Research Project Quarterly Progress Report

Date: 7/28/2021 **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: **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. Project Planning & Management & CAD	$16,853.00	0.0%	$0.00	$7,525.00	44.7%	$9,328.00
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	1.1%	$655.00	$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	-	$655.00	$43,767.00	23.5%	$142,145.00

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: 7/31/2021 **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:**
☐ 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 & Correspondence	$27,155	10%	$1,000	$9,825	50%	$17,330
2. Design and Analysis	$106,064	90%	$9,295	$10,293	10%	$95,771
3. Bogie Testing	$99,897	0%	$0	$0	0%	$99,897
4. Reporting and Deliverables	$18,311	0%	$0	$0	0%	$18,311
5.						
6.						
7.						
8.						
9. Total	$251,429	-	$10,295	$20,120	10%	$231,309

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. Concepts were developed to identify potential critical post flexure under controlled loads. The concepts were discussed and a subset were advanced for further consideration.

A new student worker was added to the project team in this quarter (Zunayed Habib). After reviewing background material & performing additional literature review related to the problem statement and need, Zunayed reviewed, updated, and developed a small number of additional post concepts for achieving the force and deflection characteristics of the modified post. As well, design options were considered which would provide a consistent force and deflection regardless of where the W6x15 post attached to the grade beam, at depths between 0 and 18 in. below grade. Initial evaluation of the concept was begun using LS-DYNA computer simulation models to predict force-deflection characteristics of the retrofit posts.

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 June 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:

Computer simulation of the initial concepts will be completed and results will be discussed. Concepts exhibiting the closest behavior to the target force and deflection characteristics will be further refined using computer simulation. Initial test plan recommendations will be provided and test plans will be started.

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

Total Percentage of Project Completion:

10%

Research Project Quarterly Progress Report

Date: 7/31/2021 **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%	$2,000.00	50%	$6,644.00
2. Full-Scale Crash Testing	$278,516.00	90%	$49,965.00	10%	$118,541.00
3. Reporting	$11,623.00	0%	$0.00	0%	$11,623.00
4.					
5.					
6.					
7.					
8.					
9. Total	$302,783.00		$51,965.00	10%	$206,808.00

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 the previous quarter, test no. FLAGT-1 was conducted on 3-31-2021 in accordance with MASH test 3-21. All of the analysis of the test was conducted in the current quarter. The 2270P pickup truck impacted the AGT approximately 93 in. upstream from the buttress at a speed of 63.3 mph and an impact angle of 3.8 +25.7=29.5 degrees. The impact point was selected to maximize snag on the concrete buttress. The vehicle was contained and redirected, and the pickup remained upright and stable throughout the test. However, deformations of 12 in. were measured in the wheel/foot well and toe pan area, where MASH specifies a maximum allowable deformation of 9 inches. Additionally, the maximum longitudinal ORA was measured as 24.2 g's, which exceeded the MASH limit of 20.49 g's. Thus, test FLAGT-1 failed to satisfy MASH safety criteria due to excessive occupant compartment crush and excessive decelerations (longitudinal ORA).

System deflections were higher than anticipated. Maximum dynamic deflections were 15.3 inches. as reference, successful AGTS typically have maximum dynamic deflections in the 6-10 in. range. Simulations conducted during Phase I of the project only predicted a maximum deflection of 10.7 in. The increased system deflections resulted in large soil displacements, and a crack opened up in the soil along the front flanges of the AGT posts. This soil behavior was not observed in previous AGT or MGS testing. It is believed that the tight spacing of the posts (18.75 in. on center) and the increased loading and displacement to the posts lead to overlapping soil forces that opened up this soil crack.

Potential modifications to the flared AGT system were discussed at the annual Pooled Fund Meeting in April 2021, and a survey was sent out to the state DOTs to gather information on the desired modifiaction. Potential modifiactions included 1) reducing the flare rate, 2) moving the location of the flare further upstream, 3) utilizing larger posts with increased embedment depth, and 4) flaring the buttress. Based on the results of this survey, utilizing larger posts was selected as the course of action. 7.5-ft long W6x15 posts were selected to replace the W6x8.5's in orignal AGT. Edits to the drawing set are currently being made to reflect this modification.

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 June 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 unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

System drawings will be completed that include the new transition posts. Full-scale testing will then resume with the modified system configuration.

Total Percentage of Project Completion:
20%

Research Project Quarterly Progress Report

Date: 7/29/2021 **Project Number:** TPF-5(430) Suppl. #4, RPFP-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	4.4%	$7,748.00	8.4%	$161,738.00
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		$235,002.22

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, draft test plans were completed for investigating end terminal performance in conjunction with curbs. Terminal configurations to be used in combination with the sloped 4-in. curb were confirmed with SDI and included in the test plan. the test plan and configuration were submitted to Midwest Pooled Fund state DOTs for review and approval before proceeding at the annual meeting in April. The states confirmed the selected test configuration. Editing of the test plan is ongoing.

MwRSF also developed a vehicle grade ramp for test no. 3-30 that will allow the vehicle to straddle the 4-in. tall curb prior to impact.

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 unforseen 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 avaiable staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing ath 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 complete the test plan for the full-scale crash testing and place the system in the current MwRSF test que. Material ordering will occur at that time. 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:

11.6%

Research Project Quarterly Progress Report

Date: 7/29/2021 **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	6.9%	$2,125.00	12.8%	$27,005.00
2. Design and Analysis	$177,021.00	4.3%	$7,634.00	5.4%	$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 also developed 15 potential design concepts and determined advantages and disadvantages of each concept. Four preferred concepts were presented to the sponsors at the Midwest Pooled Fund Annual Meeting. Additional work on this research was limited in this quarter due to other research priorities, but some addiitonal concept development was pursued.

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 unforseen 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:

5.4%

Research Project Quarterly Progress Report

Date: 7/30/2021 **Project Number:** TPF-5(430) Suppl. #6 RPFP-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	29.2%	$17,709.00	41.6%	$35,398.00
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 unforseen 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:
41.6%

Research Project Quarterly Progress Report

Date: 7/30/2021 **Project Number:** TPF-5(430) Suppl. #7, RPFP-20-PFCHS

Project Title: Pooled Fund Center for Highway Safety

Principal Investigator: Reid, Bielenberg, Faller, Holloway, Lechtenberg, Rosenbaugh, Rasmussen, Stolle

Principal Contact Information Email: kpolivka2@unl.edu **Phone:** (402) 472-9070

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. Website Develop, Populate, and Host	$14,330.00	30%	$4,245.00	100%	$0.00
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.)

Troubleshooting and fixing any issues that have occurred during the transition.

Continued maintenance, repair, and upkeep of the website

Updated research hub with new completed projects.

This will be the last quarterly report for this project as funding has been exhaused.

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.: RPFP-19-PFCHS – TPF-5(193) Supplement #148, Project Title: Pooled Fund for Highway Safety have been exhaused.

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 unforseen hurdles. MwRSF will continue to make progress on this research in the most effective manner possible moving forward.

Anticipated Work Next Quarter:

None as funding has been exhausted. Further work will be reported under FY2021 project (RPFP-21-MPFW), Project Title: Midwest Pooled Fund Website.

Total Percentage of Project Completion:

100%

Research Project Quarterly Progress Report

Date: 7/30/2021 **Project Number:** TPF-5(430) Suppl. #8, RPFP-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	67.6%	$20,711.00	68.0%	$9,795.00
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9. Total	$30,616.00		$0.00		$30,616.00

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 continued updating the Ram truck model. A new version was developed (v3d) and modified for MwRSF usage. The modifications included improvements to the tires and suspension. A new tire model incorporating blowout from another researcher is under investigation. MwRSF also continued development of ATD models for use with the Ram and Yaris vehicle models used for simulation of 2270P and 1100C impacts, respectively.

MwRSF also performed extensive research on improved comuptational 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 will be summarized in a PhD disseration in the upcoming quarter.

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 unforseen 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. Additonal work may also occur on the new tire models.

Total Percentage of Project Completion:

68.0%

Research Project Quarterly Progress Report

Date: 7/27/2021 **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 Slope

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	1.2%	$2,305.00	18.2%	$158,082.00
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 finsihing the slope. The system is currently behind several other systems in the testing que and will be tested as soon as posssible. Final slope prepartions 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 que. COVID-19 has reduced avaiable staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing ath 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 anticipates conducting the full-scale crash testing of the MGS with 1/2 post spacing adjacent to slope.

Total Percentage of Project Completion:

19.9%

Research Project Quarterly Progress Report

Date: 7/28/2021 **Project Number:** TPF-5(430) Suppl. 12 – FY20-WY-1-GATE: MASH 2016 TL-3

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:** 9/30/2021

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	$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	8.3%	$15,340.00	22.2%	$144,289.00
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.)

Previously, MwRSF received both the gate are and luminaire pole hardware for all three crash tests. The materials are currently in the full-scale test que at the MwRSF Outdoor Test Facility for conducting the three full-scale crash tests in the project. MwRSF will conduct these tests as soon as possible within the other existing tests scheduled at the site.

Note that onoging simulation modeling conducted at MwRSF with respect to breakaway luminaire poles may suggest which vehicle orientation is more critical for impacting the pole. If that research indicates a different orientation than currently planned, MwRSF would consult with WYDOT prior to moving forward.

DCAD details for the pole were revised. the pole received from Valmont used a mirrored orientation from the original CAD and what was ordered. As three poles were currently on site, MwRSF altered the CAD and test setup to accommodate the actual poles.

In this quarter, MwRSF prepped vehicles for the full-scale crash testing. Testing was not able to be conducted to to the current testin backlog.Full-scale crash testing is anticipated in the upcoming quarter.

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 avaiable staff at the outdoor test facility, created increased employee leave, and created material procurement issues. These issues have created a backlog of testing ath 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 ancitipates conducting the full-scale crash tests of the road closure gate system.

Total Percentage of Project Completion:
24.4%