TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): __Iowa DOT_____

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(295)*	**Transportation Pooled Fund Program - Report Period:** Quarter 1 (January 1 – March 31, 2016) Quarter 2 (April 1 – June 30) X Quarter 3 (July 1 – September 30) Quarter 4 (October 1 – December 31)
Project Title: Midwest Smart Work Zone Deployment Initiative	

Name of Project Manager(s): Dan Sprengeler	**Phone Number:** 515-239-1823	**E-Mail** Dan.Sprengeler@dot.iowa.gov
Lead Agency Project ID: Keith Knapp	**Other Project ID (i.e., contract #):** Addendum 535	**Project Start Date:** July 1, 2014
Original Project End Date: June 30, 2020	**Current Project End Date:** June 30, 2019	**Number of Extensions:** None

Project schedule status:

X On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$825,000 (committed)	$331,212.18	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$82,749.33		0

Project Description:
The Midwest Smart Work Zone Deployment Initiative (MwSWZDI) was initiated in 1999 as a Federal Highway Administration (FHWA) Pooled Fund Study intended to coordinate and promote research among the participating states related to safety and mobility in highway work zones.

The program is an ongoing cooperative effort between State Departments of Transportation, universities, and industry. The studies completed have consisted of evaluations of various work zone related products, various innovative topics, and several synthesis studies. Completed reports and descriptions of ongoing projects can be obtained at the Iowa State University's Institute for Transportation (InTrans) website (www.intrans.iastate.edu/smartwz/) link to the Smart Work Zone Deployment Initiative. InTrans currently operates as the program manager of the pooled fund efforts and completes administrative tasks related to request for ideas and proposals, meetings, project files, quarterly reports, and recommending reimbursement.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Quarter Ending September 30, 2016 (Overall)
During this quarter we communicated with a number of principal investigators as needed and resolved progress issues if they occurred. Contracts from Program Year 2014, 2015, and 2016 contracts progressed (see below). In addition, the request for problem statements occurred and the 16 received were discussed at a Board meeting on August 4, 2016. Ten of the problem statements were released with the RFP and a deadline of September 30, 2016 was indicated. A total of 21 proposals were received and Phase 1 of the rankings started October 10, 2016.

The following is a summary of accomplishments from July to September, 2016 for the Year 2014, 2015, and 2016 individual research projects under fund account TPF-5(295).

2016 Program Projects

- Design Optimal and Effective Queue Detection and Notification: Design of a Low-Cost Work Zone Warning System, University of Wisconsin, Madhav Chitturi as PI.

  Project began June 15, 2016. No quarterly report was submitted for this project by the contractual deadline at the time this report was written. The PI has been notified that he currently out of compliance with contract requirements.

  Project started on June 15, 2016 and is expected to finish on December 15, 2017. It is ?% complete.

- Understanding the Impact of Work Zone Activities on Traffic Flow Characteristics, University of Missouri-Columbia, Praveen Edara as PI.

  Literature review is nearing completion. The review includes studies that included the effects of work zone activity on traffic mobility and safety. The relevant chapters in the Highway Capacity Manual were also reviewed and summarized in the state of the practice report.

  Activity data is being extracted from several sources including weekly work zone schedules for the St. Louis region. Traffic flow data is being extracted from detectors and travel time data from RITIS/HERE. Traffic data was extracted for work zones on I-270 that occurred in 2014. For each work zone, data was extracted for an upstream detector, downstream detector in addition to the detector closest to the work zone.

  This project started on April 1, 2016 and is expected to finish on October 1, 2017. It is 20% complete.

- Best Practices for Managing Work Zone Data, University of Wisconsin-Madison, Steven Parker as PI.

  Task 2 Survey Design and Implementation is expected to be completed by 10/31. The draft survey was reviewed by the TAC in the meeting on 9/28. The TAC was generally satisfied with the draft survey, and provided comments and suggestions for further improvements. A revised survey will be sent to the TAC in mid-October, and the finalized survey will be distributed by 10/31. Because of scheduling difficulties, the next TAC will be scheduled in January to review the initial findings.

  This project started on April 1, 2016 and is expected to finish on March 31, 2017. It is 45% complete.

- Development of a Data Collection Prototype and a Traffic Impact Assessment Tool for Moving Work Zone Operations, University of Missouri-Columbia, Praveen Edara as PI.

  Literature review is complete. Data is being collected for moving work zones in St. Louis. Weekly work zone schedules were requested from the TMC in St. Louis. Historical data for work zones that occurred in 2015 were also requested along with access to real-time electronic alerts for work zones in 2016. Simulation model is also under development to simulate a moving work zone.

  This project is 20% complete. The project started on March 15, 2016 and expected to be finished on July 31, 2017.

2015 Program Projects

- Evaluation of Alternative Work Zone Signing, University of Wisconsin – Madison, Madhav Chitturi as PI.

  An extension to March 31, 2017 was granted to this project. No quarterly report was submitted for this project by the contractual deadline at the time this report was written. The PI has been notified that he currently out of compliance with contract requirements.

  This project is ??% complete. It was expected to end by August 31, 2016, but has been extended to March 31, 2017.

- Developing a Data Driven Traffic Impact Assessment Tool for Work Zones, University of Missouri-Columbia, Praveen Edara as PI.

  Work zone travel time prediction models were further developed using work zone data for I-70, I-270, and MO 141 in St. Louis. Progress was also made on the prototype tool integrating the prediction model, travel time and work zone data, and work zone location information. The final report documenting the data collection, reduction, and prototype development is nearing completion.

  The project is approximately 80% complete. It is expected to end by December 31, 2016.

- Orange Work Zone Pavement Marking Midwest Field Test, University of Wisconsin – Madison, Madhav Chitturi as PI.

  An extension to March 31, 2017 was granted to this project. No quarterly report was submitted for this project by the contractual deadline at the time this report was written. The PI has been notified that he currently out of compliance with contract requirements.

  The project is still about ?? % complete. It is expected to end by September 30, 2016, but it has been extended to March 31, 2017.

- Setting Work Zone Speed Limits, Iowa State University, Anuj Sharma as PI.

  The research work has been completed. The TAC meeting for final presentation has been scheduled for October 6 (1 PM - 2PM).

  This project started March 15, 2015 and is approximately 98% complete. Its end date has been extended to October 31, 2016. Its original end date was May 31, 2016.

2014 Program Projects

- Length of Need for Free-Standing, F-Shape, Portable 12.5' Concrete Protection Barrier, University of Nebraska, Ron Faller as PI

  Previously, MwRSF completed simulation of impacts on the upstream and downstream ends of the 200 ft long barrier system to determine the length of need. It was determined that three barriers would be recommended for both the beginning and the end of length-of-need for the TCB system, until the results could be further discussed with the TAC.

  The next step of the simulation analysis was to conduct impacts at the selected beginning and end of length-of-need lengths for a reduced system length in order to verify that the length-of-need definitions work for shorter lengths and to examine the minimum potential length of the TCB system. Simulation models were evaluated using a seven barrier long TCB system. The results of these models found that the 2270P vehicle was successfully redirected for the seven barrier installation at both the beginning and end of the LON. In both cases, the reduced barrier system increased barrier deflections by approximately 16" over the full-length, 16 barrier system. Additionally, the impact at the end of the LON indicated a potential for the last barrier in the system to rotate rapidly towards the vehicle as it was redirected and impact the vehicle door. Thus, while the vehicle was redirected and the increases in deflections were manageable, the impact of the barrier with the driver side door was a concern.

  These findings were discussed in detail at the July 21st TAC meeting in order to determine what the TAC concerns were and what was desired to be investigated through full-scale testing. The TAC indicated that the rotation and impact of the end barrier with the vehicle was a concern and wished to analyze the system with eight barriers, 3 for the beginning of LON, one in the middle, and 4 on the end of the LON. These models were simulated. Again both models successfully redirected the impacting vehicle. The addition of the fourth barrier on the end of LON mitigated the impact of the barriers on the vehicle door. Barrier deflections for impact at the beginning and end of LON for the 8 barrier installation were found to be 94.8 in. and 90 in., respectively. These results were given to the TAC in a meeting on 10-15-15. They concurred that testing should proceed on the 8 barrier installation.

  Details for the full-scale crash testing of the 8 barrier installation were developed and sent to the MwRSF Outdoor Testing Facility. Barriers for both full-scale crash tests were fabricated and received. Currently, full-scale testing of the 8 barrier installation will commence as soon as possible within the current MwRSF test queue.
  standard TL-3 impact conditions.

  In this quarter, MwRSF conducted the full-scale crash testing and evaluation of the reduced system lengths indicated by the simulation analysis. Two full-scale crash tests were conducted.
  1. NELON-1 = Test designation no. 3-35 at beginning of LON
  2. NELON-2 = Test designation no. 3-37 at end of LON

In test no. NELON-1, the 2270P pickup truck vehicle impacted the eight barrier long PCB system 4.3 ft upstream of the joint between barrier nos. 3 and 4 to evaluate an impact at the beginning of length-of-need. During the impact, the vehicle was safely redirected. The deflection of the barrier system was significantly higher than previous tests with a 16 barrier long PCB system in terms of both lateral motion and longitudinal motion. A peak dynamic lateral barrier deflection of 128.3 in. was measured in test NELON-1. In addition, it was noted that the increased deflection of the barriers upstream of the impacting vehicle allowed a knee to form at the joint between barrier nos. 5 and 6 that impacted the rear passenger door on the driver's side of the vehicle. While this impact did not create an occupant risk, it was one of the behaviors noted in the simulation analysis that caused concern with reduced length PCB systems.

In test no. NELON-2, the 2270P pickup truck vehicle impacted the eight barrier long PCB system 4.3 ft upstream of the joint between barrier nos. 4 and 5 to evaluate an impact at the end of length-of-need. During the impact, the vehicle was redirected, but increased roll of the vehicle was observed that caused the vehicle to roll over 80 degrees onto the driver side after exiting the system. This vehicle instability exceeded the 75 degree limitation on vehicle roll in MASH, the test result was deemed not acceptable according to MASH TL-3. Examination of the test results are continuing, but two factors are believed to have contributed to the excess roll. First, the reduced length of the PCB system allowed increased deflection of the barrier segments upstream of the vehicle which delayed the tail slap of the back end of the vehicle with the PCB system when compared to previous testing of longer systems. This delay in the impact of the rear of the truck with the PCB system as it was redirected may have provided less lateral support for the truck as it was yawing and rolling, thus allowing for increased roll of the vehicle. A second factor that may have contributed to increased vehicle roll was the formation of a knee between barrier nos. 6 and 7. Similar to test no. NELON-1, a knee formed between barrier nos. 6 and 7 in test no. NELON-2 that extended forward and impacted the rear of the front fender as well as the driver door and the rear passenger door on the driver's side of the vehicle. The lateral loading of side of the vehicle by the knee in the barrier system may have increased vehicle roll and instability.

Preliminary review of the review of these two tests suggests that defining a minimum of 3 barriers for the beginning of length-of-need for an 8 barrier long system was acceptable, but that 4 barriers for the end of length-of-need was insufficient. Thus, an eight barrier system length is not acceptable. However, the use of a 9 barrier system with 3 barriers for the beginning of length-of-need, 1 barrier in the length-of-need, and 5 barriers for the end of length-of-need would be sufficient. We can extrapolate that this system would be successful because test no. NELON-1 worked with and 8 barrier long system with 3 barriers for the beginning of length-of-need and 5 barriers downstream of impact. Thus, it would stand to reason that a 9 barrier long system should perform equally well if the end of length-of-need is defined as 5 barriers at minimum.

Following the full-scale crash tests, the researchers have conducted simulations of both crash tests to calibrate the models to the dynamic deflection observed in the tests. These calibrated models are completed. Additional simulation models to estimate barrier deflections for intermediate lengths under MASH TL-3 impact conditions and 85 percentile impact severity levels were simulated in the last quarter and the results are currently being incorporated into the research report. Work continued last quarter on the final report for the research and the report is approximately 50% completed. The report will be completed early in the fourth quarter of 2016 and sent to the sponsors for review.

The remaining work for the project will consist of completion of the final report. A journal paper will also be completed prior to the project end date.

This project is 85 percent complete and had an initial end date of December 31, 2015. An extension to December 31, 2016 has been granted.

- Development of a TL-3 Transition between Temporary Concrete Barrier and Guardrail, University of Nebraska, Ron Faller as PI

  Previously, MwRSF conducted all three of the full-scale crash tests for evaluation of the MASH TL-3 guardrail to PCB transition system. The test matrix is listed below.

  1. MGSPCB-1 - Test no. 3-21 - Impact of the 2270P vehicle on the centerline of the fifth guardrail post upstream from the end-shoe attachment at a speed of 62 mph and an angle of 25 degrees.
  2. MGSPCB-2 - Test no. 3-21R - Reverse direction impact of the 2270P vehicle 12 ft – 6 in. upstream from the end-shoe attachment at a speed of 62 mph and an angle of 25 degrees.
  3. MGSPCB-3 - Test no. 3-20 - Impact of the 1100C vehicle on the critical impact point of the guardrail to PCB transition at a speed of 62 mph and an angle of 25 degrees. MASH procedures and engineering analysis will be used to determine the critical impact point.

  All three of the full-scale crash tests successfully met the MASH TL-3 criteria. Thus, the system evaluation was completely successful. Currently, MwRSF is in the process of compiling the test report and recommendations for the implementation of the design. MwRSF was unable to complete the summary report prior to the original project end date of 12/31/15. Thus, a no-cost project extension was requested and granted.

  A TAC meeting was held on 10-15-15 to update the project status and review the full-scale crash test results.

  During this quarter, MwRSF has completed the draft of the research report evaluating the three successful crash tests. The report will be sent out to the sponsors for review early in the fourth quarter of 2016. A TRB paper for the 2017 meeting was submitted and is currently in the review process.

  In the upcoming quarter, MwRSF will continue incorporate edits from the sponsors and complete the research report summarizing the testing and evaluation of the guardrail to PCB transition. Additionally, the project team will prepare a technical brief as well as a summary presentation of the research results for the TAC.

  This project is 90 percent complete and had an original end date of December 31, 2015. An extension to December 31, 2016 has been granted.

Anticipated work next quarter:

Work will continue on contracted projects. Problem statements will be chosen and a meeting held to select those to include in the 2017 RFP. The Program Year 2017 RFP will be distributed and proposals gathered.

Significant Results:

Program Year 2016 project were contracted.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Currently there are no problems to report with the administrative contract. Any issues that have come up with the individual projects that may impact schedule or budget are resolved on a case by case basis.

Potential Implementation:

One project was finished and posted this quarter.