and Economic Development.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The MAFC will be completed the following project throughout the remainder of calendar year 2022-2023. Additional projects for 2023-2024 will be selected and voted on by MAFC members and the MAASTO Board of Directors during calendar year 2023.

1. Truck Parking Information Management Systems (TPIMS). MAFC will continue to manage the TPIMS data warehouse.
2. Preparing for Future Truck Operations: Fleet Electrification and Alternative Fuels.
3. Multistate Freight Corridor Resiliency.
4. Collaborative Freight Planning and Economic Development: Maximizing State Marine Freight Planning.

JUSTIFICATION(S) FOR REVISION (S (List the approval date for the revision(s))

Per second quarter the MAFC has been approved for extension in funding and time for 1 year beginning March 31, 2022, through March 31, 2023.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MAFC and its member states continue to share results of the MAFC research.

Michigan Department
Of Transportation
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: National Cooperative Highway Research Program (NCHRP)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(422)		MDOT START DATE	10/01/2021
PROJECT NO.	Not applicable		MDOT COMPLETION DATE (Original)	09/30/2022
OR NO.	OR22-201		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre' Clover, 517-749-9001 CloverA@michigan.gov			
LEAD AGENCY:	Federal Highway Administration (FHWA)			
PROJECT MANAGER	Jean Landolt, 202-493-3146 Jean.Landolt@dot.gov			
CONTRACTOR	Not applicable			

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$1,246,598.00		BUDGETED AMT.	(Original)	$1,246,598.00
	(Revised)*	$1,434,182.00		ACTUAL COST	(Revised)	$1,434,182.00
TOTAL FY 2022 EXPENDITURES		$1,434,182.00		Total Committed Funds Available		$0.00

PARTICPATING STATES

The NCHRP 5-1/2% total for FY 2021 (50 states plus DC) was $54,081,535.00

PURPOSE AND SCOPE

Every federal fiscal year, State Departments of Transportation are solicited to contribute 5.5 percent of their State Planning and Research (SP&R) Program federal funds to the National Cooperative Highway Research Program (NCHRP) to ensure its continued successful operation. The NCHRP is a federal program in place to develop and fund national transportation research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide. The NCHRP disseminates information throughout the transportation community and conducts independent research that benefits various transportation agencies throughout the country.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Published Materials:
NCHRP reports are often written as guidebooks or manuals. However, supplemental research project material—such as appendixes, describe technical details, information-gathering activities, or survey instruments; glossaries; and bibliographies. These are disseminated online as web-only documents.

Published syntheses report on the state of the practice based on literature reviews and surveys of recent activities in critical areas.

Other types of published works are Research Results Digests (RRDs); Legal Digests (LRDs); Web-Only searchable documents and Selected Studies in Transportation Law.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT's NCHRP annual contribution is funded through its SPR Part B Program utilizing 100% federal funds.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Research findings are published in the NCHRP Reports series and the NCHRP Syntheses of Highway Practices series. MDOT technical experts have access to all NCHRP productions and continually review, share, and incorporate NCHRP research findings and recommendations into its business operations as appropriate.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Bridge Element Deterioration for Mid-West States

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(432)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-205		MDOT COMPLETION DATE (Original)	12/30/2021
			COMPLETION DATE (Revised)	11/30/2022
MDOT TECHNICAL CONTACT	Beckie Curtis 517-449-5243 CurtisR4@michigan.gov			
LEAD AGENCY:	Wisconsin DOT			
PROJECT MANAGER	Ethan Severson ethanp.severson@dot.wi.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$40,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

IADOT, IL, IN, KS, KY, MI, MN, ND, NE, OH, SD, WI. Total Partners Commitment Level: $540,077.00
MDOT Pledge Commitment FYs 2020-2021

PURPOSE AND SCOPE

The objective of this pooled fund research is to have multiple Mid-west DOTs pool resources and historic Mid-west DOT bridge data related to element level deterioration, operation practices, maintenance activities, and historic design/construction details. This data will provide the basis for research to determine deterioration curves. A select number of deterioration curves will provide needed utility for the time-dependent deterioration of bridge elements to be used in making estimates of future conditions and work actions. This effort will pool data and through the analysis and research processes create results that will improve accuracy of various bridge management and asset management applications that the member DOTs use (BrM, Agile Assets, and other).

This study will be sequenced into three tiers based on the priorities of the DOTs:

Tier 1 National Bridge Elements (NBE) & National Bridge Inventory)
- Develop element level deterioration curves for Reinforced Concrete Deck from data that will provide the basis for research to determine the deterioration curves
- Develop element level deterioration curves for Reinforced Concrete Slab from data that will provide the basis for research to determine the deterioration curves
- Develop deterioration curves for NBI items from data that will provide the basis for research to determine the deterioration curves
- Develop element level deterioration curves for Reinforced Concrete Deck after a major preservation activity such as mill and overlay with rigid concrete wearing course
- Develop predicted improvement in condition of Reinforced Concrete Deck element after a major preservation activity such as mill and overlay
- In addition to probabilistic deterioration curves, also develop deterministic deterioration curves that better may fit with field observations

Tier 2 Bridge Management Elements (BME)
- Develop element level deterioration curves for each type of wearing surface (bare concrete, sealed concrete, thin polymer overlay, PPC overlay, ridged concrete overlay, Polymer Modified Asphalt overlay, and asphalt overlay with membrane) from data that will provide the basis for research to determine the deterioration curves
- Develop element level deterioration curves for Strip Seal Deck Joints and Modular Deck Joints from data that will provide the basis for research to determine the deterioration curves
- Determine defect level deterioration curves that describe defect development and progression (e.g., cracking and delamination)
- Develop defect level deterioration curves for Paint system (protective steel) effectiveness
- Develop defect level deterioration curves for Steel Girder corrosion, and correlate to Paint system effectiveness; specifically, how long from new paint to 75% and 50% effective and end of life
- Develop element level deterioration curves for substructure elements in harsh environments (i.e., pier caps under expansion joints, pier columns in spray zone from snowplows, etc.)

The anticipated duration of this study will be 24 months. It is mainly the identification, collection, and analysis of existing information from the partner DOTs that will drive the schedule. We would like DOT Partners to participate for two years. This effort will stay abreast of and coordinate with other national efforts (AASHTO BrM and FHWA LTBP) to ensure efficiency and effectiveness in integration of results of this project into current BMS systems.

1. Work with DOT partners to identify and prioritize limited number of bridge elements and defects to develop deterioration models and curves from data that will provide the basis for research to determine the deterioration curves.

2. Data sources:
   a. FHWA can provide past submittals of NBI and NBE information
   b. Participating states in the study will provide access/copies of their bridge inspection data
   c. Non-participating states in the Mid-West Bridge Preservation Partnership will be encouraged to provide access/copies of their bridge inspection data
3. Contact FHWA Long Term Bridge Preservation to collect relevant data to analyze.
4. Use data to provide the basis for research to produce first generation of select deterioration curves with documented methodology to update these curves and add additional element curves.
5. Identify nondestructive technologies (NDT) to correlate historic element information (past NDT results) with actual field conditions.

FISCAL YEAR 2020 ACCOMPLISHMENTS (Benefits to MDOT)

Current accomplishments with the Midwest pooled fund include selecting a consultant, completing a literature review of the national practices for deterioration modeling of components, and submittal and aggregation of the partnership bridge data. The literature review brings value to MDOT by showing how other agencies are modeling the deterioration of their bridges. It also shows the benefits of each modeling procedure. The aggregation of bridge data is the first step to combining the partnerships data in support of an enhanced deterioration model for various bridge components. This brings value to MDOT by increasing the number of data points for our bridge data to support a more precise deterioration model improving MDOT's bridge asset management.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Collected data from all the states and developed a repeatable data screening strategy. Once the data was screened and checked by the agencies, the contractor developed preliminary models using excel. The preliminary models included deck and slab element models, wearing surface models, and all four NBI component models. The states began reviewing the data models and validating the assumptions the contractor had with their analysis. The states provided a series of questions back to the contractor regarding the analysis and the contractor is working to answer each question and update each of the models as necessary.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Completed the models for deck and slab, wearing surface, various substructure and deck elements and all four NBI Components. Agencies also received the supporting data screening tool that will give them the ability to update their supporting data to keep the analysis dataset current. The final report was submitted for final review and comment. This report summarized the findings, literature review, and some of the element and component management practices that states have. States reviewed the final report and provided comments. The contractor is working to update the final report as necessary.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The TPF website latest update show a project end date of November 30, 2022. Project is noted as behind schedule with 81% of the work completed and further time extension may be required.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Behavior of Reinforced and Unreinforced Lightweight Cellular Concrete for Retaining Walls

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(433)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-206		MDOT COMPLETION DATE (Original)	9/30/2022
			COMPLETION DATE (Revised)	9/30/2023
MDOT TECHNICAL CONTACT	Joel Tichenor 517-636-4933 TichenorJ@michigan.gov			
LEAD AGENCY:	Utah DOT			
PROJECT MANAGER	**David Stevens 801-589-8340** **davidstevens@utah.gov**			
CONTRACTOR	**Brigham Young University**			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$0.00		TOTAL BUDGET	(Original)	$30,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$0.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

CA, FHWA, KS, LA, MI, NY, OR, UT, and WA. Total Partners Commitment Level: $337,500.00 MDOT Pledge Commitment FY 2020

PURPOSE AND SCOPE

The overall objective of this study is to measure engineering design parameters and failure mechanisms for unreinforced and reinforced LCC backfills based on large-scale laboratory tests.

Funded tasks for this study include the following:

1. Perform literature review and survey to determine methods currently used in design of MSE walls with LCC backfill, and review performance of these walls since construction (where possible).
2. Conduct Unconfined Compressive Strength (UCS), triaxial shear, direct shear, unit weight, and other laboratory tests to define basic material properties of LCC backfill (Caltrans Class II) that is used during each of the five large-scale laboratory tests.
3. Perform a large-scale test on unreinforced LCC using a reinforced concrete, cantilever retaining wall on the open side of an existing BYU test box. Measure pressures on wall, wall deformations, and eventual failure planes during fill placement, curing, and after application of a surcharge load at the top of the cured fill surface. (This test will be performed after reviewing results of a similar test previously performed on a separate UDOT research project.)
4. Within the BYU test box, perform the following four large-scale tests using MSE wall panels with various arrangements of LCC fill reinforced with inextensible ribbed strip reinforcements:
   > Reinforced LCC Test 1 – MSE wall with LCC backfill,
   > Reinforced LCC Test 2 – MSE wall with LCC backfill against soil slope,
   > Reinforced LCC Test 3 – MSE walls on both sides of LCC and overlapping reinforcements, and
   > Reinforced LCC Test 4 – Pull-out tests on MSE wall.

   In these MSE reinforced LCC backfill tests, measure pressures on wall panels, wall deformations, force in reinforcements, and internal failure planes during fill placement and after application of a surcharge load at the cured fill surface. In the final test, the pull-out tests of reinforcements will be performed at a variety of vertical effective stress levels with and without surcharge.
5. Compare results with design methods. Define earth pressure coefficients, wall displacement, and failure surface geometry for the unreinforced LCC backfill test and the reinforced MSE wall LCC backfill tests. Define reinforcement pull-out resistance as a function of vertical stress and LCC strength. Compare measured earth pressure, tensile force, and pull-out resistance with available design methods.
6. Prepare two Final Reports that describe the test setup, test results, and provides comparisons with existing design procedures for (a) the unreinforced LCC test and (b) the reinforced LCC tests. The reports will also provide recommendations for design procedures based on test results and analyses of data relative to existing procedures.
7. Disseminate study results in periodic TAC update meetings and in other venues as funding allows.

FISCAL YEAR 2020 ACCOMPLISHMENTS (Benefits to MDOT)

Tasks 1, 2, 3, and 4 listed above have been completed. Data analysis and final reports have not been completed and disseminated.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Two additional tests were performed to acquire additional data related to MSE wall reinforcement in LCC Backfill. This brought the total number of tests to 6 (including the 4 tests originally listed in task 4 above). The first additional test involved MSE wall panels and LCC backfill with welded-wire reinforcements. The second additional test involved additional reinforcement pull-out tests. Data related to these additional tests was provided to the research team.

Task 5 started but has not been completed and disseminated.
Task 6 is in progress but has not been completed and disseminated.

FISCAL YEAR 2022 PROPOSED ACTIVITIES

Task 5 completed.
Task 6 reports have been provided to the team for review and comment but have not been completed and disseminated.
Task 7 to be completed after review and comment of the reports.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Project is 90 percent complete and pending completion of final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

No cost time extension required to complete final report.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2023.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Aurora Program **(FY20-24)**

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF- 5(435)		MDOT START DATE	10/01/2019
PROJECT NO.			MDOT COMPLETION DATE (Original)	09/30/2024
OR No.	OR20-212		COMPLETION DATE (Revised)	12/31/2024
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 RoathJ1@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				**MDOT Total Budget**		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$25,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$50,000.00

PARTICIPATING STATES

AK, AZ, CA, CO, IL, IA, KS, ME, MI, MN, MO, ND, OH, PA, UT, VA, WA, and WI. Total Partner Pledge Commitments: $2,250,000.00
MDOT Pledge Commitment FY 2020-2024

PURPOSE AND SCOPE

The Aurora program is a partnership of highway agencies that began in 1996 to collaborate on research, development, and the deployment of Road Weather Information Systems (RWIS) to improve the efficiency, safety, and reliability of surface transportation. It is managed by the Center for Weather Impacts on Mobility and Safety (CWIMS) which is housed under InTrans at Iowa State University.

Aurora's initiatives are funded by member agencies to conduct research that services the needs of its members. The board meets twice each year to set the agenda for RWIS research, keep informed about progress on program initiatives, and discuss solutions for common in the field problems. Newly selected initiatives are led by "champion" member agencies, managed by committees of Aurora members.

Aurora works closely with the Federal Highway Administration (FHWA), having been approved for federal-aid research and development funds without state match using 100% SPR funding. Aurora also has a strong relationship with the American Association of State Highway Transportation Officials (AASHTO) and its Snow and Ice Pooled Fund Cooperative Program (SICOP). In addition, Aurora coordinates with the American Meteorological Society (AMS), the National Severe Storm Laboratory, ITS America, Clear Roads, and the National Center for Atmospheric Research (NCAR). Aurora also works closely with industry as initiated by each participating entity.

FISCAL YEAR 2020 ACCOMPLISHMENTS

Administrative:

- Coordinated with states regarding new (or interim) Board representatives.
- Managed Aurora email list. In some cases, states requested multiple individuals be included in Aurora related correspondence.
- Provided program management in terms of projects and program budgets.
- Participated in planning call (July 10) for the 2020 International Road Weather and Winter Maintenance Conference.
- Prepared presentations about Aurora for members to discuss at the following meetings.
- Coordinated with SICOP.
- FHWA Road Weather Stakeholder Meeting held.
- Updated Aurora website content.

FISCAL YEAR 2021 ACCOMPLISHMENTS

Administrative:

- Aurora website updates.
- Ontario membership follow up.
- Manage budget.
- Track new solicitation contributions.
- Update the Aurora Charter, Work Plan and Associate Members.

Project-Specific Activities:

- Tracked project status and prepared a summary for recently completed and active projects.
- Distributed quarterly reports and invoices for project team approval.
- Upon approval, submitted invoices to the Iowa DOT for payment.

 2020-02 “Roadway Ice/snow Detection using a Novel Infrared Thermography Technology”.
 Distributed quarterly report to project team.
 Had project update presentation during the spring meeting.
 2020-03 Roadway Friction Modeling
 Facilitated sharing of some sensors in support of the project.
 Collaborated in project re-scoping.
 Distributed quarterly reports and invoices.

Meetings and Conferences:

Board member monthly conference calls were held on the following dates.
April 8, 2021
 Financials
 Membership
 Submitted ideas
 Additional solicitation

May 2021 meeting was held in conjunction with the Aurora Spring meeting.
2021 Aurora Spring Meeting
• Coordinated presentations from FHWA, SICOP and researchers.
• Prepared financial details, including commitment, encumbrances and available funds.
• Solicited project ideas for the 2021 Aurora Spring Meeting. A total of 14 ideas were received.
• Prepared spreadsheet for project voting.
• Organized and distributed project ideas and voting spreadsheet to Aurora Board.
• Obtained and integrated voting results for discussion during the spring meeting.
• Prepared and distributed questions to the proposers of the five highest rated project ideas.

Conference calls were held with two of the proposers

June 10, 2021
 Project idea update
 Project update
 Other action items – equipment compatibility, data logger use

FISCAL YEAR 2022 ACCOMPLISHMENTS

Project- Non-Invasive Sensor Deployment in Aurora Member States
Continue monthly Board meeting calls.
Continue to communicate with new Aurora representatives.
Seek additional project ideas from members.
Gather and distribute project ideas to members.
Continue to hold project-related meetings.
Collaborate and facilitate addressing project needs, relating to scope and/or budget changes, that may arise.

Meetings and Conferences:

Board member monthly conference calls
 Financials
 Membership
 Submitted ideas
 Additional solicitation

May 2022 meeting was held in Portland, OR.
2022 Aurora Spring Meeting
• Coordinated presentations from FHWA, SICOP and researchers.
• Prepared financial details, including commitment, encumbrances and available funds.
• Solicited project ideas for the 2022 Aurora Spring Meeting. A total of 19 ideas were received.
• Prepared spreadsheet for project voting.
• Organized and distributed project ideas and voting spreadsheet to Aurora Board.
• Obtained and integrated voting results for discussion during the spring meeting.
• Prepared and distributed questions to the proposers of the five highest rated project ideas.

October 2022 Meeting Held in Minneapolis, MN
- Friends of Aurora Presentations
- Final Project decisions
- Projects and Invoices
- State Commitments
- Management and Board Meeting Costs
- Overall Funds Available for Projects
- Discussion regarding 2023 Spring Meeting

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Continue monthly Board meeting calls.

Continue to communicate with new Aurora representatives.
Seek additional project ideas from members.
Gather and distribute project ideas to members.
Continue to hold project-related meetings.
Collaborate and facilitate addressing project needs, relating to scope and/or budget changes, that may arise.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The project start date was delayed due to budget needs not being met; thus, delaying the contract execution. The delay required moving project end date back to complete the work.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion December 31, 2024.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Development of Criteria to Assess the Effects of Pack-out Corrosion in Built-up Steel Members

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(436)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-201		MDOT COMPLETION DATE (Original)	9/30/2022
			COMPLETION DATE (Revised)	9/30/2024
MDOT TECHNICAL CONTACT	Allie Nadjarian 517-331-6602 NadarianA@michigan.gov			
LEAD AGENCY:	Indiana DOT			
PROJECT MANAGER	Tommy Nantung tnantung@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$40,000.00		TOTAL BUDGET	(Original)	$120,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$40,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

IIL, KS, MI, MN, PADOT, and TX. Total Partner Commitments $800,000 MDOT Pledge Commitment FYs 2020-2022

PURPOSE AND SCOPE

The objectives of the proposed pooled-fund study are as follows:

1) To develop AASHTO ready specifications for the evaluation of the effects of pack-out corrosion in built-up steel tension, compression, and flexural members.
2) Provide guidance on the need for repairs and corrosion rates that can be expected in various environments to assist owners in programming when repairs may need to be made.
3) Identify the most effective methods of repairs and provide suggesting verbiage that could be used when preparing special provisions for repairs.
4) Develop several case-study examples, including calculations that will be used for training users on the methodologies to be developed. It is anticipated that the research team will host a number of webinars or on-site training sessions to ensure technology transfer and implementation.
5) The impact of this study is obvious considering there is no such quantitative guidance available at present. The results of the work will allow owners to accurately assess the effects of this form of corrosion on various limits states (e.g., strength, fatigue, buckling, etc.) in built-up steel members. Both flexural and truss-type members will be studied. The ability to program repairs based on data-driven models allows for the best possible use of limited maintenance funds and safely extend the life of the existing inventory.

Research Tasks:
To achieve the proposed objectives, the following tasks are proposed:
Task I – Perform a thorough literature review of both domestic and international research on pack-out corrosion, how various owners have addressed this problem, repair strategies, and collect data on corrosion processes and rates.

Task II – Develop a laboratory experimental program that will include large-scale testing of members which contain damage due to pack-out. At present, the research team will explore the use of both simulated pack-out (i.e., newly fabricated components with induced local distortions that simulate pack-out) and “natural” pack-out by obtaining members from various bridge being removed from service. The effects of temperature on the performance of damaged members will also be included in the laboratory testing as the fracture toughness of some older steels is minimal at low temperatures. In this regard, testing of tension and flexural members will be completed at cold temperatures. The benefits of internal redundancy will also be examined. Finally, various mitigation strategies will also be investigated. While there are some anti-corrosion products currently available on the market, it is not clear how to evaluate the effectiveness of these products. Therefore, a portion of the work will focus on the evaluation of such products and to subsequently develop methods to assess the short- and long-term effectives of such products.

Task III – As data become available from Task II, the research team will conduct numerical (FEA) parametric studies to allow a wider range of damage to be evaluated under various geometries and loading conditions which are not possible to include in the laboratory studies. It is noted the research team at Purdue University has gained extensive experience in the laboratory testing and calibrated non-linear FEA of built-up steel members during the development of the recently published AASHTO Guide Specifications for Internal Redundancy of Mechanically fastened Built-up Steel Members.

Task IV – Based on the results of Tasks I through III, proposed guide specifications for the evaluation of the effects of pack-out corrosion will be developed for consideration by AASHTO COBS. The research team has considerable experience in the development of AASHTO Specifications and has worked very closely with various AASHTO subcommittees to ensure all stakeholders, including FHWA, are involved and have input.

Task V - In addition to developing the Guide Specifications, a methodology to estimate the interval from when “non-critical” pack-out becomes “critical” pack-out corrosion will be developed. This information will be particularly useful to owners when programing funding for future repairs. Finally, guidance on the best practices for the repair of pack-out corrosion, when deemed required, will also be compiled.

Task VI – Develop training materials to ensure the results are disseminated and the research is moved into practice.

Task VII – Summarize the results of the research in a detailed Final Project Report.

FISCAL YEAR 2020 ACCOMPLISHMENTS

In spite of the challenges with Purdue being shut down from approximately mid-March through the end of June due to COVID-19, reasonable progress has been made regarding the finite element studies to evaluate the effects of pack-out on the strength of compression members. Analysis have begun to consider the effects of pack-out in flexural members considering fastener pitch, cover plate thickness, flange thickness, and degree of pack-out distortion on the strength of the member. The studies will be used to develop the details associated with the experimental portion of the research.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Prototype testing focusing on the compression flange of a beam was completed. Three tests in total were performed. A W24x68 with top and bottom cover plates was tested to focus on pack-out in a compression flange. Tests included zero distortion of the cover plate as well as various levels of distortion due to simulate pack out. For this test, no section loss was introduced to isolate the effect of the pack-out. The test yielded valuable data regarding the effect of distortion on fastener forces, local stresses, and stiffness. The second test included a girder with simulated section loss and no simulated distortion and a third specimen which included a cover plate having simulated section loss and with simulated pack out distortion. The section loss was simulated by machining material away in a profile similar to what has been measured from real specimens.
- The data from the two additional prototype tests were used to further calibrated the FEA studies. As with the other tests, excellent agreement between the laboratory measured data and the FEA results have been observed.
- An entire truss has been obtained from INDOT which included members with moderate to severe pack-out that has been taken out of service. Work is underway to develop tests which will utilize these members to evaluate the strength as well as fatigue/fracture performance.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- The tests on small portions of members with real pack out corrosion was completed, and data was reviewed and used to calibrated FEA simulations. These specimens were subjected to compression loading to evaluate the effect of section loss and distortion on local buckling. These data will be used along with the data from the compression flange girder tests to begin to develop strategies to evaluate the effects of pack-out on the capacity of compression members.
- The large-scale fatigue specimens have been fabricated and shipped to the lab.
- Continued calibrating FEA models based on the experimental data. 3D mapping of the distortion from pack-out and section loss is being incorporated into the girder FEA models to identified regions of amplified local stresses.
- Continue to calibrate FEA models of compression flanges and axial members using the large-and small-scale test date. These data will be used along with the data from the compression flange girder tests to begin to develop strategies to evaluate the effects of pack-out on the capacity of compression members. FEA parametric studies are underway for these compression members.
- Began fatigue testing the large-scale girders. The testing began later than anticipated due to equipment issues. The tests are being run at low stress ranges (7 ksi) to obtain data at stress range levels representative of in-service bridges. Hence, they will take a very long time to complete. There are 4 girders in total that will be fatigue tested.
- Continued calibrating FEA models based on the experimental data.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Continue with the finite element studies and based on the results of the prototype test, develop the detailed experimental program for compression flanges.
- Continue analytical and experimental studies on tension flanges with pack-out corrosion.
- Continue fatigue testing of corroded girders.
- Obtain additional members with pack-out corrosions.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The project will require a 12-18 month no cost extension. While the “official project start date on the TPF website was effectively September 2019, commitments did not arrive until spring of 2020. This was documented in the earlier QPRs from 2019 and 2020. COVID 19 then shut the university down in Spring of 2020 and no work could be performed and no students were hired out of caution. In order to perform all of the long-life fatigue and strength testing, finish all FEA studies, compile all project results, etc. a no-cost extension will be requested through FY24.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2024.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Technology Transfer Concrete Consortium (FY20-FY24)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(437)		MDOT START DATE	10/01/2019
PROJECT NO.	OR20-207		MDOT COMPLETION DATE (Original)	12/31/2025
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy 517-749-9067 KennedyK@Michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute Khyle.Clute@iowadot.us			
CONTRACTOR	Iowa State University			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$12,000.00		TOTAL BUDGET	(Original)	$80,000.00
	(Revised)				(Revised)	$60,000.00
TOTAL FY 2022 EXPENDITURES		$12,000.00		TOTAL COMMITTED FUNDS AVAILABLE		$36,000.00

PARTICIPATING STATES

AL, CA, CO, FL, GA, IA, ID, IL, IN, KS, KY, MA, MI, MN, MO, MT, NC, ND, NE, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, WA, WI, WV, and WY. Total commitment received: $1,828,000.00. MDOT Pledge Commitment FYs 2020-2024

PURPOSE AND SCOPE

The goals of the Technology Transfer Concrete Consortium (TTCC) are to:
- Identify needed research priorities by region
- Provide a forum for technology exchange between participants
- Develop and fund technology transfer materials
- Provide on-going communication of research needs faced by state agencies to the Federal Highway Administration (FHWA), industry, and the National Concrete Pavement Technology Center (CP Tech Center)
- Provide technical leadership for concrete related national initiatives to advance state-of-the-art construction and material practices

It is anticipated that this consortium would become the national forum for state involvement in the technical exchange needed for collaboration and new initiatives and provide tactical strategies and solutions to issues identified by the member states.

This pooled fund project allows for state representatives to continue the collaborative efforts of TPF-5(313) that originally began in TPF-5(066) Materials and Construction Optimization. The TTCC is open to any state agency desiring to be a part of new developments in concrete. TTCC will meet in conjunction with the National Concrete Consortium (NCC), twice a year. NCC Bylaws and the Executive Committee membership can be found at http://www.cptechcenter.org/ncc/TTCC-NCCMeetings.cfm.

TTCC Project Activities and Deliverables:
- Identify and guide the development and funding of technology transfer materials such as tech brief summaries, web-based courses, and training materials from research activities
- Publish Moving Advancements into Practice (MAP) Briefs on a quarterly basis
- Provide research ideas to funding agencies
- Identify and instigate needed research projects
- Include current activities and deliverables of the pooled fund on the CP Tech Center website
- Maintain the pooled fund project website with current activities and deliverables
- Maintain the TTCC pooled fund listserv; a forum for state reps to post questions to the other state reps and hear how similar problems or situations have been mitigated.
- Track TTCC listserv posted problems and discussions and categorize them for inclusion in a library on the project website
- Develop research problems statements for possible pooled fund projects to address research needs identified by member state reps
- Act as a technology exchange forum for the participating entities
- Contribute to a technology transfer newsletter on concrete pavement research activities every six months
- Submit electronic quarterly reports following lead state guidelines

Pooled fund activities and budgets are discussed at the semi-annual meetings. Proposals for minor research, synthesis studies, and/or training are often presented by partners and then discussed and voted on at the semi-annual meetings. NCC members may propose needed research and/or training, however they may not vote on how to utilize the federal pooled funds. Selection of needed work by partners does not guarantee work can be conducted under this pooled fund project since the Iowa DOT and FHWA must ensure the work will fit within the funding guidelines and scope of the project. Occasionally e-mail discussions and votes are warranted.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The spring meeting, which was scheduled for April 2020 in Nashville, TN, was postponed due to COVID-19.
The fall face to face meeting scheduled for Minneapolis, MN was postponed due to COVID-19.
The fall "virtual" meeting was held September 1-3, 2020. The agenda was comprised of the following:

- FHWA Alkali-Silica Reactivity (ASR) Update
- Managing ASR for the Future
- Post-treating for ASR
- Lightweight Cellular Concrete
- Performance Engineered Mixture (PEM) Testing Experiences
- Dowel/Tie Bars
- National Transportation Product Evaluation Program (NTPEP) Update
- Pumping Concrete
- National Road Research Alliance (NRRA) Update

FISCAL YEAR 2021 ACCOMPLISHMENTS

This pooled fund project, TPF-5-(437), is a continuation/reauthorization of TPF-5(313). The Spring 2021 meeting for TPF-5(437) was tentatively scheduled to be held in Nashville, TN on April 13-15. However, it was, again, switched to a virtual web meeting. The fall 2021 meeting was replaced by registration and attendance to the International Conference on Concrete Pavements. Several MDOT CFS staff attended this weeklong virtual web-based conference, which showcased many very informative topics relative to concrete pavements, presented by experts throughout the world.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Held NCC Spring 2022 at the Embassy Suites in Nashville on April 4-6. Attendees included 197 in-person and 75 virtual from 39 states, District of Columbia, Puerto Rico, and Canada. Information and PowerPoints from the presentations are available: https://intrans.iastate.edu/events/spring. Spring e-news is available: https://mailchi.mp/9695b280bd3c/spring-2022-nc2-news. The Fall 2022 meeting was held in Detroit on September 27-29. E-news and MAP Brief were published.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Spring and Fall conferences will be held. Technology transfer and exchanges will remain a major focus. Plans to identify and facilitate research activities. Maintain and update pooled fund website.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT's Technical Contact requested a pledge level for 3 MDOT representatives. The RAC chair approved 2 MDOT representatives.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion FY 2024.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Smart Work Zone Deployment Initiative (FY20-FY24)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(438)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-200		MDOT COMPLETION DATE (Original)	12/31/2025
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Lindsey Renner 517-202-5356 RennerL1@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute Khyle.Clute@iowadot.us			
CONTRACTOR	Iowa State University			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$125,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$25,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$50,000.00

PARTICIPATING STATES

IA, IL, KS, MI, MO, NE, TX, and WI. Total Partners Commitment Level: $1,250,000.00 MDOT Pledge Commitment FYs 2020-2024

PURPOSE AND SCOPE

This program represents an on-going effort among cooperating states' Departments of Transportation (DOTs), the Federal Highway Administration (FHWA), universities, and industry to evaluate new products and conduct related research focused on the enhancement of safety and mobility in highway work zones. Over 100 studies and evaluations have been completed since the inception of the SWZDI and final reports are posted in the Smart Work Zone Deployment Initiative (SWZDI) web site at https://swzdi.intrans.iastate.edu/.

Procedures for Project Selection, Award, Implementation

1. Board of Director (BOD) members solicit and develop problem statements.
2. BOD prioritizes problem statements.
3. Program administrator prepares Request for Proposals and collects proposals from researchers in partnering states.
4. BOD prioritizes proposal topics.
5. BOD reviews, discusses, and prioritizes submitted proposals.
6. Proposal are scored and ordered based on priorities collected in item 5 and weighted values that are based on state partner commitments that year.
7. Annual work plan is prepared by the program administrator who also facilitates contracts between the selected researcher(s) and the Iowa DOT.
8. State DOTs form and lead the individual project Technical Advisory Committees (TACs) for projects awarded to a university or entity in their state (other members can request to serve on the TAC).
9. Projects are tracked quarterly.
10. Draft final reports are reviewed by the home state as well as by the BOD.
11. Final reports are posted to the program webpage and sent to national research report repositories.
12. Implementation and technical transfer opportunities are discussed by the BOD.

Research Implementation and Technology Transfer Benefits: The benefits from the SWZDI pooled fund include a wide variety of products including completed research reports, technical transfer documents, potential presentations and training, safety equipment evaluations, support toward other research, as well as development and/or implementation of research results in areas of mutual interest and benefit to pooled fund members and others in the industry.

FISCAL YEAR 2020 ACCOMPLISHMENTS

For the 2020 program, 30 problem statements were developed; the BOD decided that 10 problem statements should be included in the annual Request for Proposals (RFP). The RFP was distributed to potential researchers at research institutions in contributing states on October 25, 2019.

The three top ranked proposals could be funded and were selected for the 2020 program year and are expected to total $200,000.

List of Approved projects

1. Temporary Traffic Control Devices at Driveways within a One-Lane, Two-Way Section
2. Using Smart Work Zone Trailer Data to Evaluate and Predict Lane Closure Impacts with a Consideration of Work Intensity
3. Work Zone Activity Data Logging – Phase II

Project 3.a is with Michigan State University and is taking place on MDOT project sites. This data collection would have been completed in house but was able to be performed by MSU instead due to the selection of the project. The voting influence gained by MDOT being an active member played a large role in this project being selected.

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Reports completed during the 2021 fiscal year are as follows:

1. Using Smart Work Zone Trailer Data to Evaluate and Predict Lane Closure Impacts with a Consideration of Work Intensity
   This report describes the implementation of machine learning (ML) models to the prediction of work-zone traffic impacts including local speed and traffic volume changes and corridor-level travel time increases. It also summarizes efforts to refine an existing tool that estimates work-zone-related delays and costs by providing consistent estimates of typical travel times that consider variations across days of the week and months of the year.
2. Work Zone Data Management Applications and Opportunities
   This project reviewed various stakeholders' current needs for pre-construction, real-time, and post-construction work zone information and compared these needs to the available work zone data sources and standards. The analysis identified a substantial mismatch between the roadway and lane closure data currently available and the data required to manage work zone traffic impacts effectively. To address this gap, the project developed a conceptual prototype for a tool that would facilitate self reporting of closure details by contractors and maintenance crews.

FISCAL YEAR 2022 ACCOMPLISHMENTS

The Reports completed during the 2021 fiscal year are as follows:

1. Investigation of Autonomous/Connected Vehicles in Work Zones
   This study is the first research project that examined truck platooning in work zones. A networked or federated simulator was used in which a vehicle driven by a human subject encountered a truck platoon with the lead truck driven by a human driver. The experiment involved 10 scenarios composed of differences in education, truck signage, and number of trucks in the platoon. The results point to the importance of education as the post-education vehicle speeds increased between 8.6% and 12.9% across scenarios, and the distance headways decreased between 28.8% and 30%. The vehicles increased in efficiency while still staying under the work zone speed limit.
2. Effective Signing Strategies and Signal Displays for Work Zone Driveway Assistance Devices (DADs)
   Work zones that include a single lane closure on a two-lane, two-way roadway present unique traffic control challenges. In these situations, traffic regulators (i.e., flaggers or temporary traffic signals) are often utilized to regulate traffic such that only a single direction utilizes the open travel lane at any time. Recently, an experimental traffic control treatment, referred to as the driveway assistance device (DAD), was developed to help drivers safely enter a one-lane, bi-directional work zone from a driveway or minor side street by using alternating left and right flashing arrows along with a steady red indication. As the DAD is a relatively new and under-researched treatment, much is still unknown about the optimal designs of the signal display and auxiliary signage to provide the highest comprehension and compliance.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

The 2023 problem statements RFP have been sent out and are as follows:

Subject #1: Usefulness and Reliability of Probe Date when Altering Work Zone Message Signs
Subject 2: Guidance for Incorporating Work Zone Data within Traffic Management Operations
Subject 3: Work Zone Presence Lighting
Subject 4: Merging Implementation Criteria

Once all RFPs are submitted the board will review and determine which will be funded for the fiscal year 2023.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

When Temporary Traffic Control Devices at Driveways within a One-Lane, Two-Way Section is completed, a recommendation will be proposed to FHWA to include a new traffic control device in the MUTCD. This would allow for expanded MOT design on MOT projects without seeking special approval from FHWA DC, as the device in question is under experimental use. If this approval take place new specifications and standard drawings will be created. Other current studies could also lead to updating MDOT polices to improve work zone safety allowing MDOT to reach its goal of Towards Zero Deaths. This report is still pending final approval and implementation will take place after approval.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: No Boundaries Transportation Maintenance Innovations

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(441)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-208		MDOT COMPLETION DATE (Original)	9/30/2024
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Todd Rowley 517-322-3311 RowleyT@michigan.gov			
LEAD AGENCY:	Colorado DOT			
PROJECT MANAGER	David Reeves **303-757-9518** david.reeves@state.co.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$50,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$10,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$20,000.00

PARTICIPATING STATES

CA, CO, CT, FL, ID, IL, IN, LA, MDOT SHA, ME, MI, MN, MO, MS, ND, NY, OH, SC, TX, VA, WA, WI
Total Partners Commitment Level: $830,000.00 MDOT Pledge Commitment FYs 2020-2024

PURPOSE AND SCOPE

Through this pooled fund project, the Colorado Department of Transportation (CDOT) will work with other State Departments of Transportation (DOTs) to facilitate the transfer of knowledge of promising non-snow and ice maintenance innovations and technologies. This project provides a forum for State DOTs to share their maintenance innovations with each other, support technology transfer activities and develop marketing and deployment plans for selected innovations through bi-annual 2-3 day peer exchange meetings at various locations selected by participating members. Resources will be provided for the transfer of knowledge and experience of various innovations that includes travel, training, and other technology transfer activities.

It is anticipated that this consortium will become the national forum for state involvement in the technical exchange needed for collaboration and new initiatives and be a forum for advancing the application and benefit of research technologies. In addition, the project will create a searchable database or warehouse where innovations and research done relating to highway maintenance can be found and showcased. State participation in this process will be through the pooled fund. FHWA, industry and others will be invited to participate in the project discussions and activities.

Workshops will continue to be provided for the states participating in the pooled fund project. This project will help DOTs to save time and money by not investing in the same research that has already been performed by other state DOTs. Rather than having each DOT identify and conduct research separately, DOTs can work collectively through this pooled fund project.

The Colorado DOT will serve as the lead state for the execution of the pooled fund project described in this proposal. The Colorado DOT will handle all administrative duties associated with the project.

1) Identify promising innovations and technologies ready to be deployed within Maintenance activities, developed by the participating State DOTs, non-participating DOTs, and outside entities.
2) Develop marketing plans for selected ready to deploy innovations and technologies
3) Organize training classes about specific research topics for member State DOTs.
4) Develop searchable database where innovations and research projects developed across the country can be identified and accessed.
5) Maintain a web site along with content management: http://maintainroads.org
6) (Optional depending on amount and interest level) Creation of synthesis (practice or literature) like reports that will dig deeper into "like issues" facing State DOT operations of maintenance. Topics might include, although not limited to (based on current hot topics):
   a. Employ recruitment & retention including maintenance degree like opportunities.
   b. Asset Management
   c. Emergency and Resiliency Management
   d. Roadside Maintenance such as pollinators
   e. Increased communication opportunities between No-Boundaries and related FHWA-AASHTO-MAC committees/and or groups
   f. New product innovations or best practices specific to operations of maintenance
7) Considering results of #6 above
   a. Develop appropriate workshops
   b. Peer Exchanges
   c. Webinars
   d. Website enhancements (http://maintainroads.org/)
   e. Best practice or manual development

8) Also considering results of #6 - Scope research necessary for funding/management, by others, that will vary dependent upon the nature and scope of the topic.

FISCAL YEAR 2020 ACCOMPLISHMENTS

FY 2020 has accomplished establishing the transition to No Boundaries Phase III from Ohio's lead in Phase II. No Boundaries transition team completed the Request for Proposals (RFPs) and consultant selection to manage the pool fund. Setting up the next phase included a series of monthly transition meetings, scope of work development, fund transfers, CDOT contracting process and consultant selection to manage the pool fund. Consultant contract was signed on Sept 1, 2020, and task order 1 signed in late Oct. Pool fund activities should resume with contracts and task order in place.

FISCAL YEAR 2021 ACCOMPLISHMENTS

FY 2021 will move forward with the above-mentioned activities using web-based format to replace travel requirements.
Because of COVID-19 pandemic from early 2020 and ongoing, our group has not had a "face to face" meeting since May of 2019 in Denver CO. Also, a factor for 2020 was the expiration of the managing contract for No Boundaries. As of 10/01/2020, Colorado has excepted the role as lead state and CTC & Associates LLC as the managing source with future virtual training session planned but not scheduled as of 10/2020. Update: No Boundaries did have a "face to Face" meeting in Denver on September 14th and 15th. Michigan attended virtually because of the short notice and lack of out of state travel approval.

FISCAL YEAR 2022 ACCOMPLISHMENTS

No Boundaries is continuing to improve on our on-line database of innovations. The group had its most recent "face to face" meeting in May 2022 at CALTRANS Sacramento CA facility which MDOT attended. Also planned for 2022 is a "face to face" meeting in Indianapolis IN in October of 2022 which will be attended by an MDOT representative.
MDOT benefited from the Sacramento CA "face to face by learning of a new QR code process of providing safety and training videos on demand for equipment operations and safety. Process is ongoing and planned to be rolled out in 2023.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Planned 'face to face" meeting for 2023 in Saint Louis MO in the spring.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion September 30, 2024.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Traffic Safety Culture - Phase 2

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(444)		MDOT START DATE	10/1/2019
PROJECT NO.	OR20-211		MDOT COMPLETION DATE (Original)	9/30/2024
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov			
LEAD AGENCY:	Montana DOT			
PROJECT MANAGER	Susan Sillick ssillick@mt.gov			
CONTRACTOR	Montana State University- Western Transportation Institute/Center for Health and Safety Culture (CHSC)			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00		TOTAL BUDGET	(Original)	$50,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$10,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$20,000.00

PARTICIPATING STATES

Kentucky Department of Transportation, CA, CT, GADOT, IADOT, ID, IL, IN, KS, KY, LA, MI, MN, MS, MT, NV, TX, UT, VT, WA.
Partners Total Commitments: $1,430,000.00

PURPOSE AND SCOPE

Only through the growth of a positive safety culture can significant and sustainable reductions in crash fatalities and serious injuries be achieved. Towards that end, this pooled fund program will:

(1) Conduct research to identify solutions to specific culture-based traffic safety problems, taking advantage of the implementation opportunities to improve traffic safety.
(2) Develop resources to enhance understanding and application of traffic safety culture strategies; and
(3) Provide technology transfer of best practices in traffic safety culture strategies.

This program will support integrated and multiyear research to guide the transformation of local, state, and national traffic safety culture. Funding partners determine the priority issues each year, and work plans are developed for the selected issues.

Three types of effort are expected in this pooled-fund program:

- Could propose culture-based research directed to specific traffic safety problems. For example, there are common behavioral risk factors amongst most state Strategic Highway Safety Plans (SHSP) such as impaired or distracted driving that can be influenced by culture.
- May generate ideas for general “services and tools” to support the understanding and application of traffic safety culture in the safety plans of project partners. For example, online courses on traffic safety culture for workforce development or a repository of relevant literature and case studies of best practice relevant to addressing the cultural factors of a risky behavior could be created.
- Can be used to implement a limited number of demonstration projects to evaluate specific strategies to transform traffic safety culture in select communities, which could then be applied elsewhere.

FISCAL YEAR 2020 ACCOMPLISHMENTS (Benefits to MDOT)

Guidance for Evaluating Traffic Safety Culture Strategies - The completion of this project is key to all future activities for the pooled fund study as it will lay out the basis for how research will be conducted. We have learned to change the culture we need to change people’s beliefs to change their behavior, which in turn will move the safety culture needle. In a safety effort, we need to convince people that a change in the bad behavior will have minimal impacts on them.

FISCAL YEAR 2021 ACCOMPLISHMENTS

- Guidance on Messaging to Avoid Reactance and Address Moral Disengagement – project is complete with webinar and poster given in addition to final report. In addition, information sheets were developed for aggressive driving and seat belt use.
- Guidance to Promote Workplace Policies and Family Rules to Reduce Cell Phone Use While Driving and Promote Engaged Driving - project is complete with webinar and poster given in addition to final report.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- A Review of Methods to Change Beliefs – project is completed with the following deliverables: PowerPoint slides, webinar, poster, and the final report
- Resources and Tools to Reduce Multi-Risk Driving Behaviors – Task 1 Literature Review and Task 2 Content Development of Brief Intervention are completed. Expected completion is October 2023.
- Resources and Tools to Improve Pedestrian Safety – Task 1 Literature review is 40% completed. Expected completion is October 2025.
-

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Resources and Tools to Reduce Multi-Risk Driving Behaviors – Task 3: Test Brief Intervention and Task 4: Create Resources and Complete Final Report. Expected completion is October 2023. The deliverables for this contract include quarterly reports, task reports, guidance resource, PowerPoint slides, webinar, poster, and the final report.
- Resources and Tools to Improve Pedestrian Safety – Task 2: Understand the Culture of Pedestrian Safety. Expected completion is October 2025.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The results from this pooled fund study will help MDOT better understand the influences on the safety culture and what role an engineering organization has on reducing fatalities and serious injuries on Michigan's roadways. Until we understand the impacts on the culture; we cannot be certain if we are truly impacted or whether there is further needed to work more efficiently with our safety partners. In addition, all results are to be shared with the Michigan Office of Highway Safety Planning.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Traffic Control Device (TCD) Consortium (3)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(447)		MDOT START DATE	1/1/2021
PROJECT NO.			MDOT COMPLETION DATE (Original)	2/28/2025
OR NO.	OR21-207		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Mark Bott 517-335-2625 BottM@michigan.gov			
LEAD AGENCY:	FHWA			
PROJECT MANAGER	Laura Mero, 202-493-3377 Laura.Mero@got.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$20,000.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$20,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$60,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

New Jersey DOT, AL, AZDOT, CO, DE, FL, GADOT, IADOT, IL, KS, KY, MA, MDOT SHA, MI, MO, MS, MT, NC, NE, NHDOT, NJ, NY, OR, PADOT, SC, TN, TX, WI: Partners Total Commitments**:** $1,750,000.00

PURPOSE AND SCOPE

This project is being created to re-new the contract for Pooled Fund Project TPF-5(316). All new Funding Commitments will need to be made on the Pooled Fund Website to this new project and all new funds will be transferred to the Lead State/Agency by the partners. The Lead State/Agency will have the responsibility for Receiving, Obligating, Expending, and Balancing the funding for this project.

To assemble a consortium composed of regional, State, local entities, appropriate organizations and the FHWA to 1) establish a systematic procedure to select, test, and evaluate approaches to novel TCD concepts as well as incorporation of results into the MUTCD; 2) select novel TCD approaches to test and evaluate; 3) determine methods of evaluation for novel TCD approaches; 4) initiate and monitor projects intended to address evaluation of the novel TCDs; 5) disseminate results; and 6) assist MUTCD incorporation and implementation of results.

The TCD Consortium will focus on systematic evaluation of novel TCDs, employing a consistent process that addresses human factors and operations issues for each TCD idea. Providing local and state agencies responses to their needs and to new technologies with the right assessment skills and tools will enable consistent TCD idea identification and evaluation. TCD Consortium efforts will address TCD issues identified by local and state jurisdictions, industry, and organizations and aid in the compliance to the MUTCD rule-making process and incorporation of novel TCDs into the MUTCD.

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

Work continues in FY 2021 on the following topics.

- Evaluation of Additional Alternatives of and Arrow Sizes for Overhead Arrow per Lane Guide Signs
- Enhancing Conspicuity for Standard Signs and Retroreflectivity Strips on Posts
- Sign Guidance for Zipper Merge

While no products have been delivered to date the outcomes will shape the standards and guidance in the Manual on Uniform Traffic Control Devices and thus impact MDOT operating practices for each of these areas.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Held the Annual meeting in person in August in San Diego

Progress has been made on the following:

- Advisory Speed Signs on Ramps: 1) Had kick-off meeting; 2) Currently processing information from most participating states; 3) A work-plan will be presented in October 2022
- Sign Guidance for Zipper Merge: 1) The research team completed data collection in New Hampshire and most of the data collection in North Carolina and Maryland. 2) In addition, the team has analyzed data collected from the three locations. 3) They are looking to finalize the research and host a final meeting
- Enhancing Conspicuity for Standard Signs and Retroreflectivity Strips on Posts: The research team has provided edits to the FHWA publications team, and the final version has been developed for publication.
- Evaluation of Additional Alternatives of and Arrow Sizes for Overhead Arrow-per-Lane Guide Signs: 1) Finished data collection, 2) Began data analysis.
- Evaluation of Symbol Signs: Phase IV Report completed, updated 2017 report (LINK)

- Countdown Pedestrian Signals Legibility and Comprehension without Flashing Hand: Phase I and II Report completed, updated 2015 report (LINK)
- Intersection Conflict Warning System Human Factors: Final Report 2016 (LINK)
- Signing, in Combination with Lane Markings, in Advance of Lane Reduction Transitions: Final Report 2019 (LINK)
- Alternative Fuels State of Practice Review: Final Report 2019 (LINK)
- Guide Sign Design: Final Report 2016 (LINK)

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Initiate research surrounding the understanding, layout and design of multi-lane roundabout signing and marking. If this research is being covered by other efforts or there is enough funding to perform another effort, then it is proposed to do research on driver perspectives and understanding of many symbol signs.
- Advisory Speed Signs on Ramps: 1) Field Review of selected sites and 2) Analysis data from field review.
- Sign Guidance for Zipper Merge: 1) The research team will complete after data collection in Maryland and North Carolina. 2) The research team will analyze the remaining data. 3) The research team will prepare the draft extended tech brief. 4) Final Report should be completed
- Evaluation of Additional Alternatives of and Arrow Sizes for Overhead Arrow-per-Lane Guide Signs: 1) Finish data analysis, 2) Present findings; 3) Prepare extended technical brief and submit for review

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Once completed the results will be distributed to the Traffic Safety Statewide Alignment Committed for consideration and necessary modifications to the MDOT standards and guidance.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: **Automated Vehicle Pooled Fund Study**

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(453)	MDOT START DATE	10/1/2020
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2025
OR NO.	OR21-203	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Collin Castle, 517-636-0715 CastleC@michigan.gov		
LEAD AGENCY:	Ohio DOT		
PROJECT MANAGER	Jill Martindale, 614-644-8172 jacquelin.martindale@dot.ohio.gov		
CONTRACTOR			

BUDGET STATUS

FY 2022 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$50,000.00	TOTAL BUDGET	(Original)	$250,000.00
	(Revised)			(Revised)	
TOTAL FY 2022 EXPENDITURES		$50,000.00	**TOTAL COMMITTED FUNDS AVAILABLE**		$150,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

CT, MDOT SHA, MI, MN, OH, PADOT, TX / Total Commitment Received: $1,850,000.00 MDOT Pledge Commitment FY21-25

PURPOSE AND SCOPE

Through this pooled fund, the Ohio Department of Transportation (ODOT) will work with federal and state departments of transportation to establish multiple projects to research vehicle-roadway interaction including data failures and mitigation methods, identify and define standards, and encourage interoperability across state borders.

The pooled fund study will focus on the following:
- Independently research and address issues that will affect the deployment of Automated Vehicle systems by state transportation agencies
- Support AASHTO's Strategic and Deployment Plans
- Support USDOT's Automated Vehicle Policy

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

Worked with PFS members to decide on initial projects and study scope.
Selected consultant and started project entitled Infrastructure Owner Operator Strategic Roadmap for Accelerated Adoption of Automated Vehicles

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Completed Infrastructure Owner Operator Strategic Roadmap project.
- Select consultant and begin research on Automated vehicle industry forum project

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Launch AV Industry Forum

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT will benefit from the information from all current and proposed projects. The strong Infrastructure Owner Operator focus of projects, in particularly the current Strategic Roadmap project will help MDOT plan for potential changes to practices or infrastructure as new technology emerges.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Flood-Frequency Analysis in the Midwest: Addressing Potential Nonstationary Annual Peak-Flow Records

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(460)	MDOT START DATE	10/1/2021
PROJECT NO.	OR22-208	MDOT COMPLETION DATE (Original)	9/30/2024
		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Erik Carlson, 517-230-8180 Carlson E2@michigan.gov		
LEAD AGENCY:	South Dakota DOT		
PROJECT MANAGER	David Huft dave.huft@state.sd.us		
CONTRACTOR			

BUDGET STATUS

FY 2022 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$55,600.00	TOTAL BUDGET	(Original)	$166,800.00
	(Revised)			(Revised)	
TOTAL FY 2022 EXPENDITURES		$55,600.00	**TOTAL COMMITTED FUNDS AVAILABLE**		$111,200.00

PARTICIPATING STATES

IADOT, IL, MI, MN, MO, Montana DNRC, SD, WI Partners Total Commitments: $1,445,600.00

PURPOSE AND SCOPE

The overall goal of this study is to evaluate the combined effects of multidecadal climatic persistence (including hydroclimatic shifts), gradual climate change, and land-use change on peak-flow frequency analyses in the multi-state region in the Midwest. This study is intended to provide a framework for addressing potential nonstationary issues in statewide flood-frequency updates that commonly are conducted by the USGS in cooperation with state DOTs throughout the nation on an ongoing basis. This will be achieved through the following primary objectives: 1. Define spatial and temporal characteristics of climatic persistence/change affecting annual peak flows in the multi-state region. 2. Develop and apply a statistical methodology for estimating changes in peak-flow frequency distributions in the multi-state region in relation to climatic persistence/change and urbanization; the effects of rural and land-use change will only be investigated in an exploratory manner. 3. Investigate methods for addressing regional climatic persistence/change and land-use change in peak-flow frequency analysis. To the extent possible, estimates of trend-adjusted flood magnitudes for various exceedance levels (such as the 10-percent or 1-percent annual exceedance probability) will be provided for comparison to previously published estimates.

The results of the proposed investigation will be presented in two peer reviewed USGS Data Releases, two Scientific Investigations Reports (SIR; online only), two journal articles and a USGS Fact Sheet. Tasks include efforts to: (1) Publicly release watershed-based climate data (metrics of precipitation and temperature) on a monthly time scale and summed to annual seasonal and annual total values. These data will also contain trend results for trends in climate metrics in annual peak streamflow and climate variables (Years 1 and 2); (2) Characterize the effects of natural hydroclimatic shifts and potential climate change on annual peak flows in Midwest: Illinois, Iowa, Minnesota, North Dakota and South Dakota (Years 1 and 2); (3) Analyze the seasonality of flood peaks in the region and their trends and implications for trend attribution (Years 1 and 2); (4) Evaluate the effect of urbanization on flood-peaks in major metropolitan areas in the study region (Years 2 and 3); (5) Publicly release data that compares adjustment methods at individual sites, such as multiple flood-frequency analysis results (Years 3 and 4); (6) Summarize methods for addressing regional hydroclimatic shifts, climate change, and land-use change in peak-flow frequency analyses in the Midwest (Years 3 and 4); (7) Succinctly summarize the above work in a short fact sheet that provides links to project products to make it easy to find data and results. This summarization is intended to be handed out at future meetings, sent to managers for an overview, etc. (Year 4).

FISCAL YEAR 2022 ACCOMPLISHMENTS

USGS is wrapping up Tasks 1, 2, and 3, as noted above. They have provided preliminary findings in climate trends of gages, including seasonality of peak flow values, for participating Midwest states at quarterly Teams meetings.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Finalizing Tasks 1, 2, and 3 and transitioning to Tasks 4, 5, and 6.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Nothing to implement currently.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: National Road Research Alliance - NRRA (Phase-II)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(466)		MDOT START DATE	10/01/2020
PROJECT NO.			MDOT COMPLETION DATE (Original)	12/31/2025
OR NO.	OR21-209		COMPLETION DATE (Revised)	01/31/2026
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-749-9067 KennedyK@Michigan.gov			
LEAD AGENCY:	Minnesota DOT			
PROJECT MANAGER	Glenn Engston, 651-366-5531 glenn.engstrom@state.mn.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$150,000.00		TOTAL BUDGET	(Original)	$750,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$150,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$450,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

CA, IADOT, IL, Local Road Research Board (LRRB), MI, MN, MO, MS, ND, and WI. Partners Total Commitments: $5,425,000.00

PURPOSE AND SCOPE

Primary objectives of the National Road Research Alliance (NRRA Phase-II) are:

- Implementation and technology transfer of NRRA Phase-I research efforts and other common interests.
- Continue to fund and support research and implementation efforts of common interest.
- Continue the communication with both its government agencies along with its associate members (industry, associations, consultants, academia).
- Continued utilization of MNROAD to conduct structured construction, field testing and evaluation of pavement materials, equipment, and methods under real-world conditions.
- Establish industry standards and develop performance measure for improving pavement performance.
- Develop and/or revise specifications and recommendations.
- Studying and promoting innovative techniques and technologies that will save agencies money, improve safety, and increase efficiency.
- Supporting technology transfer by developing practical field guides, best practices, and training curriculum to promote the results of research projects.
- Conduct cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiencies.
- Support the exchange of information and ideas through collaborative research efforts that provide opportunities for public agencies to share experiences.
- Identify and prioritize common road related research needs to address regional and national issues that are built on existing efforts such as FHWA's PCC and HMA Roadmaps as well as the Foundation for Pavement Preservation Roadmap.
- Fund high priority, readily implementable research projects though research contracts and university partnerships.
- Leverage knowledge, skills, and resources from participating partners to advances pavement research and implementation efforts while developing the workforce of the future.
- Support technology transfer that highlights the implementation of research results and the associated benefits.

The scope of work for this pooled fund project is:

- Members provide the prioritized research needs, project development and design by way of the research project teams.
- Members provide funding for high priority, readily implementable research projects.
- Members receive timely results on NRRA research projects through communication products that emphasize lessons learned and implementation.
- Assistance in putting research results into practice through technology transfer events.
- • NRRA members support committees that meet periodically throughout the year to determine priorities, develop strategies to address the priorities, and execute action plans.

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

To date ten (10) government agencies and over fifty-five (65+) industry, associations, consultants, and academic institutions have become NRRA members to share their expertise and are learning about new tools and methods to improve and expand upon transportation systems nationally.

Phase-I Projects:

- Tech Transfer - 100% of the 13/13 projects complete.

- 2017 Long Term Research – 50% of the 4/8 projects complete.
- 2019 Long Term Research – 8% of the 1/11 projects complete.
- 2019 Call for Innovation Research – 0% of the 0/5 projects complete.
- 2020 Call for Innovation Research – 0% of the 0/7 projects complete.

Phase-2 Projects:
- 2021 Long Term Research – 0% of the 0/13 projects complete.

General:
- NRRA members/Teams have met monthly again this quarter which also acts as TAP meetings for each team's short- and long-term research efforts also focusing on development of 2021 projects with inputs on MnROAD 2022 construction.
- Executive Committee meetings: Two meetings held this quarter and one expected in the next quarter to help establish Phase-II efforts in February 2021.
- Call for Construction sent out and ideas are being submitted – one formal idea so far and other potential ideas – Construction in 2022.
- Monthly Research pays off webinars have been completed and a plan for end of 2021 topics are developed.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Working on two RFPs fall/winter of 2022. NRRA members/Teams have met monthly again this year which also acts as TAP meetings for each team's short and long-term research efforts also focusing on development of 2021 projects with inputs on MnROAD 2022 construction/sensors. Monthly Research pays off webinars have been completed and a plan for 2022 topics are developed. See the NRRA website for details on all the teams' updated activities. Technical teams TAPS developing construction designs, layers, sensor requirements, and ICT related construction activities to include in the 2022 MnROAD construction. Completed partnerships with FHWA for veta and carboncure related research efforts. Finalizing partnerships with a local HMA plant to furnish HMA surface mix for the reflective cracking group study. Finalizing partnerships with a local PCC plant to furnish PCC mix need for the 2022 construction. Finalized partnerships with Missouri and the funding received for reflective cracking challenge. Successful 2022 Minnesota Transportation Conference & Expo in St. Paul, Minnesota on May 17-19 and the NRRA tracks for each technical team.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

NRRA members/Teams will continue to meet monthly which also acts as TAP meetings for each team's short and long-term research efforts. Monthly Research pays off webinars will continue. Technology transfer will remain a focus of the pooled fund. Continue to plan and schedule conferences.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

N/A

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

TAP members of each of the contracts and teams will be asked to help the development of implementation for the technology transfer team to push with its members. This is a focus area that is probably the hardest part of successful research. The technology transfer team will be focused on this topic in the upcoming months.

Michigan Department
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Structural Behavior of Ultra- High-Performance Concrete

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(468)	MDOT START DATE	2/1/2021
PROJECT NO.	[Sol. #1510]	MDOT COMPLETION DATE (Original)	9/30/2025
OR NO.	OR20-214	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Bradley Wagner, 517-256-6451 WagnerB@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Benjamin Graybeal, 202-493-3122 Benjamin.graybeal@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2022 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	$10,000.00	TOTAL BUDGET	(Original)	$50,000.00
	(Revised)			(Revised)	
TOTAL FY 2022 EXPENDITURES		$10,000.00	**TOTAL COMMITTED FUNDS AVAILABLE**		$20,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

FL, GADOT, MI, MN, MS, NJ, NY, PADOT, TX . Partners Total Commitments: $600,000.00 MDOT Pledge Commitment FYs 20-24

PURPOSE AND SCOPE

The objective of the proposed project is to develop knowledge pertinent to the structural performance of ultra-high-performance concrete (UHPC). This knowledge will be of significant value as the AASHTO Committee on Bridges and Structures considers the use of UHPC-class materials in highway bridges and structures.

The proposed project is focused on the design, fabrication, performance, and analysis of UHPC components. It is anticipated that various UHPC components will be designed, fabricated, and tested. The test results will be analyzed and used to inform proposed structural design guidance for UHPC components. Results will also be used to support usage of UHPC by interested departments of transportation. It is anticipated that bridge superstructure components (e.g., pretensioned girders) will be a significant part of this study, with behaviors related to flexure, shear, and end zones being investigated. Other components may be investigated based on available resources and the interest of participating partners.

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

This Pooled Fund Study held its project kicked off meeting in February of 2021.

The Principal Investigator discussed with each partner representative present their respective input on priorities regarding UHPC. Two (2) initial priorities identified were:

- Development of guidelines for the design of UHPC. A draft “AASHTO LRFD Guide Specifications for Structural Design with UHPC” was developed and reviewed by the pooled fund members. Member’s comments were provided.
- Develop design examples for UHPC members. This initiative is just now getting underway and will be further developed/delivered in FY 2022.

FISCAL YEAR 2022 ACCOMPLISHMENTS

- Worked on finalization of LRFD Guide Specifications
- Developed two UHPC Design Examples and submitted to AASHTO for review
- MDOT selected a UHPC beam end repair project in Grand Region and will be let and constructed FY23
- Developed visual aids to support testing methods for UHPC.
- Published AASHTO T397 “Standard Method of Test for Uniaxial Tensile Response of Ultra-High-Performance Concrete”.
- Initiated a task for full scale testing of UHCP girders.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

- Continue to support adoption of LRFD Guide Specifications
- Finalize an experimental investigation of tensile testing of UHPC
- Publish UHPC design recommendations and examples
- Work on tensile fatigue investigation
- Fabricate girders for full scale testing.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This is a rather loosely structured Pooled Fund with high level initiatives that are continually developing.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT has identified a pilot project for the evaluation of a UHPC beam end repair. The project will be let in November of 2022. The pooled fund supported specification development.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Clear Roads Winter Highway Operations Pooled Fund (Phase III)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(479)		MDOT START DATE	5/1/2022
PROJECT NO.			MDOT COMPLETION DATE (Est. Original)	9/30/2024
OR NO.	OR22-206		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Justin Droste, 517-636-0518 DrosteJ@michigan.gov			
LEAD AGENCY:	Minnesota Department of Transportation			
PROJECT MANAGER	Nicole Westadt, 651-366-4270 Nicole.Westadt@state.mn.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$50,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$25,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$25,000.00

PARTICIPATING STATES

AK, AZDOT, CA, CO, CT, DE, IADOT, ID, IL, IN, KS, KY, MA, MDOT SHA, ME, MI, MN, MO, MT, ND, NE, NHDOT, NV, NY, OH, OK, OR, PADOT, RI, SD, TX, UT, VA, VT, WA, WI, WV, WY. Total Partner Commitment Level: $3,100,000.00

PURPOSE AND SCOPE

This pooled fund project will maintain its focus on advancing winter highway operations nationally, but it will include a more pronounced emphasis on state agency needs, technology transfer, and implementation. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility. This pooled fund is needed to evaluate these new tools and practices in both lab and field settings, to develop industry standards and performance measures, to provide technology transfer and cost benefit analysis, and to support winter highway safety. This project responds to research and technology transfer needs not currently met by other pooled fund projects. Existing partners make every effort to coordinate with other agencies to avoid duplication of efforts and to encourage implementation of results.

Objectives of this ongoing pooled fund project will include:

- Conducting structured field testing and evaluation across a range of winter conditions and different highway maintenance organizational structures to assess the practical effectiveness, ease of use, optimum application rates, barriers to use, durability, safety, environmental impact and cost-effectiveness of innovative materials, equipment, and methods for improved winter highway maintenance.
- Establishing industry standards and developing performance measures for evaluating and utilizing new materials and technologies.
- Supporting technology transfer by developing practical field guides and a training curriculum that will promote the results of research
- projects.
- Conducting cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiency.
- Supporting the exchange of information and ideas via peer exchanges and collaborative research efforts that provide opportunities for maintenance specialists to share experiences related to winter maintenance.
- Promoting public education and outreach related to winter maintenance and winter driving safety.
- Conducting state of the practice surveys to share best practices on current operational issues. (For example: Salt shortages, level of service requirements, or other hot button issues).

Included in the Scope of work: Research reports, technical briefs, synthesis reports, field guides, specifications, PowerPoint presentations, video documentation, training materials, public safety messages, and software programs.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and several other projects commenced during the 2017 FY.

- 12-04 Snowplow Operator and Supervisor Training.
- 14-04 Plug and Play, Phase 2.
- 14-05 Snow Removal Performance Metrics – Phase I: Synthesis.
- 14-07 Snowplow Route Optimization.
- 15-03 North American Study on Contracting Snow and Ice Response.

Two of the five completed projects and their respective deliverables are described below.

2- 2017 Completed Projects/Respective Deliverables:

12-04 Snowplow Operator and Supervisor Training

The key outcomes of the project are presentations, course guides, exams, and other training support materials for winter maintenance operations. MDOT can use the information to help train staff during winter operations schools, region trainings, and other training events.

14-04 Plug and Play, Phase 2
Clear Roads has been leading a collaborative effort called the Plug-and-Play Initiative to develop a universal bi-directional
communications protocol for in-cab electronics, regardless of the manufacturer or service provider. This project identified the most
appropriate standard protocols and made recommendations regarding the method of transmission. MDOT will use this research to assist
with the development of an RFP for our automated vehicle location and maintenance decision support system.
Five new research projects and five new synthesis projects were also authorized for solicitation.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects, two synthesis projects and several other projects commenced during the 2018 FY.
- 14-02: Quantifying the Impact That New Capital Projects Will Have on Roadway Snow and Ice Control
- Operations (November 2017)
- 15-02: Identification and Recommendations for Correction of Equipment Factors Causing Fatigue in Snowplow
- Operators (November 2017)
- 12-03: Understanding the Chemical and Mechanical Performance of Snow and Ice Control Agents on Porous or
- Permeable Pavements (January 2018)
- 16-04: Emergency Operations Methodology for Extreme Winter Storm Events (May 2018)
- 16-06: Training Video for the Implementation of Liquid-Only Plow Routes (June 2018)
- 16-S3: Maintenance Vehicle Conspicuity (February 2018)
- 17-S1: Accuracy of Deicer and Abrasive Material Application Equipment (September 2018)

Two of the five completed projects and their respective deliverables are described below.

12-03 Understanding the Chemical and Mechanical Performance of S&I Control Agents on Porous or Permeable Pavements
This project provided better information and guidelines to help determine the optimum maintenance strategies for porous or permeable asphalt pavements, including:
- Dense graded pavements.
- Open graded pavements.
- Ultrathin Friction Course.

14-02 Quantifying the Impact that New Capital Projects Will Have on Roadway Snow and Ice Control (RSIC) Operations
The project developed an automated method of quantifying the anticipated impact that new capital projects will have on costs for RSIC. This method could be used in the early stages of project development to determine if an agency will need additional resources, such as trucks, salt, fuel, and manpower, to accomplish winter maintenance tasks after the project is completed. This methodology could also be used by maintenance managers to justify requests for additional resources after projects are complete.
Eight new research projects were also authorized for solicitation. Clear Roads also elected to form a subcommittee to manage the Clear Roads QPL (formally known has Pacific Northwest Snow fighters QPL).

FISCAL YEAR 2019 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed six research projects and continued several other projects during the 2019 FY. These projects and their respective deliverables are described below.

13-05 Developing Test Bed Software to Qualify Plug and Play Technology
The goal of this project is to develop a software suite that will be used to validate and certify candidate spreader controllers and AVL equipment for compliance with the current Clear Roads Universal In-Cab Performance Specification and Communications Protocol.

14-03 Developing a Training Video and Manual for Best Practices and Techniques in Clearing Different Interchange Configurations and Other Geometric Layouts
This project was extended into FY 18. It will be a 15-20-minute video that showcases the most efficient pass sequences to properly clear various interchange and intersection layouts. MDOT plans to use this to instruct operators on the best way(s) to safely clear various intersection geometries.

15-01 Synthesis of Material Application Methodologies for Winter Operations
The goal of this project is to create a synthesis of best management practices for application rates, material application methodologies and material usage, including chloride brines applied directly or as additives to abrasives and rock salts.

16-01 Utilization of AVL/GPS Technology: Case Studies
The goal of this project is to help state DOTs make more informed decisions with respect to implementation of winter maintenance AVL/GPS. MDOT was one of the case studies highlighted in this report.

16-02 AWSSI Enhancements in Support of Winter Road Maintenance
The objective of this project is to expand on the current AWSSI Tool to add more stations and provide features to allow for winter severity projections and connect winter severity to winter maintenance costs.

16-05 Weather Event Reconstruction and Analysis Tool
The goal of this project is to allow transportation agencies to reconstruct winter weather events quickly and easily, with a focus on drawing from data sources that cover the entire United States or large regions.

16-03: Standards and Guidance for Using Mobile Sensor Technology to Access Winter Road Conditions
Through rigorous testing of sensor equipment, development of standardized scales, and creation of guidance for using an array of measurements in concert for decision-making, Clear Roads will make better use of road sensor data than is now currently available.

FISCAL YEAR 2020 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and continued several other projects during the 2020 FY. Completed projects and their respective deliverables are described below (click link for more detail).

PROJECT NUMBER	TITLE	COMPLETION DATE	STATUS
18-S1	Mechanic/Operator Training and Training Needs for Winter Maintenance Equipment	09/2020	Completed
18-01	Defensive Driving for Snowplow Operators	08/2020	Completed
18-05	Alternative Methods for Deicing	07/2020	Completed
17-02	Standard Specifications for Plow Blades with Carbide Inserts	04/2020	Completed
16-05	Weather Event Reconstruction and Analysis Tool	12/2019	Complete

FISCAL YEAR 2021 ACCOMPLISHMENTS

The Clear Roads pooled fund study plans to commence and continue several projects during the 2021 FY. These projects are listed below.

- 21-01 Grip Sensor Technology and Salt Application
- 21-02 Update to CR 13-04 Best Practices for Protecting DOT Equipment from Corrosive Effect of Chemical Deicers
- 21-03 The Efficacy and Environmental Impact of Non-Chloride Deicers
- 21-04 Training Module Development for CR 18-03 Evaluation of SSI/WSI Variables
- 21-05 Synthesis Evaluation of Electric Vehicle Technologies and Alternate Fuels for Winter Operations
- 21-06 Calculated Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types Adjacent to Chloride-treated Roadways
- 20-06 Salt Shed Design Template
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-04 Expanded Use of AVL/GPS Technology
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-02 Understanding the NaCl Phase Diagram
- 20-01 Entry-Level Driver Training (CDL) for Maintenance Equipment Operators
- 19-04 Synthesis of Technical Requirements and Considerations for an Automated Snowplow Route Optimization RFP Template
- 19-03 Measuring the Efficiencies of Tow Plows and Wing Plows
- 19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 18-02 High Performance Blade Evaluation

FISCAL YEAR 2022 ACCOMPLISHMENTS

Project selected for FY2022

- ***22-01 Comprehensive Guide to Prewet*** [A comprehensive guide that will provide optimal application rates for meeting pre-wetting goals and will quantify the benefits of different rates, speeds, and other delivery factors. The guide will also present the findings of using two to four salt spreader configurations and delivery systems (e.g., auger, Monroe hopper, zero-velocity spreader). The evaluation will include a discussion of the advantages and disadvantages of each in meeting pre-wetting goals.]
- ***22-02 Liquid Chloride Storage and Pump System Best Management Practices*** [This project will develop a guidance manual that explores the issues transportation agencies should consider when choosing or replacing deicing liquid storage systems. There are several areas of interest associated with operating a reliable system including safety, environment, and cost-effectiveness. A review of the systems different agencies use, including system benefits and challenges, will help agencies better understand their options when procuring a new system or updating an existing one.]
- ***22-03 Effects of Additives in Lowering the Freezing Point*** [While manufacturers of deicing salt products claim that additives enhance product performance, there is no definitive evidence to substantiate these claims. Evaluating these products in the lab and in the field will establish the effectiveness of additives to lower eutectic temperatures and will indicate whether additives increase the performance of deicing salts. Research recommendations can be used to inform the decision-making of state departments of transportation (DOTs), municipalities and other winter maintenance practitioners when choosing a deicing salt for winter maintenance operations.]
- ***22-04 Evaluation of DLA of Salt Brine vs Granular Salt as Measured through Various Performance and Safety Metrics*** [Many of the studies conducted to date focus on cost savings and environmental impacts of the DLA of salt brine while not addressing the efficacy and safety impacts of its use. Without performance comparison data to support DLA practices, the traveling public may conclude that while the advantages of DLA in cost savings and environmental impacts are clear, granular salt treatments are still the more effective way to treat winter roadways. This study aims to provide DOTs with the information they need to defend the use of DLA treatments where appropriate.]

- ***22-05 Synthesis: Use of Dashboards for Winter Operations*** [Advances in information technology offer agencies the capability to capture and track data obtained from winter maintenance equipment. A review of which agencies are using dashboards in winter maintenance operations, including necessary resources and best practices for developing and implementing this tool, will give Clear Roads an understanding of how this data is obtained and displayed through these dashboards. Then, how is the information displayed used to gain efficiencies related to Level of Service, material use, resource allocation, and the cost of winter maintenance operations.]
- ***22-S1 Synthesis: Corrosion and Connectors Don't Mix*** [The goal of this synthesis is to identify the various setups / connectors used by Clear Roads members. Determine if anyone is experiencing success in keeping the lights operating for an entire winter season. Identify a setup / connector that is most likely to operate for an entire snow season.] Project completed in FY 2022
- ***19-02 Recruitment and Retention of Highway Maintenance Workers*** [This project developed a concise guide of innovative but practical ways for DOTs to recruit and retain a highly proficient, productive, versatile, and committed roadway maintenance workforce. The final report includes case studies in several categories, including recruitment programs, retention strategies, recruitment and retention for underserved communities, recruitment and retention of the next generation, and capturing information to inform program improvements.]
- ***20-07 AWSSI Enhancements, Phase 2*** [This project continued the process of improving the tool developed by the MRCC. This iteration added additional locations to the AWSSI tool; updated the average AWSSI seasonal total map through the 2019-2020 season; added the ability to download the daily seasonal data for any given station during the current season; and provided the user with the ability to add up to five specific historical seasons to be included in any station's current year chart.]
- ***20-01: Entry-Level Driver Training (CDL) for Maintenance Equipment Operators*** [This project developed the following materials: (1) complete curriculum to meet the FMCSA requirements for the instructor-led classroom and behind-the-wheel components of the entry-level driver training rule, focusing on obtaining an initial Class B CDL, upgrading from a Class B CDL to a Class A CDL, and obtaining the hazardous materials endorsement for the first time; (2) all training materials and resources necessary for states to execute the training program; (3) train-the-trainer materials to assist agencies in implementing the training program; and (4) fact sheet and timeline to help agencies ensure that all of their training locations are added to the TPR before February 7, 2022. To date, there have been 750 requests for this material from agencies all over the U.S.]
- ***19-04 Synthesis of Technical Requirements and Considerations for Automated Snowplow Route Optimization*** [Through a survey and follow-up interviews with agencies and vendors, this project captured the technical requirements and considerations involved in selecting an automated snowplow route optimization program. The project produced two complementary documents as appendices to the final report: 1) Decision Support Guidance: An accessible and in-depth discussion of the technical requirements for route optimization and the key decisions DOTs should consider when developing the project scope and managing a provider. 2) Contracting Language Template: A flexible template to assist DOTs with developing a scope of work for an RFP for automated snowplow route optimization services. The language in the template is intended to ensure that DOTs and service providers have a shared understanding of the scope of work that the DOT requires and to maximize the likelihood that the project will result in safe, feasible, implementation-ready routes.]
- ***19-01 Expanding Application Rate Guidance for Salt Brine Blends for Direct Liquid Application and Anti-icing*** [Through a survey of practice and subsequent field testing, researchers gathered a robust set of data on how agencies apply various liquid deicers across a broad range of field conditions, particularly at lower temperatures. The test results, along with the survey results and information gathered through a literature review, were used to create a set of application rate tables for brine and brine blend usage for DLA and anti-icing.]
- ***19-03 Measuring the Efficiencies of Tow Plows and Wing Plows*** [Through a practitioner survey, testing/simulation, and analysis, this project created a spreadsheet-based Decision Support Tool to help agencies more accurately assess the efficiencies, costs of ownership, and return on investment for tow plows and wing plows and determine the best locations to deploy it. A companion Best Practices Guide will help agencies understand the considerations for purchasing, deploying and operating specific plow types.]
- ***20-02 Understanding the NaCl Phase Diagram*** [Project deliverables include the development of training materials (a fact sheet and a video) to help provide winter maintenance practitioners with a better understanding of the phase diagram for sodium chloride and how to apply it to yield the best results in roadway deicing. This knowledge will help winter maintenance agencies apply salt and salt brines effectively for the best performance on winter roadways.]

Ongoing Projects for FFY 2022

- 18-02 High Performance Blade Evaluation
- 18-06 Standard Test Procedures for Ice Melting Capacity of Deicers
- 20-03 Evaluation of Indoor Automated Stockpile Measurement Systems
- 20-04 Expanded Use of AVL/GPS Technology
- 20-05 Using GIS to Highlight Highway Segments Sensitive to Deicing Materials
- 20-06 Salt Shed Design Template
- 21-01 Grip Sensor Technology and Salt Applications
- 21-02 Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers
- 21-03 Efficacy, Cost, and Impacts of Non-Chloride Deicers
- 21-04 Training Module Development for Evaluation of Storm Severity Index and Winter Severity Index Variables
- 21-05 Evaluation of Electric Vehicle Technologies and Alternative Fuels for Winter Operations
- 21-06 Calculating Plow Cycle Times from AVL Data
- 21-07 Determining the Migration of Chloride-based Deicers through Different Soil Types

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This continuation project (formally TPF-5(353)) will maintain its focus on advancing winter highway operations nationally through practical, practice-ready research related to materials, equipment, and methods. State departments of transportation are aggressively pursuing new technologies,
practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Thirty-Six (36) state partner's leveraged funds provide support for investigator work on research projects, implementation and technology transfer activities, administrative management of the pooled fund, and travel expenses for member representatives to attend 2 Technical Advisory Committee meetings per year.

As a participating state MDOT can:

- Inform the research agenda for Clear Roads by proposing topics for future projects.
- Help prioritize and select projects for funding.
- Evaluate technical proposals to conduct the research from academic and private-sector investigators.
- Serve on subcommittees that oversee research projects.
- Meet with experts from around the country on winter maintenance issues.
- Travel to TAC meetings with expenses paid by the pooled fund.

One of the most important aspects of Clear Roads membership is access to the Clear Roads members themselves and their expertise. Members often send inquiries to their member peers for quick turnaround information. They can then report back to their management within days and provide information based on actual experiences of member states. Those inquiries and the summary of the information they receive back from the states is posted on a members-only page on the Clear Roads website.

Regarding the above list of projects 21-05 was proposed by MDOT and the project-subcommittee formed was championed by a Michigan Rep. Also, a Michigan Rep serve on several other project subcommittees, including 21-01 and 21-04.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Building Information Modeling (BIM) for Infrastructure

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(480)		MDOT START DATE	7/1/2021
PROJECT NO.			MDOT COMPLETION DATE (Original)	9/30/2025
OR NO.	OR21-210		COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Luke Arnold, 517- 243-8313 ArnoldL1@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$30,000.00		TOTAL BUDGET	(Original)	$150,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$30,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$90,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AZDOT, FL , IADOT , IN , KY , MI , MT , NE , NY , PADOT , SC , TX , UT Total Commitments Received: $2,460,000.00

PURPOSE AND SCOPE

The pooled fund serves as the mechanism for stakeholders to work collaboratively to advance BIM for Infrastructure. This will involve building off the foundational work that was charted out in the BIM National Strategic Work Plan, with emphasis on increasing coordination and awareness of BIM technologies and activities. Activities that advance the short- and medium-term goals of the BIM National Strategic Work Plan will be prioritized and carried out by the pooled fund participants. Meetings will serve as a forum to facilitate knowledge sharing among participants. Proposed activities include:

- Develop BIM foundational use cases and workflows. Highlight more effective digital exchange of information (e.g., survey to design, design to construction, construction to asset management, etc.). This kind of exchange will increase collaboration and automation, reduce duplication of effort, and avoid errors.
- Establish BIM Processes (e.g., Develop contract model language to guide BIM procurements.)
- Identify and Execute Capacity-Building Activities (e.g., Establish project selection criteria for BIM implementation; Identify project types and use cases for early pilot projects phase).
- Enhance Skills and Collaboration (e.g., Establish workforce training curriculum to set expectations about required BIM qualifications. Understand organizational roles and responsibilities to connect data silos).
- Deploy Standards-Based Data Management Tools and Techniques (e.g., Develop catalog of information model requirements to define what data should be created and why. Develop standard information delivery specifications for data exchange between systems).
- Lessons Learned - Identify issues with current implementation efforts and share potential solutions to help move toward to greater BIM maturity.
- Research Priorities - Identify short-term and long-term research needs and strategically prioritize the needs so the most urgent and impactful opportunities are addressed first.
- • Information Exchange - Establish a forum/expert hub for practitioners in the highway industry to understand the various tools and technologies being used, promote the common modeling formats, and share experiences.

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

What products or services were delivered from study activities performed in 2021? The project was approved by FHWA and assigned federal project number TPF-5(480) in August 2021. The lead agency's current activities include identifying participants to serve on the Technical Advisory Committee (TAC).

FISCAL YEAR 2022 ACCOMPLISHMENTS

The TAC met virtually several times throughout FY 2022 in order to discuss the key objectives of TPF-5(480), along with drafting and finalizing the RFP for this project. The RPF was posted in September, 2022 with proposals due on November 1, 2022.
Current activities underway include scheduling of the first TAC meeting in 2022.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Proposals due: Tuesday, November 1, 2022.
Notification of virtual interview: Friday, November 11, 2022
Virtual interviews: Friday, November 18, 2022
Notification of proposal selection: Tuesday, November 22, 2022
Virtual kick-off meeting to discuss Year 1 Scope of Work: Friday, December 16, 2022
Year 1 Scope of Work approval and contract negotiation: End of January

Project start date: February 1, 2023.

In addition, the TAC intends on meeting in-person for two days per year of the project.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2025.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE (Continuation)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(486)		MDOT START DATE	10/1/2021
PROJECT NO.	OR22-205		MDOT COMPLETION DATE (Original)	9/30/2026
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Rebecca Curtis, 517-449-5243 CurtisR4@michigan.gov			
LEAD AGENCY:	Indiana DOT			
PROJECT MANAGER	Anne Rearick, 317-232-5152 arearick@indot.in.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$30,000.00		TOTAL BUDGET	(Original)	$60,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$30,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$30,000.00

PARTICIPATING STATES

AKDOT, AR, FHWA, IADOT, ID, IL, KS, MI, MN, MT, NC, NY, SD, TX, WI Total Commitments: $1,864,000.00

PURPOSE AND SCOPE

Objectives and Impact: The objective of the proposal is to request a continuation of SPR-5(281) the Steel Bridge Research, Inspection, Training, and Education Engineering Center (S-BRITE Engineering Center) focused on existing steel highway bridges. This National Center when initially proposed in 2013, has become a national Center leading education, training, research, and engineering benefitting the existing aging steel bridge and structure inventory. Over the life of the project, ten (10) states, the US Army Corps, and FHWA have provided support through TPF-5(281) and continue to do so. Current funding is very strong and partner states continue to be added. Although the Center has been focused on highway bridges, it will also support stakeholders of steel railroad bridges as well as steel ancillary structures, such as lighting towers and sign supports. As a result, in-kind support from the railway industry has been strong as well. The Center has contributed to improved asset management decisions for DOTs, FHWA, and other partners relative to existing steel bridge inventory. However, since the existing TPF-5(281) needs to sunset per FHWA guidelines, the Research Team, and the current active partners are requesting a continuation of this pooled fund study, albeit under a different TPF number. The original project objectives and deliverables remain unchanged. Nevertheless, a summary of the Center is presented below.

Educational Aspects: A long-term goal of the S-BRITE Center has been to create the next generation of bridge engineers and inspectors who are properly educated to be effective stewards of the existing aging steel bridge inventory. At the university level, the development of a new “minor” or certificate within Civil Engineering is proposed that will prepare engineering students for a career in the area of transportation structures. At the professional level, high-quality, specialized short courses for professionals will be developed and targeted at those individuals currently responsible for the existing infrastructure. The courses would go beyond the current NHI course level. Bridge Component Gallery Although training, education, and research are the overall focus of the Center, the cornerstone of the S-BRITE Engineering Center will be a multi-acre gallery which will include full-scale bridge structures, portions of complete structures, and individual components that will include a host of common and uncommon details used in steel bridges. Similar centers exist for the aircraft, ship, and offshore industries, though nothing has been developed for the steel bridge industry. The gallery has provided a unique hands-on experience for education of individuals of all levels regarding steel fabrication, deterioration, inspection techniques, etc. The reader is encouraged to view the S-BRITE flyover video highlighting the scale of the bridge component gallery. The video can be found at: https://engineering.purdue.edu/CAI/SBRITE/Facilities Since the bridge components are not actually in service and are in more accessible conditions, costly traffic control and extensive fall-protection will not be required during training. Conveniently, they have been situated so that real-world conditions exist to truly simulate in-situ inspection conditions. The S-BRITE “living laboratory” has become incredibly useful for research tools being developed for inspection, durability modeling, and performance testing of inspectors. Distributed Expertise Network (DEN) To help fill the technical voids found at most DOTs, a unique team of experts have been assembled through the S-BRITE Center to create a Distributed Expertise Network (the DEN). Some of these individuals are local to Purdue at the Center while others are located at their respective institution. The DEN serves the role that no longer exists in many individual state DOTs today, specifically the existence of a group of highly specialized technical experts that are “on-call” to assist as issues arise. These experts are effectively “on call” to the Center and the participants and have been able to travel to the participant’s location if required and per the funding level provided. There is no need for special subcontracts between the individual state and the expert since the agreements are already in place as participants of the Center. Levels of Commitment: Since states have different needs and resources, three different levels or “tiers” of contributions were developed with each tier receiving defined benefits. Participants will be stakeholders in the direction of the Center, research program directions, and coursework development. It is noted that although the fees associated with participation were developed over seven years ago, no increases have been made to date. Details are contained in the Table below. Tier 1A and Tier

1B Tier 1A • $ 30,000 per year for 2 years for a total commitment of $ 60,000 • This level provides support for the administration and policy development for center operations and strategic plan as well as for course development, traditional research and the gallery development and maintenance. • Specific deliverables will include 1 training course at the stakeholder's facility for up to 30 people as well as 1 training course for up to 2 people including travel to Purdue University for specialized training at the bridge

FISCAL YEAR 2022 ACCOMPLISHMENTS

- MDOT 125869 CAH S13 Beam E Pier 2 Pin Hole Corrective Action Stress Analysis & Repair Plan - Provided some guidance on this issue. Turned out it got replaced.
- Parish Road s span bridge with damage flanges that were weld repaired. Girders lifted off supports. Provided FEA analysis on estimated locked in stresses due to the many CJP welds added to the flanges. provided in put on heat straightening etc. should the contract elect to go that route
- M-55 Colleyu Bridge over Pine Creek (Cooley Bridge) plug weld questions. Provided suggested strategies moving forward and retrofit suggestions.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Training and miscellaneous support as needed

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

NA

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT continues to rely on SBRITE for steel bridge issues and attending trainings are available.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: Safety Service Patrol Standardization and Management Practices

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(489)		MDOT START DATE	10/1/2021
PROJECT NO.	OR22-209		MDOT COMPLETION DATE (Original)	9/30/2025
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Sarah Gill, 248-867-6841 GillS@michigan.gov			
LEAD AGENCY:	Minnesota DOT			
PROJECT MANAGER	Paul Jodoin, 202-366-5465 paul.jodoin@dot.gov			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$25,000.00		TOTAL BUDGET	(Original)	$100,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$25,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$75,000.00

PARTICIPATING STATES

CA, FHWA, GADOT, IN, MDOT SHA, MI, MN, NC, NJ, NY, PADOT, TN, TX, WA Total Commitments: $1,300,000.00

PURPOSE AND SCOPE

The primary objective of this PFS study will be to gain technical information related to SSP program management, standards associated with SSP response protocol and the implementation of traffic control, and references and guidance related to staffing, training, and resource allocations within SSP programs. The goals include: 1. Assemble best practices and lessons learned from existing programs 2. Develop guidance documents based on lessons learned from existing programs 3. Reference or create tools that will help agencies make informed program decisions such as route selection, staffing levels, and resource allocation.

The work plan is described in three primary phases. Phase 1 is best practices research effort on the deployment of emergency traffic control (ETC) and potential SSP vehicle configurations used by agencies across the country. Phase 2 is focused on the staffing resources with a research effort focused on Staffing strategies, training programs, and the use of associated certifications. Phase 3 includes a focus on the strategic level of managing an SSP program and will focus on funding strategies and budgets, and resource management (route selection, number and type of vehicles, lengths of patrol routes, time of day, etc.) Phase 1 Best Practices in ETC and Vehicle Configurations (est. $250,000) Phase 1 includes an assessment in standards for both SSP vehicle and emergency traffic control implementation. SSP programs can range widely in the types of services provided to the motorists and it is paramount that responders can safely manage the on-scene response. This requires the appropriate type of vehicle, communications, technology and resources to be contained within a single vehicle. This phase will look at emergency traffic control layouts that optimize the safety of all responders and the public and balance with the available storage capacity of an SSP vehicle. This will include the color and visibility of the vehicles, traffic control devices and placement, lighting systems and other emerging technologies (beacons, tethered drones, etc.) that add value to the response and safety. In addition, it will look at additional technologies and equipment contained on an SSP vehicle and the effectiveness of those tools in supporting a response. Tasks: 1. Multi-state Program and Literature Review 2. Focused research and outreach to agencies on ETC layouts, vehicle equipment, and use of emerging technologies 3. Technical guide for best practices in ETC implementation, including device requirements and schematics of actual layout 4. Technical guide for potential vehicle configurations (chassis, 4x4 etc.), equipment needs, and emerging technology applications Phase 2 Staffing, Training, and Certification ($275,000) Phase 2 is focused on how agencies are staffing their SSP program. Programs can use in-house, contracted staff, or even a hybrid structure to provide the necessary staffing levels and oversight of the day-to-day operations. Additionally, SSP staff are required to perform independently every day and must have a broad technical skill set to respond to a variety of issues while on duty. This phase will include research on the structure and content of existing training programs as well as identifying lessons learned or the future direction of established programs. This research also should capture the integration of certification within agencies' training curriculum and how that certification is used to support the staffing, hiring, and promotion structure. Tasks: 1. Multi-state Program and Literature Review 2. Focused research and outreach to agencies on staffing structure including policies or legislation that may steer the decisions around the staffing structure 3. Focused research and outreach to agencies on training and certification programs and how they are integrated into the resource management and staffing strategy 4. Technical guide for best practices in staffing structures including job descriptions, qualifications job postings, policies, and legislation that drive staffing decisions 5. Technical guide for developing, implementing, and maintaining a training and certification program Phase 3 Program Management ($225,000) Phase 3 is focused on an assessment of existing programs and their program management strategies. This includes a look at tools used for route selection, asset management, staffing levels, and budgeting purposes. All public agencies are required to commit to a budget and that is no exception for an SSP. This research will focus on how SSP programs are determining and managing budgets.

FISCAL YEAR 2022 ACCOMPLISHMENTS
We have formed our technical group and meet regularly. Share information and have started to collect and compare documentation.
FISCAL YEAR 2023 PROPOSED ACTIVITIES
We plan to have an in-person meeting and we are going to start our best practice report to unify Courtesy Patrol activities.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
No revisions at this time.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Group was just formed so the recommendations have not been produced yet.

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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: ITS Pooled Fund Program (ENTERPRISE) Phase III

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF SOLICITATION NO.	TPF-5(490)		MDOT START DATE	10/25/2022
PROJECT NO.			MDOT COMPLETION DATE (Original)	09/30/2027
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Elise Feldpausch			
LEAD AGENCY:	Michigan Department of Transportation			
PROJECT MANAGER	Elise Feldpausch			
CONTRACTOR				

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$35,000.00		TOTAL BUDGET	(Original)	$175,000.00
	(Revised)				(Revised)	$509,721.17
TOTAL FY 2022 EXPENDITURES		$35,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$140,000.00

PARTICIPATING STATES

KS, MI, MN, TX, WI To Date- Total Partner's Pledge Commitments: $895,000.00

PURPOSE AND SCOPE

This study is a continuation of TPF-5(359) to enhance innovation in highway operations and Intelligent Transportation Systems (ITS) through research and technology transfer. Another purpose of this study is to continue the assessment of transformational technologies and their impact on the transportation industry.

FISCAL YEAR 2021 ACCOMPLISHMENTS (Benefits to MDOT)

This proposed study was approved for solicitation by FHWA- Michigan Division and is included on the FY 2021 annual work plan. Current state partners pledge commitments total is $450,000.00.

FISCAL YEAR 2022 ACCOMPLISHMENTS

100% waiver approval. Obtain FHWA final approval of the proposed study and a federal project number assignment. (A full waiver has been approved.) Upon final approval, MDOT will request all state partners transfer their FY 2022 pledge commitment amounts.

FISCAL YEAR 2023 PROPOSED ACTIVITIES

Secure state partner's fund transfers for FY 2023.

Initiate Phase 1 research projects

- Project 1: State of the Art Roadway Sensors – Phase 1
- Project 2: New Methods of Traffic Data Collection
- Project 3: Potential Approaches for Wrong- Way Driving Applications – Phase 2
- Project 4: Procurement Specification for Physical Security of ITS
- Project 5: Novel Uses of Unmanned Aerial Systems (UAS) in ITS
- Project 6: State of the Art of Roadway Sensors – Phase 2

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Phase III completion is anticipated in FY 2026/2027.

Michigan Department
Of Transportation
5307 (11/17)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: 2023 Technology Exchange on Low Volume Road Design, Construction and Maintenance

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(495)		MDOT START DATE	9/1/2021
PROJECT NO.	OR22-207		MDOT COMPLETION DATE (Original)	9/30/2023
			COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Lindsey Renner 517-202-5356 RennerL1@michigan.gov			
LEAD AGENCY:	Iowa DOT			
PROJECT MANAGER	Khyle Clute Khyle.Clute@iowadot.us			
CONTRACTOR	Iowa State University			

BUDGET STATUS

FY 2022 MDOT Budget				MDOT Total Budget		
FY FUNDS	(Original)	$12,000.00		TOTAL BUDGET	(Original)	$12,000.00
	(Revised)				(Revised)	
TOTAL FY 2022 EXPENDITURES		$12,000.00		**TOTAL COMMITTED FUNDS AVAILABLE**		$0.00

PARTICIPATING STATES

IADOT, ID, KS, LA, MI, MO, OH, TX, VA Total Partners Commitment Level: $108,000.00

PURPOSE AND SCOPE

The primary activities of this pooled fund project are technology exchange, information sharing, and the facilitation of partnering relationships among state agencies and participating members with FHWA, Local Public Agencies and other appropriate agencies and associations. Technology exchange activities in conjunction with the 13th International Conference on Low Volume Roads will be advantageous to participating members. Specifically, this pooled fund will: 1. Provide communication and information sharing among member participants: Discuss research, development and technology transfer needs in the areas of design, construction, maintenance, and safety on low volume roads and provide research ideas to TRB in the areas of Low Volume Roads. 2. Member workshop at the 13th International Conference on Low Volume Roads: Provide a technology and knowledge exchange forum to enhance the practical knowledge of pooled fund participants concerning low volume road management with a focus on encouraging State DOT and other agency participation in the pooled fund. 3. Pooled Fund Member Meeting on Low Volume Road Issues: Provide a technology and knowledge exchange forum focused on Low Volume Road issues. Topics may include agency collaboration, funding, asset management, shared ROW/utilities, safety programs, emergency response, training and certifications, maintenance of traffic, federal oversight, standards and specifications, contracting methods, environmental issues, energy development, maintenance, material sources and quality, and bonding. 4. Technology Transfer through paper publication, webinars, technology field demonstrations, and expanding access to solutions on issues selected by pooled fund member in areas of Low Volume Road Design, Construction and Management.

The principal tasks are: 1. TRB will organize arrangements for the Low Volume Road pooled fund member agencies for the technology exchange on best practices in management of Low Volume Roads. The pooled fund will help support the travel and per diem expenses of pooled fund members associated with the technology exchange. This will include expenses to attend the 13th International Conference on Low Volume Roads. It is anticipated that individuals from pooled fund partner members may be invited to participate on the Conference Planning Committee calls to coordinate technology exchange events with the conference. These calls will help in coordinating the activities during the conference as determined by participating member agencies. 2. TRB will provide for a learning session and technology exchange forum to be held during the conference at the same venue as the conference. The intent will be for pooled fund partners and other invited agencies plus invited speakers to discuss member agency issues related to Low Volume Roads. This is an opportunity for the pooled fund partners to collaborate and share best practices and strategies for overcoming certain challenges. The exchange forum will be held during the conference due to the anticipated opportunity to interact with experts and other technical professionals at the conference. The Iowa DOT will coordinate the learning session with other pooled fund partners. The Conference Planning Committee will not be involved in planning the pooled fund partner session, though collaboration is expected on venue accommodations and conference program planning. TRB will synchronize the conference and pooled fund member activities to allow pooled fund members to accomplish its business and technology deployment goals while also providing opportunity to participate in key components of the international conference. 3. If funds allow, follow-up post conference webinars will be organized by pooled fund partners and led by TRB for dissemination and execution. The webinars will share highlights from activities and include an open forum question/answer discussion or it may be to highlight the best papers of presentation that pooled fund members find of interest from the conference. In addition, pooled fund member agencies will review topics and projects through a selection process and select those worthy of dissemination through publications. In addition, pooled fund partners will identify technologies for field demonstration as part of technology exchange and outline activities to increase outreach to low volume road agencies for technology transfer efforts.

FISCAL YEAR 2022 ACCOMPLISHMENTS

Participation in Low Volume Roads conference planning.

FISCAL YEAR 2023 PROPOSED ACTIVITIES
MDOT attendance at Low Volume Roads Conference in Iowa.
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Dissemination of best practices gained from participation in Low Volume Roads Conference.

Michigan Department
Of Transportation
5307 (2011)

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2022

STUDY TITLE: TRB Core Program Activities FFY 2022 (TRB FY 2023)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (*PLEASE EXPLAIN*)

TPF NO.	TPF-5(496)		MDOT START DATE	10/01/2021
PROJECT NO.	Not applicable		MDOT COMPLETION DATE (Original)	09/30/2022
OR NO.	OR22-200		PROJECT COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	André Clover, 517-749-9001 CloverA@michigan.gov			
LEAD AGENCY:	Federal Highway Administration (FHWA)			
PROJECT MANAGER	Jean Landolt, 202-493-3146 Jean.Landolt@dot.gov			
CONTRACTOR	Not applicable			

BUDGET STATUS

FY 2022 MDOT Budget				Total Budget		
FY FUNDS	(Original)	$198,000.00		BUDGETED AMT.	(Original)	$198,000.00
				ACTUAL COST		$222,468.00
TOTAL FY 2022 EXPENDITURES		$222,468.00		**Total Committed Funds Available**		$0.00

PARTICIPATING STATES

AK, AL, CA, CT, DE, GA, ID, IN, MD, ME, MI, MN, MO, MT, NC, ND, NH, OH, OR, PA, SC, SD, TX, UT, WI, and WV
Total Commitments Received: $6,470,589.00

PURPOSE AND SCOPE

The Michigan Department of Transportation (MDOT) provides annual financial support for the Transportation Research Board's (TRB's) Core Program technical activities. This support helps to operate TRB annual meetings, the committee structure, state visits by TRB, and the TRB publication program. This pooled fund study permits states to make their contributions to the TRB Core Program instead of sending their contributions to the TRB directly. TRB FY 2022 covers the period from July 1, 2021- June 30, 2022

FISCAL YEAR 2022 ACCOMPLISHMENTS

TRB Annual Meeting, committee/subcommittee meetings, state field visits and TRB publication program administration completed.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT selected to transfer its FY 2022 federal funds via the TPF-5(496) pooled fund study. Thus, FY 2022 commitment paid in full.

NOTE: The TRB Executive Committee recommend annual contributions from each state be based on the most current SP&R funding tables available.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT technical experts have access to all TRB publications to review and share internally as appropriate.

APPENDIX

FISCAL YEAR 2021 REPORT UPDATES

The following update notes a change to the MDOT *State Planning and Research Part II Program Fiscal Year 2021 Annual Report*:

Table 1 – 80% Federally Funded Projects (Pg. 6):

- Last year, $100,721.21in costs were reported for project number 209564, “Michigan Transportation Construction Price Index,” under contract with Western Michigan University (WMU) number 2019-0313 Authorization 3. Expenses should have been reported as *$95,110.93*. The cost is reported correctly on the project form (Pg. 65).