

Research Project Quarterly Progress Report

Date: 10/28/2021 **Project Number:** TPF-5(430) Suppl. #1, RPFP-20-MGS-2
Project Title: MGS with Reduced Embedment and Post Spacing over Low-Fill Culverts
Principal Investigator: Faller, R.K., Bielenberg, R.W., Lechtenberg, K.A., Rosenbaugh, S.K., Mojdeh Pajouh
Principal Contact Information Email: mojdeh.pajouh@unl.edu **Phone:** 402-472-0920
Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period:

- Quarter 1 (July 1 – September 30)
- Quarter 2 (October 1 – December 31)
- Quarter 3 (January 1 – March 31)
- Quarter 4 (April 1 – June 30)

Due Date:

- October 31
- January 31
- April 30
- July 31

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Project Planning & Management & CAD	\$16,853.00	0.6%	\$94.00	\$7,619.00	45.2%	\$9,234.00
2. Dynamic Bogie Testing	\$78,032.00	0.0%	\$0.00	\$35,587.00	45.6%	\$42,445.00
3. Dynamic Bogie Testing	\$61,310.00	0.0%	\$0.00	\$655.00	1.1%	\$60,655.00
4. Reporting and Project Deliverables	\$29,717.00	0.0%	\$0.00	\$0.00	0.0%	\$29,717.00
5.						
6.						
8. Total	\$185,912	-	\$94.00	\$43,861.00	23.6%	\$142,051.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Previously, MwRSF had started the research effort by conducting six (6) bogie tests to evaluate post behavior through a range of reduced embedment depths. All tests were conducted with W6x8.5 posts. Two tests were performed at each reduced embedment increment of 4 in. from the standard 40 in. MGS post embedment, to a minimum of 28 in. (embedment depths of 28 in., 32 in., and 36 in.). The data from these tests was analyzed and compared with previous testing of guardrail posts at the standard embedment depth of 40 in. The data will also be used to develop post-soil resistance input for computer simulation.

Additional bogie testing was conducted. Analysis of the initial bogie tests found that the post soil interaction forces were limited by yielding of the W6x8.5 post used in the first six bogie tests. In order to isolate the soil response at lower embedments, a second set of three bogie tests was conducted with W6x16 posts at 40 in., 34 in. and 28 in. embedments. The data from these tests was further utilized to characterize the post response for shallow embedments.

MwRSF has continued development of models of the bogie tests in LS-DYNA to develop accurate post-soil models for further MGS system analysis with shallow embedments. Models of both the W6x8.5 and W6x16 dynamic component tests were developed. The W6x16 models are being calibrated to provide accurate soil response. The soil models used in the W6x16 post in soil models are then being applied to a model of W6x8.5 posts in soil with various embedment depths and compared with the previous component tests to ensure that the LS-DYNA models will produce the proper response when used to model the MGS with shallow embedment depths. Only limited progress was made this quarter due to other priorities and project deadlines.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

In the upcoming quarter, MwRSF will continue to develop validated models of the post-soil interaction with reduced embedments and begin simulation analysis of potential MGS design alternatives.

Total Percentage of Project Completion:

23.5%

Research Project Quarterly Progress Report

Date: 10/31/2021 **Project Number:** TPF-5(430) Suppl. #2
Project Title: Additional Retrofit Options for Post Conflicts within AGTs
Principal Investigator: Faller, Rosenbaugh, Rasmussen, Bielenberg, Lechtenberg, Reid, Stolle
Principal Contact Information Email: srosenabugh2@unl.edu **Phone:** (402) 472-9324
Project Start Date: 10/1/2018 **Project Completion Date:** 12/31/2021

Report Period:	Due Date:
<input checked="" type="checkbox"/> Quarter 1 (July 1 – September 30)	October 31
<input type="checkbox"/> Quarter 2 (October 1 – December 31)	January 31
<input type="checkbox"/> Quarter 3 (January 1 – March 31)	April 30
<input type="checkbox"/> Quarter 4 (April 1 – June 30)	July 31

Project Schedule Status:

On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Planning & Correspondence	\$27,155	20%	\$2,352	\$12,177	52%	14,978
2. Design and Analysis	\$106,064	80%	\$21,170	\$31,464	30%	\$74,600
3. Bogie Testing	\$99,897	0%	\$	\$0	0	\$99,897
4. Reporting and Deliverables	\$18,313	0%	\$0	\$0	0	\$18,313
5.						
6.						
7.						
8.						
9. Total	\$251,429	-	\$23,522	\$43,641	18%	\$207,788

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

The research team reviewed background information and related testing with W6x15 posts installed in soil and identified a target “baseline” force and deflection combination for the updated retrofit post options. Computer simulation models were performed to investigate the potential for post and baseplate options to provide a similar force-deflection behavior similar to W6x15 posts embedded in soil. Concepts evaluated saw cut flanges, various configurations of holes in the flanges, and with posts welded all around or with welds omitted on the back side flange.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The budgets herein do not include September labor charges as those billing typically takes about a month to process.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Analysis of post-installed epoxy anchors into the grade beam will be investigated and concepts with the potential to provide enough moment and flexural resistance for the post and baseplate combination will be advanced. Baseplate concepts will be generated with and without gusseted reinforcements which are able to transfer the loads between the post and the grade beam under controlled force-deflection of the post member. If possible, the research team will identify a post, baseplate, anchor, and grade beam combination that can work at any grade beam depth; however, if a suitable flexible design cannot be constructed, concepts will be shown that perform well for the expected configuration of the grade beam and post design.

Note that results of this project will be shown to the MwRSF Pooled Fund during the fall update.

Total Percentage of Project Completion:

18%

Research Project Quarterly Progress Report

Date: 10/31/2021 **Project Number:** TPF-5(430) Suppl. #3, RPFP-20-AGT-2
Project Title: Guidelines for Flaring Thrie-Beam Approach Guardrail Transitions - Phase II
Principal Investigator: Scott Rosenbaugh, Faller, Bielenberg, et al.
Principal Contact Information Email: srosenbaugh2@unl.edu **Phone:** (402) 472-9324
Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) ----- October 31
 Quarter 2 (October 1 – December 31) ----- January 31
 Quarter 3 (January 1 – March 31)----- April 30
 Quarter 4 (April 1 – June 30) ----- July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning & Correspondence	\$12,644.00	10%	\$1,000.00	50%	\$5,644.00
2. Full-Scale Crash Testing	\$278,516.00	90%	\$16,338.00	40%	\$102,203.00
3. Reporting	\$11,623.00	0%	\$0.00	0%	\$11,623.00
4.					
5.					
6.					
7.					
8.					
9. Total	\$302,783.00		\$17,338.00	25%	\$189,471.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

On September 21, MwRSF ran the 2nd full scale crash test evaluating flared AGTs. Recall, the first test conducted on an AGT with a 15:1 flare rate resulted in excessive occupant compartment deformations and high ORA values, both of which failed to meet MASH standards. After test FLAGT-1 failed, the Pooled Fund desired to stay with the 15:1 flare rate, but use larger transition posts in an effort to reduce the system deflections and the sharp guardrail pocket angle that formed adjacent the buttress. Thus, the 6.5-ft long W6x9 posts were replaced with 7.5-ft long W6x15 posts, as shown in the attached drawing set.

Test FLAGT-2 was conducted in accordance with MASH test 3-11 with the 2270P pickup impacting the downstream end of the AGT near the concrete buttress. The impact point was the same as the failed test, FLAGT-1. During the test, the pickup truck impacted the AGT at a speed of 62.6 mph and an angle of 25.3 degrees (creating an effective impact angle of $3.8 + 25.3 = 29.1$ degrees). The test article contained and redirected the truck, and all OIV and ORA values were within the MASH limits. However, the front tire was disengaged and pushed backward and against the vehicle toe pan and floor board. Maximum toe pan deformations were measured to be 9.9", which exceeded the MASH limit of 9". Thus, the test FAILED per MASH safety criteria.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Both tests FLAGT-1 and FLAGT-2 failed to meet MASH performance criteria. As such, the project has had to be rescoped and system has had to be redesigned and the tests re-run. Additional project funds will be necessary to complete the full-scale testing on flared AGTs. A Phase III of this project has already been approved as part of the FY 2021 program, but a Phase IV may also be needed.

The budget numbers presented herein do not include labor charges from September 2021 as those expenditures had not yet been charged to the project.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

A meeting with the project sponsors will be necessary to discuss the scope of the project following the 2nd failed crash test. The sponsors and the research team will need to discuss options for modifying the flared AGT to satisfy MASH criteria.

Total Percentage of Project Completion:

25%

Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Suppl. #4, RPPF-20-TERM-1
Project Title: Further Evaluation of the End Terminals Adjacent to Curb
Principal Investigator: Robert Bielenberg and Cody Stolle, Faller, et al
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) ----- October 31
 Quarter 2 (October 1 – December 31) ----- January 31
 Quarter 3 (January 1 – March 31)----- April 30
 Quarter 4 (April 1 – June 30) ----- July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning & Correspondence	\$19,248.00	0%	\$0.00	65.3%	\$6,679.00
2. Full-Scale Crash Testing	\$176,505.00	0.9%	\$1,590.00	9.3%	\$160,148.00
3. Design & Analysis	\$39,381.00	0%	\$0.00	6.6%	\$36,763.52
4. Reporting & Deliverables	\$22,074.00	0%	\$0.00	0%	\$22,074.00
5.					
6.					
7.					
8.					
9. Total	\$257,208.00		\$0.00		\$225,665.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, only limited work was completed on this project. RSI reviewed and accepted the proposed test plan. Additionally, procurement of test plan materials was initiated. The test plan is in the MwRSF testing que.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Currently, the full-scale testing may be delayed due to its status in the MwRSF testing que. COVID-19 has reduced available staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing at the facility. MwRSF is trying our best to resolve the test backlog, but delays are currently expected for most projects. We will continue to update the status of the full-scale testing and its effect on the overall project timeline.

Anticipated Work Next Quarter:

in the next quarter, MwRSF will continue to obtain materials for system fabrication and prepare of the full-scale crash testing. Pre-test evaluations may be conducted to investigate vehicle stability when traversing non-level terrain, before installing the guardrail system.

Total Percentage of Project Completion:

12.3%

Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430)_Suppl5_RPFP-20-SR-1
Project Title: Development of a Short-Radius Guardrail for Intersecting Driveways or Roadways
Principal Investigator: J. Reid, R. Faller, R. Bielenberg, K. Lechtenberg, S. Rosenbaugh
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 1/16/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) ----- October 31
 Quarter 2 (October 1 – December 31) ----- January 31
 Quarter 3 (January 1 – March 31) ----- April 30
 Quarter 4 (April 1 – June 30) ----- July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$30,952.00	11.2%	\$3,454.00	23.9%	\$23,551.00
2. Design and Analysis	\$177,021.00	1.5%	\$2,697.00	6.9%	\$167,537.00
3. Reporting and Project Deliverables	\$43,059.00	0.0%	\$0.00	0.0%	\$43,059.00
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF continued to develop design concepts in addition to 15 potential design concepts noted in previous progress updates. MwRSF also further reviewed previous short-radius guardrail testing to identify potential system improvements. New designs focused on inertial systems and more symmetric loading during vehicle capture.

MwRSF plans to further develop these initial concepts and present them to the sponsors at a separate meeting.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

MwRSF will further develop the previous concepts and hold a meeting with the sponsors to discuss the concepts, receive feedback, and potentially determine a preferred concept for further development and analysis.

Total Percentage of Project Completion:

7.8%

Research Project Quarterly Progress Report

Date: 10/30/2021 **Project Number:** TPF-5(430) Suppl. #6 RFP-20-CONSULT

Project Title: Annual Consulting Services Support

Principal Investigator: J. Reid, R. Faller, R. Bielenberg, K. Lechtenberg, S. Rosenbaugh

Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064

Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

- Report Period:** **Due Date:**
- Quarter 1 (July 1 – September 30) ----- October 31
 - Quarter 2 (October 1 – December 31) ----- January 31
 - Quarter 3 (January 1 – March 31)----- April 30
 - Quarter 4 (April 1 – June 30) ----- July 31

- Project Schedule Status:**
- On Schedule**
 - On Approved Revised Schedule**
 - Ahead of Schedule**
 - Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$60,647.00	7.7%	\$4,645.00	50.7%	\$30,753.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

This project allows MwRSF to be a valuable resource for answering questions with regard to roadside safety issues. MwRSF researchers and engineers are able to respond to issues and questions posed by the sponsors during the year. Major issues discussed with the States have been documented in our Quarterly Progress Reports and all questions and support are accessible on a MwRSF Pooled Fund Consulting web site.

In the past quarter MwRSF has responded to a series of state inquiries. The Quarterly Progress Report summarizing these responses has been attached to this document. The summary will also be available for download at the recently completed MwRSF Pooled Fund Consulting web site - <http://mwrsf-qa.unl.edu/>

We are continuing to work with and improve the MwRSF Pooled Fund Consulting web site as our experience with it grows. We would ask that all Pooled Fund member states use the new site from this point forward for their inquiries and to contact us with any issues they experience with the web site.

The summary of the consulting effort for this quarter is attached with the progress update.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward

Anticipated Work Next Quarter:

MwRSF will continue to answer questions and provide support to the sponsors during the upcoming quarter.

We would ask that all questions be submitted through the web site so that they can be answered and archived therein.

<http://mwrsf-qa.unl.edu/>

Total Percentage of Project Completion:

50.7%

Research Project Quarterly Progress Report

Date: 10/30/2021 **Project Number:** TPF-5(430) Suppl. #8, RFPF-20-LS-DYNA
Project Title: LS-DYNA Modeling Enhancement Support
Principal Investigator: Reid, Faller, et al.
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 1/21/2020 **Project Completion Date:** 12/31/2022

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) ----- October 31
 Quarter 2 (October 1 – December 31) ----- January 31
 Quarter 3 (January 1 – March 31)----- April 30
 Quarter 4 (April 1 – June 30) ----- July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. LS-DYNA Modeling Enhancement	\$30,616.00	32.4%	\$9,796.00	100%	\$0.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9. Total	\$30,616.00		\$9,796.00		\$0.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

MwRSF also performed continued research on improved computational methods for soil modeling that can be applied to future roadside hardware models in Midwest Pooled Fund research. This work involved a large amount of modeling and was summarized in a PhD dissertation.

Additionally, MwRSF is writing a summary report on the previous LS-DYNA effort from this research that developed AGT models for use in Pooled Fund research efforts.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

MwRSF will continue to use the LS-DYNA funds to support modeling needs in ongoing Midwest Pooled Fund Projects. This may include the following.

1. MwRSF has recently done an extensive amount of research in advance soil modeling techniques for use in modeling dynamic post in soil interactions. These models have been primarily developed on a component level. Research is needed to more fully developed these advanced soil modeling techniques and incorporate them into existing roadside hardware models to improve our model fidelity and allow improved investigation of soil parameters effects on roadside hardware such as post embedment, slopes, and other factors.
2. MwRSF has recently developed advanced steel fracture parameters for the GISSMO material failure command in LS-DYNA. This allows users to relate the stress state of the material to the failure strain in order to aid in predicting failure under multiple types of loading conditions. To date, the research in this area has focused mainly on the simulation of coupon samples used to develop the failure parameters. Research is needed to incorporate this steel failure methodology into existing guardrail and roadside hardware models.
3. MwRSF sees a need for advancement in concrete modeling methods. Currently several concrete material models exists and previous research at MwRSF has investigated the material models themselves. However, further research is needed to investigate the incorporation of reinforcing steel and in the concrete material and ensuring effective load transfer through the reinforcing steel. Additional investigation of bonding and development of the reinforcement is needed as well.
4. Vehicle model improvements are a constant need for Midwest Pooled Fund research efforts. Currently needed vehicle model improvements include more refined tire models, enhanced suspension models with suspension failure, and upgrades to existing TL-4 single unit truck and TL-5 tractor-trailer models.

It is anticipated that summary reports on the soil modeling and AGT modeling will be completed. Additional work may also occur on the new tire models.

Total Percentage of Project Completion:

68.0%

Research Project Quarterly Progress Report

Date: 10/27/2021 Project Number: TPF-5(430) – Suppl. #10 – FY20-WISC-1-
MGS SLOPE HALF POST 1Q 2020
 Project Title: MASH 2016 TL-3 Evaluation of the MGS with Half Post Spacing and 7-ft Posts Adjacent to
 Principal Investigator: R. Bielenberg and R. Faller,
 Principal Contact Information Email: rbielenberg2@unl.edu Phone: (402) 472-9064
 Project Start Date: 1/16/2020 Project Completion Date: 12/31/2021

Report Period: Due Date:
 Quarter 1 (July 1 – September 30) ----- October 31
 Quarter 2 (October 1 – December 31) ----- January 31
 Quarter 3 (January 1 – March 31) ----- April 30
 Quarter 4 (April 1 – June 30) ----- July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$10,490.00	0.0%	\$0.00	81.2%	\$1,968.00
2. Full-Scale Crash Testing	\$193,277.00	0.3%	\$2,305.00	18.5%	\$157,439.00
3. Reporting and Project Deliverables	\$16,441.00	0.0%	\$0.00	0.0%	\$16,441.00
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

MwSRF has completed most of the system installation except for finishing the slope. The system is currently behind several other systems in the testing queue and will be tested as soon as possible. Final slope preparations and anchorage posts will be installed shortly before testing.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Note that the original start date for the project was listed as October of 2019 with an end date in the 3Q of 2021 (Sept. 30, 2021). Authorization of for the project was not received until January 2020, so the end date has been pushed back accordingly to end of December 2021.

Currently, the full-scale testing has been delayed due to its status in the MwRSF testing queue. COVID-19 has reduced available staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing at the facility. MwRSF is trying our best to resolve the test backlog, but delays are currently expected for most projects. We will continue to update the status of the full-scale testing and its effect on the overall project timeline.

Due to the delays noted above, MwRSF has requested an NCE to extend the project end date to 12/31/2022

Anticipated Work Next Quarter:

In the next quarter, MwRSF anticipates conducting the full-scale crash testing of the MGS with 1/2 post spacing adjacent to slope.

Total Percentage of Project Completion:

20.1%

Research Project Quarterly Progress Report

Date: 10/28/2021 **Project Number:** TPF-5(430) Suppl. 12 – FY20-WY-1-GATE: MASU 2016 TL 2
Project Title: Evaluation of Drop-Arm Road Closure Gate
Principal Investigator: R. Bielenberg and R. Faller,
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 2/26/2020 **Project Completion Date:** 9/30/2022

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) ----- October 31
 Quarter 2 (October 1 – December 31) ----- January 31
 Quarter 3 (January 1 – March 31)----- April 30
 Quarter 4 (April 1 – June 30) ----- July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$17,507.00	0.0%	\$2,115.50	38.3%	\$10,796.50
2. Design and Analysis	\$10,862.00	0.0%	\$0.00	75.1%	\$2,708.34
3. Full-Scale Crash Testing	\$185,441.00	0.6%	\$15,340.00	22.8%	\$143,230.00
4. Reporting and Project Deliverables	\$16,147.00	0.0%	\$0.00	0.0%	\$16,147.00
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF conducted the first full-scale crash test of the WYDOT road closure gate. Test no. WRCG-1 was conducted on the WYDOT road closure gate system on October 1, 2021. This test was conducted according to MASH test no. 3-60. This is a low-speed test (19 mph) with the 1100C vehicle on the system at a ¼ vehicle offset and a critical impact angle. The test mainly serves to evaluate activation of the slip base at low speeds, vehicle velocity change, and occupant compartment deformation due to contact with the support structure. For this test, we selected a 25-degree impact angle and an ¼ vehicle offset with the bulk of the vehicle offset towards the gate arm. This impact condition was selected to maximize the potential for the road closure gate and pole to contact the vehicle.

During test WRCG-1, a 2,434 lb Kia Rio impacted the road closure gate at a speed of 20.1 mph. After initial impact, the pole released cleanly from the slip base with little change to the vehicle velocity. As the vehicle proceeded downstream, the pole and arm assembly translated downstream, rotated slightly clockwise about its vertical axis, and rotated down towards the vehicle. At approximately 714 msec after initial impact, the gate arm mount contacted the vehicle hood. By 762 msec after initial impact, the pole and gate arm assembly were bridging across the hood and the roof on the right side of the vehicle. As the impact continued, the pole and gate arm continued to rotate downward and fell off to the right of the vehicle. After the pole lost contact with the vehicle, brakes were applied, and the vehicle was brought to a stop.

During the test, there was a small penetration of the windshield near the upper right corner of the windshield. This penetration was caused by the wing of one of the gate arm guides. This wing allows for attachment of the U-bolts that hold the arm guides in place.

MASH criteria denote that penetration of the windshield is a cause for test failure. We have observed similar issue in sign supports and work zone signs as well. MwRSF has internally discussed the penetration of the windshield that was observed. While the penetration appears to be small and a limited hazard, it would require us to deem the test WRCG-1 a failure based on the MASH criteria. The only argument that could potentially be made in favor of the test would be that the pole itself is bridging the hood and the roof at the time the penetration occurs, thus the potential for the corner of the mast arm guide to penetrate significantly into the occupant compartment is limited. However, there is no mechanism to make that argument in MASH currently, and we could not find an example where this argument has been used for sign supports or work zone signs. In fact, we identified cases for signs where a bolt head had penetrated the windshield and had been deemed a cause of test failure. As such, we currently plan to deem test no. WRCG-1 as unacceptable under MASH TL-3 criteria.

WYDOT was presented with several options for moving forward.

1. WYDOT can choose continue moving forward with the higher speed tests. If those tests pass, they could choose to self-certify the road closure gate based on limited concerns for occupant risk in the low-speed test. This may not be the optimal path to take, but it has been chosen by some states. As such, I wanted to list it as an option.
2. MwRSF can suggest modifying the system to alleviate the windshield penetration and rerun test no. 3-60. Several options exist, including modifying the metal plate extension used for the gate arm guide U-bolt attachment to be shorter, have rounded edges, or to flare back the corners. These changes could reduce the potential for windshield penetration significantly. One could also consider redesign of the gate arm guide attachment to a c-clamp or other design that does not create the same windshield hazard. Design and retesting of the modified system would likely require additional funding at some point to complete the test matrix.
3. WYDOT could terminate the effort – although this may leave one without a crashworthy gate system.

WYDOT has indicated that they prefer option 2 and MwRSF will be working on updating the project budget and scope to reflect the change.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

Currently, material shipping delays and delays to the overall MwRSF test que have put the project behind schedule. MwRSF will attempt to continue to meet the proposed schedule to the degree possible.

Currently, the full-scale testing has been delayed due to its status in the MwRSF testing que. COVID-19 has reduced available staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing at the facility. MwRSF is trying our best to resolve the test backlog, but delays are currently expected for most projects. We will continue to update the status of the full-scale testing and its effect on the overall project timeline.

Due to these delays, MwRSF has requested and received an NCE until 9/30/2022.

As noted previously, the failure of test no. WRCG-1 will require revision of the scope and budget for the project. MwRSF will revise these items and provide them to WYDOT for approval.

Anticipated Work Next Quarter:

In the next quarter, MwRSF will update the project budget and scope to reflect the change in the research due to the failed test. Once that is completed, the researchers will propose design modifications to mitigate the windshield tearing and prepare for re-testing of the system.

Total Percentage of Project Completion:

24.8%

Pooled Fund Research Project Quarterly Progress Report

Date: 10/30/2021 **Project Number:** TPF-5(430) Suppl. #15, RPFP-21-CABLE-1
Project Title: Redesign of the High-Tension Cable Phase II
Principal Investigator: Faller, Asadollahipajouh, Bielenberg, Holloway, Lechtenberg, Rosenbaugh,
Principal Contact Information Email: kpolivka2@unl.edu **Phone:** (402) 472-9070
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	7/1/21 - 9/30/21	10/31/21

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Plan/Corresp, CAD, Material Certs	\$16,861.00	0%	\$0.00	0%	\$16,861.00
2. Full-Scale Crash Testing	\$217,148.00	0%	\$0.00	0%	\$217,148.00
3. Reporting & Project Deliverables	\$19,887.00	0%	\$0.00	0%	\$19,887.00
4.					
5.					
6.					
7.					
8.					
9. Total	\$253,893.00	0%	\$0.00	0%	\$253,893.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

None

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

Anticipated Work Next Quarter:

Begin preparing test plan for first test.

Total Percentage of Project Completion:

0%

Pooled Fund Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Supp#16 - RFP-21-CONC-2
Project Title: Anchoring of Temporary Barrier to Asphalt - Phase II
Principal Investigator: Faller, Bielenberg, et al.
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	7/1/21 - 9/30/21	10/31/21

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$13,939.00	0	\$0.00		\$13,393.00
2. Design and Analysis	\$59,224.00	0	\$0.00		\$59,224.00
3. Full-Scale Crash / Bogie Testing	\$122,413.00	0	\$0.00		\$122,413.00
4. Reporting and Project Deliverables	\$29,295.00	0	\$0.00		\$29,295.00
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF reviewed previous testing of the asphalt ;pin anchorage for F-hsape PCBs as well as other similar testing to better understand the failure mechanism and determine potential mechanisms for improving the system performance. Potential improvements included better shear transfer at the joint, vertical restraint of the front of the barrier, and shielding of the PCB joint

The researchers also developed a series of potential retrofit concepts to improve the system performance. These concepts were reviewed in terms of their pros and cons, including crash performance, cost, and installation ease.

Please note that the budget numbers in the QPR only reflect labor charges through August.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

In the next quarter, MwRSF will present the retrofit concepts to the member states and garner feedback on them. In addition, the researchers will provide a survey to the states to identify preferred concepts for further development and analysis.

Total Percentage of Project Completion:

0.0

Pooled Fund Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Suppl#17 - RFPF-21-CONC-3
Project Title: MASH TL-3 Portable Barrier System
Principal Investigator: Faller, Bielenberg, et al.
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	July 2021 - September 2021	10/31/21

Project Schedule Status:

- On Schedule
- On Approved Revised Schedule
- Ahead of Schedule
- Behind Schedule

Progress:

	Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1.	Project Planning and Correspondence	\$33,717.00	0	\$0.00	0	\$33,717.00
2.	Design and Analysis	\$81,642.00	0	\$0.00	0	\$81,642.00
3.	Reporting and Project Deliverables	\$32,937.00	0	\$0.00	0	\$32,937.00
4.						
5.						
6.						
7.						
8.						
9.						

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

In this quarter, MwRSF met with the member states and reviewed previous PCB concepts and simulation analysis. Following the review, MwRSF submitted a survey to the member states to prioritize which concept or concepts will be further developed and analyzed in this research.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

In the next quarter, MwRSF will begin analysis and development of the prioritized concept.

Total Percentage of Project Completion:

0

Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Suppl. #18, RPPF-21-AGT-1
Project Title: Approach Guardrail Transition Behind Elevated Sidewalk
Principal Investigator: Faller, Pajouh, Bielenberg, Lechtenberg, Rosenbaugh, Steelman, and Stolle
Principal Contact Information Email: srosenabugh2@unl.edu **Phone:** (402) 472-9324
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) October 31
 Quarter 2 (October 1 – December 31) January 31
 Quarter 3 (January 1 – March 31) April 30
 Quarter 4 (April 1 – June 30) July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Planning and CAD	\$27,125	100%	\$342	\$342	1%	\$26,783
2. Design and Analysis	\$87,468	0%	\$0	\$0	0%	\$87,468
3. Reporting and Project Deliverables	\$31,548	0%	\$0	\$0	0%	\$31,548
4.						
5.						
6.						
7.						
8. Total	\$146,141	-	\$342	\$342	1%	\$145,799

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Work on this project has yet to begin.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The budget numbers presented herein do not include labor charges from September of 2021 as those expenditures had not yet been charged to the project.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

The literature review will be completed and the state survey will be sent out. Work to create and validate the models for the simulation effort will be started.

Total Percentage of Project Completion:

1%

Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Suppl. #19, RPPF-21-AGT-3
Project Title: Guidelines for Flaring AGTs, Phase III
Principal Investigator: Faller, Pajouh, Bielenberg, Lechtenberg, Rosenbaugh, Steelman, and Stolle
Principal Contact Information Email: srosenabugh2@unl.edu **Phone:** (402) 472-9324
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Report Period: **Due Date:**
 Quarter 1 (July 1 – September 30) October 31
 Quarter 2 (October 1 – December 31) January 31
 Quarter 3 (January 1 – March 31) April 30
 Quarter 4 (April 1 – June 30) July 31

Project Schedule Status:
 On Schedule
 On Approved Revised Schedule
 Ahead of Schedule
 Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total Expenses to Date	Total % of Task Completed	Remaining Budget
1. Planning and CAD	\$4,705	0%	\$0	\$0	0%	\$4,705
2. Design and Analysis	\$109,854	0%	\$0	\$0	0%	\$109,854
3. Reporting and Project Deliverables	\$6,748	0%	\$0	\$0	0%	\$6,748
4.						
5.						
6.						
7.						
8. Total	\$121,307	-	\$0	\$0	0%	\$121,307

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

Work on this project has yet to begin as the research efforts are still being conducted on the previous phase of this project – see project TPF-5(430)_Supplement 3 for details on Phase II efforts.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The budget numbers presented herein do not include labor charges from September of 2021 as those expenditures had not yet been charged to the project.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Work on this project will begin once Phase II of this project has been completed.

Total Percentage of Project Completion:

0%

Pooled Fund Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Suppl. #20, RPFP-21-SIGN-1
Project Title: Breakaway Systems for Ground Mounted, Large Steel Sign Support Structures
Principal Investigator: Faller, Asadollahipajouh, Bielenberg, Holloway, Lechtenberg, Rosenbaugh,
Principal Contact Information Email: joshua.steelman@@unl.edu **Phone:** (402) 472-1972
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	7/1/21 - 9/30/21	10/31/21

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Plan/Corresp, Lit search, survey	\$21,681.00	0%	\$0.00	0%	\$21,681.00
2. Sign Configuration Analysis & Selection	\$28,702.00	0%	\$0.00	0%	\$28,702.00
3. Research Report & Deliverables	\$27,357.00	0%	\$0.00	0%	\$27,357.00
4.					
5.					
6.					
7.					
8.					
9. Total	\$18,573.00	0%	\$0.00	0%	\$18,573.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

None

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Initiate literature review

Total Percentage of Project Completion:

0%

Pooled Fund Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430)-Suppl #21
Project Title: NDOT Breakaway Pole Research (Wisconsin)
Principal Investigator: Faller, Bielenberg, Pajouh, Holloway, Lechtenberg, Rosenbaugh, Steelman, Stolle
Principal Contact Information Email: mojdeh.pajouh@unl.edu **Phone:** (402) 472-0920
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	July 1 - September 30	October 31

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$66,665.00	3	\$54.00	3	\$66,611.00
2. Design and Analysis	\$162,291.00	0	\$0.00	0	\$162,291.00
3. Reporting and Project Deliverables	\$40,509.00	0	\$0.00	0	\$40,509.00
4.					
5.					
6.					
7.					
8.					
9. Total	\$269,455.00	3	\$54.00	3	\$269,411.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

A kickoff meeting was held internally to plan for conducting literature review. This search aims to identify potential critical configurations of a slip base breakaway luminaire pole. The comprehensive literature review that was previously conducted under NCHRP Project 03-119 was found a primary reference while supplementary literature search is being conducted to add more recent slip-base luminaire pole studies.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward

Anticipated Work Next Quarter:

In the next quarter, research team will continue the literature review. A survey will be designed and sent to the pooled fund members to determine commonly used pole configurations

Total Percentage of Project Completion:

3%

Pooled Fund Research Project Quarterly Progress Report

Date: 10/30/2021 **Project Number:** TPF-5(430) Suppl#22 / RFP-21-CONSULT
Project Title: Annual Consulting Services Support
Principal Investigator: Faller, Bielenberg, et al.
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	July 2021 - September 2021	10/31/21

Project Schedule Status:

- On Schedule
- On Approved Revised Schedule
- Ahead of Schedule
- Behind Schedule

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Project Planning and Correspondence	\$61,446.00	0	\$0.00	0	\$61,446.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

None. Funding from the previous Pooled Fund Consulting effort will be depleted prior to utilizing the funding for this project.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. Additionally, changes to businesses outside of MwRSF may lead to possible delays in material acquisition. MwRSF will continue to make progress on this research in the most effective manner possible moving forward

Anticipated Work Next Quarter:

MwRSF will continue to answer questions and provide support to the sponsors during the upcoming quarter.

We would ask that all questions be submitted through the web site so that they can be answered and archived therein.

<http://mwrsf-qa.unl.edu/>

Total Percentage of Project Completion:

0

Pooled Fund Research Project Quarterly Progress Report

Date: 10/29/2021 **Project Number:** TPF-5(430) Suppl. #15, RPFP-21-MPFW
Project Title: Midwest Pooled Fund Website
Principal Investigator: Faller, Asadollahipajouh, Bielenberg, Holloway, Lechtenberg, Rosenbaugh,
Principal Contact Information Email: kpolivka2@unl.edu **Phone:** (402) 472-9070
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	7/1/21 - 9/30/21	10/31/21

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1. Website Develop, Populate, and Host	\$18,573.00	0%	\$0.00	0%	\$18,573.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9. Total	\$18,573.00	0%	\$0.00	0%	\$18,573.00

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

None

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

This is continuation funding untill the funds from Project No.: RPF-20-PFCHS – TPF-5(430) Supplement #7, Project Title: Pooled Fund Center for Highway Safety have been exhausted.

The COVID-19 pandemic and business responses may play a factor in future efforts. MwRSF has not been shut down and is still working, but much of the personnel has transitioned to working remotely, as has much of the country during this time of social distancing. This major shift in regular work operations may lead to delays and inefficiencies as well as other unforeseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

Troubleshooting and fixing any issues that have occurred during the transition. Continue maintenance, repair, and upkeep of the website. Update research hub with new completed projects.

Total Percentage of Project Completion:

0%

Pooled Fund Research Project Quarterly Progress Report

Date: 10/30/2021 **Project Number:** TPF-5(430) Suppl. #24, RPFP-21-LS-DYNA
Project Title: LS-DYNA Modeling Enhancement Support
Principal Investigator: Faller, Bielenberg, et al.
Principal Contact Information Email: rbielenberg2@unl.edu **Phone:** (402) 472-9064
Project Start Date: 7/1/2021 **Project Completion Date:** 7/31/2024

Identify Quarter:	Identify Period of Performance:	Identify Quarterly Report Submittal Deadline:
Quarter 1	7/1/21 - 9/30/21	10/31/21

Project Schedule Status:

- On Schedule**
- On Approved Revised Schedule**
- Ahead of Schedule**
- Behind Schedule**

Progress:

	Task	Total Budget	% work Completed This Quarter	Expenses This Quarter	Total % of Task Completed	Remaining Budget
1.	LS-DYNA Modeling Enhancement	\$43,823.00	0	\$0.00	0	\$43,823.00
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

Progress and Accomplishments this Quarter:

(Provide an informative summary of tasks/activities that occurred this quarter includes meetings, work plan status, significant progress, etc.)

No work was done on this effort in the quarter as funding from the FY2020 LS-DYNA support was being depleted before utilizing these funds.

Circumstances Affecting Project, Scope, or Budget:

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints, along with recommended solution to those problems.)

None

Anticipated Work Next Quarter:

MwRSF will continue to use the LS-DYNA funds to support modeling needs in ongoing Midwest Pooled Fund Projects. This may include the following.

1. MwRSF has recently done an extensive amount of research in advance soil modeling techniques for use in modeling dynamic post in soil interactions. These models have been primarily developed on a component level. Research is needed to more fully developed these advanced soil modeling techniques and incorporate them into existing roadside hardware models to improve our model fidelity and allow improved investigation of soil parameters effects on roadside hardware such as post embedment, slopes, and other factors.
2. MwRSF has recently developed advanced steel fracture parameters for the GISSMO material failure command in LS-DYNA. This allows users to relate the stress state of the material to the failure strain in order to aid in predicting failure under multiple types of loading conditions. To date, the research in this area has focused mainly on the simulation of coupon samples used to develop the failure parameters. Research is needed to incorporate this steel failure methodology into existing guardrail and roadside hardware models.
3. MwRSF sees a need for advancement in concrete modeling methods. Currently several concrete material models exists and previous research at MwRSF has investigated the material models themselves. However, further research is needed to investigate the incorporation of reinforcing steel and in the concrete material and ensuring effective load transfer through the reinforcing steel. Additional investigation of bonding and development of the reinforcement is needed as well.
4. Vehicle model improvements are a constant need for Midwest Pooled Fund research efforts. Currently needed vehicle model improvements include more refined tire models, enhanced suspension models with suspension failure, and upgrades to existing TL-4 single unit truck and TL-5 tractor-trailer models.

It is anticipated that summary reports on the soil modeling and AGT modeling will be completed. Additional work may also occur on the new tire models.

Total Percentage of Project Completion:

0