Final Abstract

Final Report Approved on February 16, 2026

M.L. 2022 Project Abstract

For the Period Ending June 30, 2025

Project Title: Increased Intense Rain and Flooding in Minnesota's Watersheds

Project Manager: Jason Ulrich

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Funding Source:

Fiscal Year:

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 04h

Appropriation Amount: $192,000

Amount Spent: $192,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

This project showed that increased flooding in the Cottonwood River and nearby watersheds is driven mainly by wetter conditions and more frequent, closely spaced intense rain events. Modeling found that added water storage can reduce smaller floods but has limits during extreme events, helping communities set realistic flood-risk expectations.

Overall Project Outcome and Results

Flooding has become more frequent and damaging across southern Minnesota, especially in agricultural watersheds. Communities such as Springfield and New Ulm in the Cottonwood River watershed have experienced repeated floods in recent decades, raising questions about whether changes in rainfall, farming practices, or drainage systems are responsible—and what actions can realistically reduce future risk.

This project focused on understanding why major floods occurred in 2018 and 2019 in the Cottonwood River watershed and how similar risks apply to nine other southern Minnesota watersheds. The study combined long-term rainfall and river-flow records with watershed modeling to identify the main causes of flooding and to test practical flood-reduction options.

Results show that Minnesota's climate has become wetter, with more intense rainstorms and soils that are already saturated when storms occur. These wet conditions leave less room for water to soak into the ground or river channels, causing rainfall to run off more quickly and produce higher flood peaks. In many watersheds, this change—not farming alone—is the dominant driver of modern flooding.

The project found that wetlands and flood-control basins remain important tools for reducing smaller and moderate floods. However, even large increases in storage cannot fully prevent flooding during extreme, multi-day rain events. This means flood-control practices are most effective when paired with realistic expectations about their limits.

By extending the analysis to multiple watersheds, the project also identified where added water storage is likely to be most cost-effective across southern Minnesota. These results provide state agencies, watershed organizations, and local governments with clear, science-based guidance to improve flood planning, target investments, and better protect Minnesota's land, water, communities, and natural resources under a changing climate.

Project Results Use and Dissemination

Project progress and preliminary results were presented at several Science Museum of Minnesota and Research Station events. Because project completion was delayed, many final results are only now available for dissemination. Planned activities include submission of a peer-reviewed journal article; updates to the final report reflecting journal revisions; presentation at the 2026 Minnesota Water Resources Conference; development of a project website hosted by SMM with access to reports, GIS data, and model files; and a stakeholder meeting within the Cottonwood watershed to present findings and implications.

Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: March 5, 2026

ID Number: 2022-166

Staff Lead: Noah Fribley

Project Title: Increased Intense Rain and Flooding in Minnesota's Watersheds

Project Budget: $192,000

Project Manager Information

Name: Jason Ulrich

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Project Reporting

Final Report Approved: February 16, 2026

Reporting Status: Project Completed

Date of Last Action: February 16, 2026

Project Completion: June 30, 2025

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Sec. 2, Subd. 04h

Appropriation Language: $192,000 the second year is from the trust fund to the Science Museum of Minnesota for the St. Croix Watershed Research Station to partner with local communities to determine the causes of increased flooding and the most cost-effective solutions for reducing flood risk in the Cottonwood River watershed and other agricultural watersheds in southern Minnesota.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: The causes of increased flooding and the most cost-effective solutions for reducing flood risk will be determined for the Cottonwood River watershed and nine other agricultural watersheds in southern Minnesota.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

In recent decades, many river communities across southern Minnesota's agricultural watersheds have seen a marked increase in flooding. In particular, research has shown the Cottonwood River watershed to be an epicenter of increased major flooding, as evidenced by the City of Springfield on the Cottonwood River experiencing several damaging floods in the last decade.

Suggested causes for increased flooding include increases in intense rain events, increased overall precipitation as well as a history of continual agricultural land alteration; however, there is still a lack of scientific consensus and usable information as to the relative importance of each of these potential causes.

As a result, many communities and watersheds are struggling to answer the following questions:
-What are the primary causes of recent increases in flooding?
-What is the relative importance of each of these causes?
-Based on these answers, what are the most cost-effective solutions for reducing flood risk?

An opportunity exists to fill a gap in our understanding of increased flooding in our agricultural watersheds. Filling this gap will ensure future flood planning -- and our State-wide narrative regarding flooding and its causes -- are informed by sound science and economic practicality.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

We propose quantifying the relative importance of potential causes of recent flooding in ten major, agricultural watersheds in southern Minnesota. With this information, we will then analyze the most cost-effective solutions to reduce future flood risk in these areas.

First, we will focus on the Cottonwood watershed because of its location at the center of recent flood increases, and its current, specific need for the proposed project results; the City of Springfield will provide a local perspective on the need for the project.

Our approach will be to develop a very detailed watershed model of the Cottonwood watershed to analyze past flood events from 1950-2020 to understand the causes and how they may have changed over time, including (but not limited to):
-Increases in intense storms
-Increases in overall precipitation
-Decreases in watershed storage (e.g., draining of wetlands, loss of soil-water storage)

Then, the model will be used to test and optimize solutions for reducing future flood risk based on cost and effectiveness. Last, the detailed analysis and results for the Cottonwood River watershed will be extended to the other nine project watersheds (to be determined) using a more generalized approach.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Outcomes will include:
-A first-of-its-kind, quantitative understanding of the relative causes of flooding in ten major agricultural watersheds.

-Analyses of cost-effective solutions for reducing future flood risk in these ten watersheds.
-The Cottonwood watershed (including the City of Springfield) will receive needed information relevant to their current challenges and future planning efforts.

These outcomes will help State agencies, watershed organizations, counties, and municipalities develop - and successfully fund - cost-effective strategies to reduce future flood risk.

An overarching outcome will be providing needed science-based information to policy-makers and the general public regarding this important and often contentious issue.

Project Location

What is the best scale for describing where your work will take place?

Region(s): SE, SW,

What is the best scale to describe the area impacted by your work?

Region(s): SE, SW,

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Conduct detailed analysis and modeling of Cottonwood River watershed to quantify relative importance of flood causes.

Activity Budget: $70,000

Activity Description:
Our approach entails first intensively modeling the entire Cottonwood River watershed with specific focus on major towns on the river (e.g., Springfield, New Ulm). The Cottonwood will be modeled using the watershed model SWAT. The model will be developed to explicitly incorporate the most relevant hydrologic/flooding factors including climate, extent of drain tile, extent of row-crop agriculture, local tillage practices, and depressional/wetland/lake storage -- and how these factors have changed over time from 1950-2020. The model will be primarily calibrated and validated using USGS flow gauging data at New Ulm and with other flow data as available. Once this ”base-condition” model is completed it will be iteratively modified to alter (e.g., increase, decrease, or remove) the extents of the hydrologic/flooding factors individually. The comparison between the base-condition model results and each set of modified model results will quantify the flooding impact and relative importance of each cause/factor.

An important part of this Activity will be quarterly meetings with a technical advisory committee (TAC) which will review work progress and provide expert guidance. The TAC will consist of the local groups/agencies (Redwood-Cottonwood-Rivers-Control-Area, City of Springfield, SWCDs), as well as MPCA and DNR.

Activity Milestones:

Description	Approximate Completion Date
Gather necessary climate and watershed data (soils, LiDAR, landuse, drain tile extent, wetland storage, etc.).	December 31, 2022
Construct and calibrate watershed model.	May 31, 2023
Run watershed model simulations and analyze results to quantify relative importance of flood causes/factors.	October 31, 2023

Activity 2: Simulate solutions for reducing future flood risk in the Cottonwood watershed and calculate cost-effectiveness.

Activity Budget: $50,000

Activity Description:
Activity 2 entails using the completed, calibrated model and analyses of relative importance from Activity 1 to simulate different solutions for reducing flood risk in the Cottonwood watershed. Solutions will consist of one or more specific practices such as (but not limited to):
-“Mitigative”: Increasing upstream, field-scale storage (e.g., wetland restorations, controlled drainage, cover-cropping/no-till, land retirement).
-“Adaptive”: Increasing downstream, on-river storage (e.g., dams and impoundments) and construction of protective levees.

For each solution, the model will be modified to reflect the presence of the solution's practices. The simulations of the solution-modified model will be compared to the current, “base-condition” model simulations to quantify the effectiveness of each solution on flooding (in terms of reduction of flood risk) at different locations in the watershed. Cost and cost-effectiveness (a ratio of the dollars spent per unit effectiveness) will be calculated based on current published ranges of costs and the model-simulated effectiveness associated with each solution's practices. Last, the

solutions will be ranked and optimized by cost-effectiveness.

As with Activity 1, the project's technical advisory committee (TAC) will meet quarterly to discuss progress and provide expert guidance.

Activity Milestones:

Description	Approximate Completion Date
Select solutions and practices to be analyzed for cost-effectiveness.	December 31, 2023
Modify watershed model to analyze cost-effectiveness of solutions and practices.	April 30, 2024
Run watershed model solution simulations and summarize all Cottonwood findings.	August 31, 2024

Activity 3: Extend results of Cottonwood watershed analyses to the other project watersheds.

Activity Budget: $72,000

Activity Description:
Activity 3 entails extending results from Activities 1-2 to nine additional agricultural watersheds in Southern Minnesota (TBD). These watersheds will be selected based on the availability of relatively complete precipitation and flow data, and their general similarity in terms of climate and landscape causes/factors (soils, extent of agriculture, watershed storage, etc.). Then, to ensure the applicability of the Cottonwood SWAT modeling results to the additional study watersheds, a SWAT model will be created for one of the nine (non-Cottonwood) study watersheds; the rigor of this model's parameterization/calibration will be largely consistent with the Cottonwood SWAT model except to reduce the cost/effort the model will be constructed only for the flood reduction/cost-effectiveness period (2010-2020; plus 2007-2009 for model warmup), will not be constructed with time-varying drain tile and storage. Last, a statistical, GIS-based framework will be constructed to correlate/extend results from Activities 1-3 to the eight additional watersheds based on their shared climate and landscape causes/factors.

Much of the activity will be concerned with communicating the goals, progress and results of the project (See Dissemination section).

Activity Milestones:

Description	Approximate Completion Date
Select additional project watersheds and gather necessary data.	October 31, 2024
Develop SWAT model for an additional project watershed.	December 31, 2024
Develop and execute statistical, GIS-based framework to extend Cottonwood results to all project watersheds.	February 28, 2025
Develop reporting/outreach/dissemination deliverables.	June 30, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Shawn Schottler	Science Museum of Minnesota - St. Croix Watershed Research Station	Dr. Schottler will assist and advice in all phases of the project.	Yes
Dr. Bruce Wilson	University of Minnesota - Department of Bioproducts and Biosystems Engineering	Dr. Wilson will assist and provide advisement in all Project Activities -- primarily, the modeling and statistical analysis aspects of Activities 1-3.	No
Kerry Netzke	Redwood-Cottonwood Rivers Control Area	Ms. Netzke is the executive director of the Redwood-Cottonwood Rivers Control Area. She will provide advice from a stakeholder's perspective based on her experience in the Cottonwood watershed and her extensive local knowledge of the issues around water and agriculture. She will also assist in coordinating outreach and communication deliverables.	No
Joe Stremcha	City of Springfield, MN	Mr. Stremcha is City Manager of Springfield and will provide assistance in gathering data necessary for modeling and analysis in Activities 1-2. He will also help coordinate outreach and communication deliverables in Activity 3.	No
Melanie Krueger	Brown County Soil and Water Conservation District	Ms. Krueger is District Manager of the Brown County SWCD, and will provide advice and data gathering assistance, and will participate in the periodic technical advisory meetings	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
As described in Activity 3, significant project resources will be allocated to provide as many means as possible to share the project's results to stakeholders and interested parties State-wide. The planned Dissemination activities/deliverables will include:

(1) A full report with all project methodologies, results and conclusions/recommendations presented to LCCMR; the report as well as GIS files will be placed on Science Museum websites for sharing/download.
(2) A Cottonwood watershed-specific report with all project methodologies, results and conclusions/recommendations directly relevant to the City of Springfield and Cottonwood watershed.
(3) One or more public meetings will held in the City of Springfield to inform regional stakeholders and citizens of the project results.
(4) The results will be presented at two or more professional/scientific MN/regional conferences in the last year of the project.
(5) Project-related social media posts will be created and posted to Science Museum social media outlets; these posts will highlight the aims of the projects and incremental results as the project progresses; posts will include links to the completed project results (e.g., reports, GIS files).

All written and electronic files/documents/social media posts/presentations related to the project will prominently feature the ENRTF logo on the title pages; and in the case of presentations and meetings, the ENRTF will be verbally

acknowledged as well. Any scientific manuscripts will include notice of ENRTF funding and support within their respective Acknowledgements sections.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

As described in Activity 3, implementation will consist of conveying the project results via many different outreach/communication deliverables: reports, fact-sheets, public meetings, social media posts, and presentations at conferences. The intent is to provide as many means possible to share the project's results to stakeholders and interested parties State-wide. Further, the completed Cottonwood watershed model developed in the project will be available to anyone to use in the future with no additional funding required.

All project implementation will take place within the funded project timeline. However, the project results could be extended State-wide with future funding.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Develop Market-Based Alternatives for Perennial Crops to Benefit Water Quality and Wildlife	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 08c	$150,000
Mapping Unprofitable Cropland for Water and Wildlife	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04n	$100,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Assistant Scientist		Project manager, primary modeler, analyst; developer of outreach/communication deliverables			30%	1.6		$129,000	-	-
Senior Scientist		Assist and advise with modeling, analysis, development of outreach/communication deliverables			30%	0.6		$63,000	-	-
							Sub Total	**$192,000**	**$192,000**	**-**
Contracts and Services										
							Sub Total	**-**	**-**	**-**
Equipment, Tools, and Supplies										
							Sub Total	**-**	**-**	**-**
Capital Equipment										
							Sub Total	**-**	**-**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
							Sub Total	**-**	**-**	**-**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**

Printing and Publication										
							Sub Total	**-**	**-**	**-**
Other Expenses										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$192,000**	**$192,000**	**-**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
			State Sub Total	**-**	**-**	**-**
Non-State						
In-Kind	Science Museum of Minnesota	Support services from Science Museum of Minnesota 40.83% of direct costs	Secured	$76,352	$58,093	$18,259
In-Kind	City of Springfield - 25 hours of engineering staff time	Help in data collection and coordinating/hosting meetings.	Secured	$4,075	-	$4,075
In-Kind	Brown County Soil and Water Conservation District -- staff time	Technical staff time for help with data collection and project advisement	Secured	$3,000	-	$3,000
			Non State Sub Total	**$83,427**	**$58,093**	**$25,334**
			Funds Total	**$83,427**	**$58,093**	**$25,334**

Attachments

Required Attachments

Visual Component

File: 583997fe-f91.pdf

Alternate Text for Visual Component

Graphic illustrates proposal to understand causes of recent flooding in southern Minnesota's agricultural watersheds and to determine cost-effective solutions for reducing future flood risk. The project proposes first studying the Cottonwood watershed, an epicenter of increased flooding, and then extending these results to nine other agricultural watersheds in southern Minnesota,...

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Redwood-Cottonwood Rivers Control Area - Letter of Support	b2ba3e6c-1db.pdf
City of Springfield, MN - Letter of Support	2e3ef264-226.pdf
Brown County Soil and Water Conservation District - Letter of Support	e9ffe2ca-b18.pdf
Science Museum of Minnesota - Organizational Letter of Support	feb9c865-217.pdf
LCCMR 2022-166 Ulrich_ResearchAddendum	5e311d45-8f3.pdf
Background Check	44cef685-bf9.pdf
Figure SR1. Existing Cottonwood watershed flood control basins	aaea051e-649.pdf
Figure SR2. Comparison of flows vs. intense rain events in exceptional flood year of 2018 in the Cottonwood watershed	08e978f0-ae7.pdf
Figure SR3. Attribution of floods over 10YR return period since 1950 in the Cottonwood watershed	a1cad50b-8a7.pdf
FINAL REPORT v1	82fadfd5-14f.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Initial Revision: No substantive changes other than changing the project term from 2 to 3 years and changing Activity completion dates to reflect this change.

Additional Revisions (6/22/22): Added text in Activity 3 for development of an additional SWAT model and added an additional Milestone to reflect this effort (Also: removed text from Activity 3 description that was redundant to that outlined in Dissemination section). Added text to Dissemination section describing how the ENRTF will be acknowledged in project deliverables.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

N/A

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Amendment Request	• Budget • Other • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Printing and Publication • Budget - Personnel • Attachments	I've discovered that we ended up spending about $4000 on the project towards salaries but that was budgeted for travel and software. It was an error on my part in over-allocating salaries the last 2 months of the project. However, travel ended up not being needed because meetings were all over Zoom, and free software or existing licenses were utilized instead of any new purchases.	December 31, 2025	Yes	January 20, 2026

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: December 31, 2025

Date Approved: January 20, 2026

Overall Update
Fulfillment of intended-outcomes:
Outcome1:
The project developed a novel flood-attribution framework correlating watershed precipitation and flow events (from 1950-2019) to determine flood causes. While applicable broadly, it was used most intensively in the Cottonwood watershed; results for the other nine watersheds require further refinement before reporting. A key finding for the Cottonwood is the previously under-appreciated role of pre-storm antecedent moisture (in conjunction with intense rain) in recent major floods. This framework may be used for any Minnesota watershed.

Outcome2:
Early in the project, surface water storage was found to be the most cost-effective practice for major flood risk reduction, eliminating the need to rank all possible practices. Cost-effectiveness analyses were instead reframed to estimate the storage needed to reduce flood magnitudes in each watershed, based on 70 years of flow data.

Outcome3:
SWAT+ flood reduction scenario modeling of the Cottonwood at Springfield (exceptional flood years 2018-2019) predicted: 1-significantly-increased surface water storage negligibly reduced major flood magnitudes; 2-significantly-reduced drain tile extent (not realistic) increased some floods and decrease others. These findings support better understanding of flood causes, and better expectations for potential flood reduction solutions.

See attached Final Report for full project details and results.

Activity 1
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 2
We concentrated the flood reduction scenario modeling on the most recent major flood episodes (2018-2019) vs. 60-70 year period originally proposed. A number of factors went into this decision: modeling the changes over a long (60-70 year) time period introduced substantial uncertainty as it can only be roughly estimated how and where tile has been installed since 1950, how crop genetics have changed affecting water use and ET, and how farm operations have evolved over time; these unknowns -- all important for quantifying hydrologic changes -- compound to make modeling setup extremely laborious yet still producing a model with high uncertainty; In addition, the model chosen (SWAT+) requires intensive computer resources and processing time; model runs of 70 years would have been completely untenable in the alotted time and with available SMM computer resources. Last, TAC members were most interested in evaluating the most recent flood periods (2010-2019), as these are the conditions for which they are actively planning for. We also curtailed the assessments of cost-effectiveness because flood control basins/wetlands are already known to be the most cost-effective; the question is the cost, not which solutions perform the most effectively (more in Activity 3 update).
(This activity marked as complete as of this status update)

Activity 3
A significant change here was the omission of an additional watershed model (for the Redwood watershed); with the

challenges and time-intensiveness experienced in constructing and calibrating the Cottonwood (Springfield) model there was not time or resources to construct a second model, especially given its contribution to the overall project results was judged marginal as the project progressed. Instead, this time was used to generalize the Cottonwood results to the nine additional watersheds (including the Redwood) using statistical trends- and GIS analyses. Cost-effectiveness, instead of being about testing and selecting from many possible options, was quickly determined to center on flood control basin/restored wetlands (i.e., surface water storage): for major floods there are no more cost-effective BMPs: soil health (from cover crops/no-till), controlled drainage, and perennial conversion (at scales that are economically feasible -- conversion is far and away the most expensive BMP) had no demonstrable effect compared to impoundments. However, a relative ranking of the cheapest/most-cost effective watersheds to implement surface water storage was developed for floods of different magnitudes based on an intensive hydrograph analysis approach. Thus, this solution approaches the question of cost-effectiveness from a different angle than what was originally proposed. *(This activity marked as complete as of this status update)*

Dissemination

The project progress and provisional results were presented on several occasions at Science Museum (SMM) and Research Station events. As the project completion was delayed and only recently completed, many of the final results have just become available for dissemination. The following activites are planned: (1) composition and submittal of a peer-reviewed journal article, (2) updates to the attached final report reflecting enhancements/edits made during journal article preparation/revision, (3) presentation at next year's MN Water Resources Conference (this will be in addition to a previous presentation on the project at this conference two years ago), (4) a project website hosted at SMM with links to all deliverables including GIS and model files once SMM completes updates to its website infrastructure (scheduled for early 2026), (5) a meeting in a location in the Cottonwood watershed to present conclusions to local stakeholders.

Status Update Reporting

Status Update March 1, 2025

Date Submitted: December 31, 2025

Date Approved: January 20, 2026

Overall Update
The Cottonwood calibrated SWAT+ model has been used to assess the role of changes in climate and tile drainage vs. the effectiveness of past flood mitigation practices in the Cottonwood, particularly in the recent high flooding years since 2010. (Activity 1 is complete; See Activity 1 Update). Work is finishing on simulating flood reductions scenarios and assessing cost-effectiveness (Activity 2 is 90% complete; See Activity 2 Update). Work since last update has focused on Activity 3 which has a diverse set of milestones and deliverables. Much of the dessemination deliverables depend on final completion of the project and thus are still in development. (Activity 3 is 50% complete; See Activity 3 Update).

Activity 1
Update for this Activity mostly unchanged from last update. Activity 1 is now 100% complete. See Figures SR2 and SR3 in the Attachments section for examples of the generated outputs from this Activity. Final results await feedback from Technical Advisory Committee.
(This activity marked as complete as of this status update)

Activity 2
We are finishing the last model runs for the flood reduction scenarios and cost-effectiveness calculations in Milestone 3 with Activity 2 is approximately 90% complete. The last stages of this Activity will comprise paring down and compiling the extensive datasets into the final report deliverables. These final results will also need feedback from the Technical Advisory Committee.

Activity 3
The Redwood SWAT+ model has been completed and is being used for comparison with -- and validation of -- the more-detailed Cottonwood SWAT+ model. The statistical, GIS-based analyses for the additional eight watersheds is in progress and is utilizing the R (stats software) coding framework developed earlier in the project for the Cottonwood pre-modeling flooding analysis. Activity 3 is approximately 50% complete.

Dissemination
Project purpose and progress has been periodically presented at SMM and Research Station outreach activities. However, the bulk of the dissemination is pending final completion of the project and will take place in June and after the project completes this summer and fall 2025.

Status Update Reporting

Status Update September 1, 2024

Date Submitted: September 9, 2024

Date Approved: October 1, 2024

Overall Update
The calibrated SWAT+ model was modified to test the sensitivity/effectiveness of existing flood mitigation practices as well as the proportional effects of tile drainage and changes in precipitation and intense rain events (See Activity 1 Update). Activity 1 is approximately 95% complete. Activity 1 work comprises the majority of the project progress since the last update. Work is finishing on creating flood reduction scenarios for model simulation and calculations of cost-effectiveness with help of Technical Advisory Committee (See Activity 2 Update). Activity 2 is approximately 50% complete. A second SWAT model has been started and data collection for this watershed and the eight other watersheds to be analyzed is complete. (See Activity 3 Update). Activity 3 is approximately 15% complete.

Activity 1
The calibrated Cottonwood SWAT+ model was modified to test the sensitivity/effectiveness of existing flood mitigation practices as well as the proportional effects of tile drainage and changes in precipitation and intense rain events. Provisional results show that existing flood control measures (chiefly flood control structures installed from the 1970s to 2010s, combined with lakes in the upper watershed) have the most flood reduction impact on lower magnitude floods (1- to 5YR return periods); similarly tile drainage, through its increase in total drainage contributing to increases in per-storm baseflow, also had its largest impact (resulting in flooding increases) in lower magnitude floods. However, pre-storm precipitation (resulting in wetter antecedent conditions) and magnitude of intense rain events are primary drivers of all floods -- and the overwhelming drivers of high magnitude floods; with flood control and tile drainage playing relatively small roles. Milestones 1-3 have been provisionally completed pending some tidying up of data and results (Activity 1: 95% finished).

Activity 2
Work is finishing on creating flood reduction scenarios for model simulation and calculations of cost-effectiveness with help of Technical Advisory Committee. Beyond higher-relief flood control basins, additional work has been done to properly account for and find sites for additional simulated “road retention” practices whereby culverts at road crossings are altered to hold back flood water temporarily (but not permanently storing any). Investigations into new, not-yet-standardized practices are continuing as well with select members of the technical advisory committee. Activity 2 is approximately 50% complete; with Milestones 1 and 2 nearly completed.

Activity 3
Work on Activity 3 has begun to proceed. Progress so far has been in selecting a watershed to build the additional SWAT+ model for the project (Milestone 2) and collecting necessary modeling data; for this we have selected the Redwood watershed which is adjacent to the Cottonwood and is similar in terms of its flooding impacts and current watershed efforts to help reduce them. The additional eight watersheds to be included in the GIS/statistical analysis (extending/applying the modeling results to other watersheds/regions; Milestone 1) have been selected and relevant data collection nearly complete. The 8 additional watersheds are all major watersheds in southern Minnesota along a roughly west-to-east line: Lac qui Parle, Yellow Medicine, Des Moines, South Crow, Le Sueur, Cannon, Cedar, and Root. Activity 3 is approximately 15% complete.

Dissemination
Background and provisional project results have been presented at two Science Museum outreach events since the last update.

Status Update Reporting

Status Update March 1, 2024

Date Submitted: March 10, 2024

Date Approved: May 22, 2024

Overall Update
The SWAT+ model for the Cottonwood watershed has been completed and calibrated, and is now being modified to simulate flood mitigation solution/practice scenarios, principally those involving increases in watershed-wide surface water storage. Quantification of existing flood storage was a important component of the model development (shown in the Figure sr1 pdf file in Attachments). Activity 1 is over 75% complete, with Activities 2 and 3 still in early stages (<10% complete).

Activity 1
The SWAT+ model for the Cottonwood watershed has been completed. Considerable work and attention was paid to locating and quantifying as many existing water storage areas in the watershed as possible (in the form of lakes, ponds and actual flood control basins present). Also, the locations and properties of tile-drainage systems were an important modeling focus. Progress was slowed to allow creation of a replicable process for model development that can be used for the second (and final) watershed to be modeled with SWAT+ later in the project (Activity 3). Milestones 1-2 have been completed and Milestone 3 is approaching completion. Provisional results from Milestone 3 underscore the importance of both intense/extreme rainfall events AND high antecedent moisture (i.e., when they occur at the same time) as causes of most of the major floods in the Cottonwood since 1990.

Activity 2
Milestones 1 and 2 have been started, with increased surface water storage comprising the simulated solution/practice scenarios thus far (e.g., adding restored wetlands in the flatter non-coteau plains and additional small dam/reservoir flood control basins in the higher relief/coteau areas). Additional flood reduction solutions/practices will be identified and simulated later after consultation with the technical advisory committee.

Activity 3
No substantive work done for Activity 3 during this reporting period.

Dissemination
Provisional project results were presented at the 2023 MN Water Resources Conference (October 2023) to over 100 audience members. Additionally, these results were presented at a Science Museum public outreach event in January 2024 with 50+ guests attending.

Status Update Reporting

Status Update September 1, 2023

Date Submitted: September 15, 2023

Date Approved: September 27, 2023

Overall Update
Work since the last update has consisted of building the Cottonwood watershed (SWAT) model; this task is still in progress. The model is the core analytical component of the project as it will quantify the relative importance of factors such as watershed flood storage, weather/climate, cropping and artificial drainage for Cottonwood River flooding from 1950 - 2021. Insights and methodologies from the finished model will be extended to the other watersheds in the study area (TBD).

Activity 1
Work is concluding on construction and calibration of the Cottonwood watershed model -- Milestone 1 has been completed and Milestone 2 is close to completion; Milestones 1-3 will be completed by the next status update. The front-loading of conducting additional statistical analyses and developing reusable analytical methodologies, (see last status update; and Activity 3 update in this status update) not originally planned at this stage, have pushed the deadlines of Milestones 1-3 forward about 3-4 months. Collaboration with local project partners has been invaluable for quantifying the extent of existing flood storage projects in the Cottonwood and incorporating them in the SWAT model; this has not been attempted in previous modeling efforts in the watershed.

Activity 2
No substantive work has been completed for Activity 2 thus far.

Activity 3
Expanded statistical analyses, concentrating on the Cottonwood but also applicable to the other study watersheds (TBD), have been conducted to understand the climate/weather linkages to flooding. Specifically, the analyses investigated the link between flooding and both intense rain events AND the antecedent moisture (short- and mid-term rainfall preceding intense rain events). Reusable methodologies developed for these analyses will be implemented in Activity 3 later in the project. (These analyses were reported in the last status update but were not reported under Activity 3 as they should have been.)

Dissemination
There have not been formal Dissemination efforts beyond discussions with project partners/TAC; however, some of the early project results will be presented (as a supplement to other non-project research content) at the MN Water Resources Conference in October 2023.

Status Update Reporting

Status Update March 1, 2023

Date Submitted: March 24, 2023

Date Approved: March 24, 2023

Overall Update
Work so far has centered on the Cottonwood watershed. Tasks thus far have been focused on building a watershed dataset of climate and landscape-related data for hydrologic modeling, and conducting statistical analyses on climate and flow/flooding data; these statistical results will be used in modeling and analyses phases throughout the remainder of the project.

Activity 1
Work so far has centered on the Cottonwood watershed. We have built and statistically analyzed a detailed dataset of climate and flood data. Analyses include quantifying all intense rain events and high flow events and scrutinizing each one individually over the 70 years of the study period to understand the linkages between occurrences of intense rain events, antecedent moisture conditions and flooding; this analyses serve to better parameterize and calibrate the hydrologic model in development.

Because the statistical analysis has been a larger part of the project than anticipated at this stage (it was meant to be conducted later), the model has not been completed as of yet but will be by the end of the FY23; however, the model will greatly benefit from integrating the statistical analysis. We have had informal meetings and communications with members of the TAC but have not convened a formal quarterly meeting as of yet; we anticipate the first TAC meeting occurring in May 2023.

Activity 2
No work has been conducted for Activity 2 thus far.

Activity 3
No work has been conducted for Activity 3 thus far.

Dissemination
No Dissemination work has been conducted thus far.