Final Abstract

Final Report Approved on December 18, 2025

M.L. 2022 Project Abstract

For the Period Ending June 30, 2025

Project Title: Mitigation Strategies for Agroplastic PFAS and Microplastic Contamination

Project Manager: Joel Tallaksen

Affiliation: U of MN - WCROC

Mailing Address: U of M, West Central Research and Outreach Center 46352 State Highway 329

City/State/Zip: Morris, MN 56267

Phone: (320) 589-1711

E-mail: tall0007@umn.edu

Website: https://wcroc.cfans.umn.edu/

Funding Source:

Fiscal Year:

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

Appropriation Amount: $169,000

Amount Spent: $166,340

Amount Remaining: $2,660

Sound bite of Project Outcomes and Results

This project examined the extent and solutions for PFAS and microplastics contamination in agriculture. The major finding was that pollution was mostly confined to places where they were made, used, or disposed of. Reducing new pollution at these sites is the most cost-effective solution to the PFAS and microplastics problem.

Overall Project Outcome and Results

Over the past 20 years, two emerging pollution concerns—PFAS ("forever chemicals") and microplastics—have raised concerns for Minnesota agriculture. Plastics can break into microscopic particles that move through wind and water, allowing both on-farm and off-farm sources to come into contact with crops and livestock. Some studies suggest microplastics can be taken up by plants and animals. PFAS are man-made chemicals used in many consumer and industrial products that do not break down easily, and some are known to cause health effects at low levels. Microplastics can also carry PFAS and can affect plant growth at high concentrations.

Because these pollutants can spread widely in the environment, there is concern that Minnesota's extensive agricultural landscape could be at risk. To address this issue, the University of Minnesota's West Central Research and Outreach Center (WCROC), with funding from LCCMR, began research in 2022 to examine how PFAS and microplastics might enter

the food supply, their potential impacts, and options for reducing contamination in agricultural areas.
The research team reviewed more than 300 scientific papers, technical reports, and government documents. Using this information, they developed an information “toolbox” to help farmers and others understand these pollution issues and explore potential solutions. Findings shared through web resources, newspaper articles, and technical publications indicate that PFAS risks in agriculture are largely limited to farms near sites where PFAS were manufactured, used, or disposed of, while microplastic risks are higher near areas of plastic use or disposal. Most agricultural land experiences only low-level background exposure. Modeling shows that cleaning up PFAS contamination at rural landfills after it occurs would likely be cost-prohibitive.
Overall, the results emphasize that preventing contamination at high-risk hotspots, such as rural landfills, is the most practical and cost-effective way to reduce environmental and agricultural risks.

Project Results Use and Dissemination

This project was designed as an information gathering effort to provide well-researched data to farmers, researchers, regulators, and the public. The project’s results were developed into a number of documents that comprise an information toolkit available online at: https://wcroc.cfans.umn.edu/research/pfas-and-microplastics. Findings were presented in handouts, reports, and multimedia publications. These include information written for a wide spectrum of audiences, from laypeople to research scientists. In addition, the team has and will continue to give public presentations on the findings. Ultimately, these audiences will be the people responsible for implementing PFAS and microplastics policy and actions.

Environment and Natural Resources Trust Fund

M.L. 2022 Approved Final Report

General Information

Date: December 19, 2025

ID Number: 2022-251

Staff Lead: Lisa Bigaouette

Project Title: Mitigation Strategies for Agroplastic PFAS and Microplastic Contamination

Project Budget: $169,000

Project Manager Information

Name: Joel Tallaksen

Organization: U of MN - WCROC

Office Telephone: (320) 589-1711

Email: tall0007@umn.edu

Web Address: https://wcroc.cfans.umn.edu/

Project Reporting

Final Report Approved: December 18, 2025

Reporting Status: Project Completed & Additional Update Approved

Date of Last Action: December 18, 2025

Project Completion: June 30, 2025

Legal Information

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

Appropriation Language: $169,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the West Central Research and Outreach Center, Morris, to study plastic use in the agricultural supply chain and to research and communicate strategies to reduce impacts of this plastic use, including water and land contamination from microplastics, PFAS, and related compounds.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: This project examines strategies to reduce water and land contamination from microplastics, PFASs, and other contaminants due to plastics use in agriculture (agroplastics) and their limited recycling options

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

Plastics use in the agricultural supply chain (agroplastics) has been increasing significantly. As a result, the risks of these plastics and their components, such as poly-fluoroalkyl substances (PFAS) and microplastics, ending up contaminating water and soils has grown dramatically. This project's objectives are to identify the scope and scale of agroplastics use, model potential environmental impacts, examine opportunities for mitigating problems, and finally, develop information for farmers, policy makers, and recyclers to establish a system for reducing impacts.

The environmental impacts of microplastics, PFAS, and other agroplastic related compounds are now better understood. PFAS are a particular concern as they are water soluble, long-lasting, and bioaccumulate; meaning that crops will accumulate PFAS from groundwater, and then livestock or people eating the plants will further concentrate the PFAS in their bodies. Microplastics particles from the breakdown of agroplastics have been shown to impact plant growth, and can be moved from soil to water during erosion.

Agroplastics are indispensable in modern agriculture; often being used for containers, in greenhouse construction, plastic mulches, and forage covering. Developing strategies to mitigate the long-term environmental impacts from these agroplastics is important, but very little organized data currently exists on agroplastics or potential environmental impacts.

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.

This project quantifies Minnesota's agroplastic use and potential impacts in order to foster the informed discussions between farmers, commercial recyclers, and policy makers needed to develop mitigation strategies to reduce agroplastic impacts. Recycling this material has been difficult because of contamination with dirt or livestock feed, manufacturing chemicals like PFAS, remnant fertilizers, or pesticides.

First, we will work with farmers and farm suppliers to understand the types and volumes of agroplastics in use, where they are being used, and how they are being disposed of.

The next phase of work examines how the contaminants and microplastic particles impact the environment. Already, a handful of farms nationwide have had milk contaminated by non-agricultural PFAS from PFAS contaminated well water. However, are the current quantities in Minnesota's water and soil sufficient to cause health or other problems? Which problems? And what is the result of not attempting mitigation?

A final area of investigation is the current, past, and potential recycling efforts to reduce the likelihood of contaminants entering the environment; and, the factors influencing the success or failure of these efforts. Recently, agroplastic recycling systems have experienced economic challenges related to international plastic prices and their large, dispersed collection territories.

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?

The main outcome from this project is an informational 'toolbox' that covers the use of and impacts from agroplastic contaminants entering our water and soil systems, and potential mitigations strategies. It will establish a baseline of information so that key participants in the agroplastic issue can develop policies and systems to protect Minnesota's waterways and other natural resources from contamination by the components of agroplastics. Additionally, we intend that this information be more widely disseminated in the agricultural community so that farmers understand why there are growing concerns about the plastics they have been using for decades.

Project Location

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

Statewide

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

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Identifying the Use of Agricultural Plastics

Activity Budget: $65,000

Activity Description:
Estimating total agroplastic use and the types of plastic will be conducted using a number of data sources to overcome the lack of specific data collection on agroplastics. In person/phone call Interviews with willing farm stakeholders will examine their opinions and suggestions on plastics in agriculture. This initial feedback will aid in the development of an online farmer survey. The farmer survey will focus on the plastic use of different farm types and sizes. Disposal methods for plastics will also be a part of the survey. A similar survey will target agricultural chemical and supply vendors. To scale this data up to represent the full volume of agroplastic use in the state, existing data from the USDA-NASS and USDA-ARMS databases on the number and types of farms in each region of the state be combined with data from the farm surveys.

The findings from the survey work will help identify particular problem areas in current recycling efforts. Overcoming these barriers would provide important opportunities for reducing the contaminants from agroplastics that are entering the environment. These opportunities will then be further explored in Activity 3.

Activity Milestones:

Description	Approximate Completion Date
Initial Interviews with Farm Stakeholders	March 31, 2023
Finish Survey and Data Collection	June 30, 2023
Final Report on Agroplastic Use	June 30, 2025

Activity 2: Investigate Potential Agroplastic Environmental Impacts

Activity Budget: $65,000

Activity Description:
Potential environmental impacts will be modeled using the farm survey agroplastic type and quantity data from Activity 1. The persistence and movement of agroplastic contaminants in the water and soil will be modeled. The modeling will also rely on existing scientific literature on plastics. Several scenarios will be modeled by looking at the different farm systems (plastic types) and disposal methods identified in Activity 1. Mitigation measures will be modeled based on best management practices of recycling or incineration at regulated facilities.

A further component of the environmental impacts will include data on current contamination of agricultural areas with PFAS and microplastics from the application of biosolid fertilizers and irrigation water from urban and rural wastewater treatment plants. Improper incineration, a potential concentrating source of PFAS for airborne contamination, will also be studied for impacts on agricultural areas. Another emerging issue that will be examined is the potential impact of PFAS that have been reported to be leeching from landfills throughout the state, many of which are in rural areas.

Activity Milestones:

Description	Approximate Completion Date
Collect MN-based Contamination Data and Review Technical Literature on Environmental Issues	March 31, 2023
Model Typical Minnesota Agroplastic Contamination Scenarios	December 31, 2023
Final Report on Potential Impacts of Agroplastics	June 30, 2025

Activity 3: Explore Previous, Existing, and Potential Agroplastics Mitigation Strategies

Activity Budget: $39,000

Activity Description:

This activity examines existing and potential options for mitigating likely problems with agroplastic use including recycling, landfilling, and incineration. Interviews will be conducted with willing recycling services that are or have recycled agroplastics, retailers required to accept plastic container returns, and counties working to meet farmer needs. Questions will include, 'what factors are/have limited agroplastic recycling?', 'what opportunities do they see for recycling a broader range of plastics?', and 'what would help stabilize the agroplastics recycling sector for long-term viability?'. We also will contact the leaders of agroplastic collection/mitigation efforts in other states to identify whether these efforts may work in Minnesota or can be modified to meet Minnesota's needs. A major focus of these strategies will be to foster areas for cooperation involving farmers, those in the recycling/mitigation sector, and policy makers/citizens. Strategies will be evaluated based on economics, logistics, and environmental impacts. Outreach literature, videos, and web pages will be established to introduce the agroplastics issues to agricultural and non-agricultural audiences. Developed in a farmer-friendly tone, this outreach information will likely be needed to overcome reluctance of farmers and farm organizations to engage in discussion and actions to reduce potential agroplastic impacts.

Activity Milestones:

Description	Approximate Completion Date
Investigate Current Agroplastic Mitigation Strategies and Barriers	December 31, 2022
Identify and Examine Alternative Agroplastic Potential Mitigation Strategies	September 30, 2023
Final Report on Agroplastic Mitigation Strategies, with Outreach Materials	June 30, 2025

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.
The main outcome from this project is an informational 'toolbox' that covers the use of and impacts from agroplastic contaminants entering our water and soil systems, and potential mitigations strategies. It will establish a baseline of information so that key participants in the agroplastic issue can develop policies and systems to protect Minnesota's waterways and other natural resources from contamination by the components of agroplastics. Additionally, we intend that this information be more widely disseminated in the agricultural community so that farmers understand why there are growing concerns about the plastics they have been using for decades.

This project is a semi-technical project, with our audiences' with knowledge basis ranging from research scientists to high school students. The toolbox will include a technical report for the more research orientated sector of the audience, newspaper/newsletter/popular for those with a general interest, and a set of policy and practices briefings that will discuss best practices in agroplastic disposal and mitigation measures for farmers and policy makers. We will also create multi-media content to visually highlight the issue and potential solutions. The University of Minnesota, West Central Research and Outreach Center website (https://wcroc.cfans.umn.edu/) will be used as the central hub to store the information. However, we intend work with local media, commodity groups, local farmer groups, and our research colleagues to spread our project's information throughout the state.

Project staff will verify that Environment and Natural Resources Trust Fund is acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENTRF Acknowledgment Guidelines

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?
The long-term goal of this work is development of an economically self-sustaining system that meets the convenience needs of participating farmers and the environmental needs of the citizens of Minnesota. The farmers, recycling businesses, and policy makers interested in keeping contaminants such as PFAS and microplastics out of our waterways and soils will be the ones whose efforts will be required to agree to and implement changes to mitigate agroplastic contamination. It is not expected that funds beyond those requested for this proposed data collection effort would be needed to provide data to these core audiences.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
Joel Tallaksen-Technical staff		Principle Investigator-This position is a soft-funded position and is reliant on external research dollars (i.e. the University of Minnesota does not support the position with recurring funds. Depending on Dr Tallaksen's time committments, funds will be split with a part-time reseach assistant.			36.5%	0.76		$70,000	-	-
Student Interns		Assist with data collection & outreach-4 summer students @ 540 hours			0%	1		$28,080	-	-
Research Assistant		Depending on Joel Tallaksen's availability, a part-time research assistant will be used to organize information and collect data. Time and funds allocated for this position are approximate.			36%	0.74		$66,217	-	-
							Sub Total	**$164,297**	**$163,741**	**$556**
Contracts and Services										
							Sub Total	**-**	**-**	**-**
Equipment, Tools, and Supplies										
	Tools and Supplies	Data collections supplies	Supplies for collection, storage, and organization of research data					$1,359	$995	$364
							Sub Total	**$1,359**	**$995**	**$364**
Capital Expenditures										
							Sub Total	**-**	**-**	**-**

Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
	Miles/ Meals/ Lodging	2 yrs x 4 trips per year X 300 miles X $0.56/mile	Travel to meet with stakeholders and professionals within state					$1,844	$1,604	$240
							Sub Total	**$1,844**	**$1,604**	**$240**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										
	Printing	Printing of project report and surveys	Printing of surveys, project outreach literature, and final report.					$1,500	-	$1,500
							Sub Total	**$1,500**	**-**	**$1,500**
Other Expenses										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$169,000**	**$166,340**	**$2,660**

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	University of Minnesota In-kind funds	In kind: The University of Minnesota is forgoing the typical 54.5% federally negotiated indirect cost recovery normally associated with research grants. This funding covers facilities, support staff, and other University activities that are not directly part of the research, but must be present to support research activities.	Pending	$92,045	$90,655	$1,390
			Non State Sub Total	**$92,045**	**$90,655**	**$1,390**
			Funds Total	**$92,045**	**$90,655**	**$1,390**

Attachments

Required Attachments

Visual Component

File: 1e6dec28-5dc.pdf

Alternate Text for Visual Component

The increasing use of plastics in agriculture. The images below show some of the most important uses of agroplastics in modern agriculture in Minnesota. The Largest use of agroplastics is for preserving forage for livestock feed by wrapping with plastic. Other uses include ground cover, containers, and pots....

Supplemental Attachments

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

Title	File
University of Minnesota Approval Letter	79edffb6-f7b.pdf
Background Check Certification	6449ef0e-c2b.pdf
Fact Sheet- Microplastics	406b8859-aed.pdf
Factsheet- PFAS	ef80e423-b15.pdf
Published literature review on PFAS in Minnesota	d1c5d480-efc.pdf
2023 Newspaper Article on Microplastics -Stevens County Times	b6fa6d91-a7b.pdf
2024 Newspaper Article on Microplastics- Stevens County Times	b9049b32-4fd.pdf
2023 Newspaper Article on PFAS- Stevens County Times	14b4e930-525.pdf
2024 Newspaper Article on PFAS- Stevens County Times	7dbdca06-a2f.pdf
Activity 3 Final Report: PFAS Mitigation report/ Draft PFAS Journal Article	f4c3ae55-1c9.pdf
Activity 1 Final Survey Report: Ag Plastic Information from Surveying Minnesota County Environmental Services	97b9e057-e38.docx
Activity 2 PFAS Impacts Technical Report: Making the connection between PFAS and Agriculture	1ac085e7-6a8.pdf

Media Links

Title	Link
WCROC Microplastics Research	https://wcroc.cfans.umn.edu/research/renewable-energy/microplastics
WCROC PFAS Research	https://wcroc.cfans.umn.edu/about-us/wcroc-news/forever-chemicals-concerning
Microplastic and PFAS podcast	https://drive.google.com/file/d/1GvZlV-HgDdE3Zaba6vSPjWRMSFPs6Q02/view?usp=sharing
Microplastics and PFAS Video	https://drive.google.com/file/d/1bIc4CLEpw0OCWTTmQHV09dnJB50vKwbd/view?usp=sharing=sharing
Activity 2 PFAS Impacts Technical Report: Making the connection between PFAS and Agriculture	https://www.mdpi.com/2077-0472/15/15/1676/pdf
Activity 1 Final Survey Report: Ag Plastic Information from Surveying Minnesota County Environmental Services	https://drive.google.com/file/d/1HYWf0UqEdkUus7nP9UJhOMyRObD1vpC2/view

Microplastics and PFAS Project Toolbox and Landing Page	https://wcroc.cfans.umn.edu/research/pfas-and-microplastics

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

On the budget, added text to indicate that a research assistant may help with some of the work using a portion of the salary/time dedicated to the project manager.

Added a description of dissemination work for the project.

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?

Yes, I understand the UMN Policy on travel applies.

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?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

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	Completion Date	Previous Completion Date: 06/30/2024 New Completion Date: 06/30/2025	While much of our research has been completed, our short staffing has slowed our report writing and dissemination activities. I would like to request a 1-year extension until 6/30/25, with additional progress reports using the current 6-month reporting (due 9/1/24 and 3/1/25) schedule. Due to reduced staffing, our remaining funds (estimated to be $62,000) are sufficient to meet our needs during the extension.	April 19, 2024	Yes	April 30, 2024
2	Amendment Request	• Activities and Milestones	The new completion dates for the final milestones of each activity account for the short staffing we have encountered early in the project and the need for additional time to complete the task of developing a final report for each milestone. The new dates align with the date change request previously submitted and approved on 4/30/24.	May 10, 2024	Yes	May 21, 2024
3	Amendment Request	• Other • Budget - Capital, Equipment, Tools, and Supplies • Budget - Travel and Conferences • Budget - Printing and Publication • Budget - Non-ENRTF Funds Contributed	The printing and publication budget line was decreased by $1,000 to accommodate an increase of $500 in both the supplies and travel budget lines. We are not seeing a strong demand for printed results, so this budget line is unlikely to be fully spent. Travel costs have been slightly higher than expected. We also wanted to allow room for any last-minute supply needs as we close out the project.	April 7, 2025	Yes	April 16, 2025

Additional Status Update Reporting

Additional Status Update November 12, 2025

Date Submitted: November 14, 2025

Date Approved: December 1, 2025

Overall Update
The final funds spent amount was reconciled with the final invoice to include two days of the final pay period at the end of the project that was missed previously.

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

Activity 2
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Activity 3
This activity was previously marked complete.
(This activity marked as complete as of this status update)

Dissemination
As requested by LCCMR staff, additional hyperlinks and files were added to the project attachment page (tab 7) on the LCCMR project reporting website. Specifically, text was added to the activity summary results to label them "Activity X Final Report". Summary report files that were in the "information toolbox", but not included as attachments in the LCCMR project reporting website are now included. The html link to the project toolbox/landing page was added to the LCCMR project management site.

Status Update Reporting

Final Status Update August 14, 2025

Date Submitted: November 14, 2025

Date Approved: December 1, 2025

Overall Update

When starting this work, we had anticipated that plastic and microplastic waste would be the primary concern in agriculture and only function as a vector for PFAS contamination of farms and agricultural lands. As we began examining both issues, we observed that microplastics were likely the less problematic pollutant than PFAS was. Additionally, microplastic is not the most substantial vector for PFAS in agriculture. Therefore, our most detailed examination focused heavily on PFAS.

In reviewing plastic contamination in farming, a lack of data on agricultural plastics made estimates on ag plastics waste and recycling almost impossible. While some waste management systems in rural areas do track plastics and recycling, they don't differentiate between rural and city, nor household vs agricultural. Our initial discussions with farmers and early attempts at surveying found that they had little idea how much plastic they used. Therefore, estimates of plastic use in agriculture focus on the amount reported by recycling.

In terms of PFAS, the project examined the major sources of PFAS in Minnesota and specifically considered which sources impact agriculture. Mitigation methods for agricultural contamination were examined. Informational handouts, video and audio were developed to help audiences understand the issues around these contaminants.

Activity 1

Our initial discussions with farmers and horticulturalists found that though they did care about plastic waste, they had very little understanding about the amount of plastic they used. Both these conversations and trial surveys at Farmfest indicated that more intense surveying would not yield reliable data. Our findings suggested that our initial assessments of the types of plastic being used in agriculture was fairly accurate.

A somewhat better source of information was the county environmental services staff. In phone, email, and video meetings, they provided us with their data, collection-recycling activities, and viewpoints on agricultural plastics and PFAS. In addition, we examined the county SCORE (Select Committee on Recycling and the Environment) data submitted to the state to look at trends in plastics recycling by rural counties.

In terms of PFAS contamination, most rural counties did not have any research or activities targeting PFAS contamination. Our discussions with farmers found that few had any knowledge of PFAS or how it may affect their farms. A few counties that had urban centers or were near the Minneapolis-St. Paul metro area did have staff tasked with PFAS tracking. A final report on our county environmental services survey presents our findings from Activity

(This activity marked as complete as of this status update)

Activity 2

In our initial investigations of environmental impacts, it was very apparent that PFAS were of much more concern than agroplastics. While the physical volume of agroplastics is higher, PFAS has much more significant impacts on human health even at very low levels. Therefore, we focused on the problem of PFAS.

An initial study of the agricultural sources of PFAS contamination and its potential impacts on agriculture was conducted. We found that for general farmland across the state, biosolids application was a key vector for both PFAS and microplastics entering cropland. PFAS pollution could also occur at farms located near both military and civilian airports that used PFAS-based firefighting foams. Another common source of PFAS contamination is leaching from landfills, where products that incorporated PFAS were disposed.

It was decided to focus our investigation of contamination potential on PFAS from landfills. MPCA well sampling at rural landfills has indicated that PFAS leaching from them has the potential to migrate to adjacent agricultural lands.

Much of the PFAS background information for this activity was developed into a summary technical paper/report. Statistical analysis examined the expected levels of contaminants and was included in the report for activity 3.
(This activity marked as complete as of this status update)

Activity 3

Our analysis of plastic mitigation strategies identified two primary factors as limiting current plastic recycling efforts, economics and ease of access. County and private recycling costs more money than can be generated by selling plastics in many cases. Farmers are also not willing to clean, sort, and deliver plastics for recycling. Increasing recycling of plastics will likely have some support from county or state programs.

Activity 3 further analyzed landfill PFAS contamination data and considered different mitigation scenarios for cleaning up adjacent farmland. The two primary scenarios examined were traditional membrane/charcoal adsorption technologies and a novel phytoremediation method. The mitigation research used the Stevens County Landfill as a case study to evaluate these mitigation techniques at a landfill representative of those found throughout Minnesota's rural areas. It examined the efficiency and economics of using the two mitigation methods.

The mitigation study results are currently in a report format as a final report on mitigation that includes all data and findings. They are also being narrowed down and developed into a scientific publication.
(This activity marked as complete as of this status update)

Dissemination

The main outcome from this project is an informational 'toolbox'. It includes technical content, as well as semi- and non-technical content. The hub for this content is the University of Minnesota's West Central Research and Outreach Centers Website's 'PFAS and Microplastics in Agriculture' landing page (https://wcroc.cfans.umn.edu/research/pfas-and-microplastics). Toolbox content includes

Microplastics and PFAS Information Toolbox:

- Microplastics: Introduction to Microplastics
  - Factsheet: Agricultural Plastics and Microplastics
  - Newspaper: Microplastics in the Food Production System
  - Newspaper: Microplastic contamination in Agriculture
  - Report: Ag Plastic Information Survey
- PFAS: Introduction to PFAS
  - Factsheet: PFAS and Agriculture
  - Newspaper: Forever Chemicals may be a Concern for Agriculture
  - Newspaper: PFAS contamination in agriculture, an update
  - Technical Report: Making the Connection Between PFASs and Agriculture
  - Technical Report: TEA of Treatment Methods to Remediate PFAS
- Multimedia Content
  - Podcast: Microplastics and PFAS
  - Video: Invisible Contaminants In Food

Outreach has also been in person at events, such as Farmfest. Though funding from this LCCMR grant has ended, the project team will be continuing to give PFAS and microplastics talks to different groups. We also expect to refine the toolbox with further results and publish the mitigation manuscript.

Status Update Reporting

Status Update March 1, 2025

Date Submitted: April 7, 2025

Date Approved: April 16, 2025

Overall Update
At the beginning of this reporting period, we completed all new data collection and began wrapping up modeling of mitigation efforts. For all activities, the final task is to summarize several hundred pages of readings, writings, and analysis into clear, accessible guidance for farmers, citizens, and policymakers at the appropriate technical level.

Activity 1
In previous reporting periods, we completed Milestones 1 (talking with farmers) and 2 (survey and data collection) for Activity 1. Writing the text that will be included in the final report (Milestone 3) and related dissemination goals is currently underway.

Activity 2
In previous reporting periods, we completed much of the work on agroplastics and PFAS contamination mechanisms (Milestone 1) and mitigation scenarios (Milestone 2). During the last reporting period, PFAS contamination modeling was fully completed (Milestone 2). The work by the student intern quantified PFAS contamination from rural landfills near farm fields. We have now fully shifted focus to reporting results and preparing dissemination materials.

Activity 3
Work during this reporting period for Activity 3 focused on modeling alternative mitigation strategies for PFAS (Milestone 2) and reporting on the effort (Milestone 3). The master's student intern, Thomas Mietla, modeled mitigation as part of his master's thesis research. His research reported on the relative costs and time required for mitigating the low- to medium-level contamination expected at landfills. He successfully defended his thesis at his home university, F.H. Münster, in Münster, Germany. As part of Milestone 3, we will be integrating the thesis data into the final reports and dissemination materials.

Dissemination
During the current reporting period, the project team wrote an article that was published in the regional newspaper, the Stevens County Times, and will also appear in our research center's newsletter. The title of the article was "PFAS Contamination in Agricultural Biosolids: A Growing Concern for Farmers."

A review article entitled "Making the Connection Between PFASs and Agriculture Using the Example of Minnesota, USA: A Review" was submitted to an American Chemical Society (ACS) research journal. It was not accepted for publication and will be revised for re-submission.

Work on remediation strategies is being developed into a technical publication. A section of the research center's website is being set up to house the final report, which will include guidance for producers.

Where appropriate, we have included written acknowledgments of LCCMR.

Status Update Reporting

Status Update September 1, 2024

Date Submitted: September 6, 2024

Date Approved: October 9, 2024

Overall Update
The project team has amassed a great deal of data over the last two years in its research and analysis, including in the last reporting period. At this point we are switching gears to begin using our notes, analysis, and maps to complete the final 'toolbox' envisioned as the outcome of this project. Already drafts of informative documents for farmers have been developed. Writing the final report and fully developing informational tools is on track to be completed by the June 31st 2025 project end date.

Activity 1
In previous reporting periods, we completed milestones 1 and 2 for activity 1. Writing of text that will be in the final report (milestone 3) is ongoing, but will accelerate as the project team gets nearer completion and integration of the writing for Activities 2 and 3.

Activity 2
In the previous updates, we completed much of the work on agroplastic contamination mechanisms and mitigation scenarios. Our findings to date have indicated that although agroplastic is a concern, PFAS is more of concern. We have therefore continued much of our efforts during this reporting period to examine mechanisms of PFAS contamination and, specifically, rural landfills that are leaching PFAS.
Agroplastic contamination tends to remain at the site where the plastic was deposited in soil or on the ground. PFAS contamination spreads in soils, water, and air; and is health risk at very low levels. We have worked on better PFAS contamination pathways, concentrations, and health risks at landfill sites. Work by a previous intern on contamination scenarios (Milestone 2) is being developed into both a scientific paper for technical publication/dissemination and as a component of the final report (milestone 3) for this objective. For final reporting, we are also continuing working on mapping PFAS presence in rural areas based on updated MPCA data and more strict standards from the EPA.

Activity 3
Work in previous reporting periods work identified strengths and weakness associated with current agricultural plastics recycling (mitigation) strategies and plans (milestones 1 and 2). The primary focus for activity 3 in the current reporting period has shifted more towards the PFAS mitigation strategies. As mentioned above, PFAS appears to be a much greater problem than the agroplastics which can be a source of low-level PFAS contamination. With the assistance of a master's degree student intern, the project team has been evaluating methods of mitigation of PFAS at rural landfill sites during the current update period. These methods may also apply at other rural contamination sites. The two major methods being compared are phytoremediation using cultivated plants and more conventional adsorption technologies. The student has built a model that looks at general costs, equipment needed and potential removal efficiencies. He is using the data to develop a technical paper for publication and will use it for his master's thesis when he returns to F.H. Münster University in Münster, Germany. These are being integrated into the final report for this activity (milestone 3).

Dissemination
During the current reporting period, the project team wrote two articles that were published in the regional newspaper, the Steven's County Times, and in our research center's newsletter. The titles of the articles were "Microplastic contamination in Agriculture" and "PFAS contamination in agriculture, an update". The project team is also working on a technical publication titled "Making the connection between PFASs and agriculture using the example of Minnesota,

USA: A Review". We have begun early work on a technical research paper on PFAS remediation that we will continue to work on. Where appropriate, we have included written acknowledgments of LCCMR.

Status Update Reporting

Status Update March 1, 2024

Date Submitted: March 13, 2024

Date Approved: April 30, 2024

Overall Update

Data collection on both the central agroplastics question and the related PFAS contamination issues is substantially complete, with a few surveys trickling in. Farmer and horticultural surveys have generated less data than hoped, but a survey of counties has been much more successful as some counties collect a fair bit of data on waste sources. This has provided a solid baseline to formulate agroplastic and PFAS management strategies and policy suggestions. Thus, the research on the project has been substantially completed for the initial investigative milestones. The final milestones for each activity (reporting and dissemination) are behind due to initial and continuing post-Covid staffing challenges. Based on our progress, we will be asking for a no cost extension. Our staffing shortfalls have resulted in sufficient funds to complete the project over an extended period without need for further funds. This will allow us to finalize these milestones and the associated reports, the information toolbox, and outreach materials.

Activity 1

Initial survey methods for Milestone 1 (Interviews with stakeholders) were not particularly success due to the changing nature of farm inputs/chemicals, who applies them, and how. While not interested in completing surveys, farmers were very willing to engage in conversations about the topic when it was brought up in person at an event like Farmfest. Our initial plan was to work with USDA chemical application data, but we found that their data was not as helpful as hoped. Chemical use is no longer easily correlated to plastics use as newer large (200-300 gallon) reusable containers have become standard. The best data we have found has come from surveying county environmental managers who track farm waste. These are dedicated waste management staff who have a better understanding of the waste data, current options for farmers, and interact with recyclers. The data they supplied provided a general magnitude of the agroplastic problem, though it might not give us as accurate an estimate as we had hoped to model. This data collection has allowed us to complete milestone 2 (finish survey and data collection). We are working on milestone 3 (report on agroplastic use), which documents data from milestones 1 and 2.

Activity 2

We have completed milestone 1 of this activity, collecting and reviewing contamination data. In reviewing this issue, we have determined that general modeling efforts (milestone 2) would not provide great data due to the complexity of soils, hydrology, and other factors unique to each potential contamination site. Instead, we have identified the most common scenarios where plastics would enter agricultural systems, both from agricultural and non-agricultural sources. Similarly, with PFAS contamination we examined which sites would be likely to see contamination from the agricultural sector and the environment as a whole. This information has allowed us to identify which farms and farm fields may be at risk for contamination and how farmers can further identify and test for risks on their land. The same findings are also driving our work on which policies and monitoring activity should be considered to limit future risks. While we consider this milestone (modeling contamination scenarios) complete, we are still improving our policy and monitoring suggestions as we complete the last milestone for the activity (final report for activity 2).

Activity 3

County waste management staff have been very helpful in providing us with the information to complete milestone 1 (investigating current mitigation efforts). Our findings are that for much of the state, previously developed agricultural material recycling strategies have not worked over the long term and many areas that had more organized recycling have had their main commercial partner reduce their services. Milestone 2 has been an extension of this effort and examines why these efforts are failing and what can be done to bolster the recycling system. In our internal discussion,

we have identified the issues that recyclers, counties, and farmers are facing. This work completes milestone 2 for this activity.
Milestone 3, the documentation of our discussion and observation on migration strategies is continuing. We are behind in this area and especially the outreach component of our work. As mentioned in the overall update, having staff time to comb through the data and develop content has been challenging. We think that extra time is needed to complete this work to the standards we feel it deserves.

Dissemination
During the last reporting period, we have begun to organize the final report sections that include our outreach materials. We have also prepared articles to share with local newspapers this spring that talk about our microplastic and PFAS research. Since the research has begun to wind down, we will be greatly expanding our efforts in this area. As always, we will include the LLCMR acknowledgement on all our materials.

Status Update Reporting

Status Update September 1, 2023

Date Submitted: September 5, 2023

Date Approved: October 17, 2023

Overall Update
As a result of our review of relevant literature, we have developed an understanding of the relative risk of PFAS and microplastic contamination in agriculture. Early findings have led to a shift in our focus, with greater emphasis now placed on PFAS rather than agroplastics. We are currently in the process of documenting this risk level and establishing best practices for farmers to mitigate these risks. Additionally, we are in the process of developing GIS maps and infographics that will be added to the 'toolbox' of resources for agroplastics and PFAS. To disseminate this information, we have initiated outreach efforts through newsletters and events, and this will continue as we refine the information into pamphlets and presentations.

Activity 1
Estimating plastic usage in agriculture has proven challenging due to the sheer volume of plastic use and the diverse agricultural and horticultural systems in use across Minnesota. We conducted surveys at Farm Fest, Minnesota's largest gathering of farmers, which included written surveys and discussions. Unfortunately, the response rate for the survey was low. We are now considering further surveying efforts at the annual corn and soybean growers meeting. Initial results indicate that farmers are concerned about agroplastics, but their levels of knowledge, willingness, and ability to recycle vary.

Activity 2
Our early work on agroplastics and PFAS indicates that the plastic issue is less critical than PFAS contamination. Generally, plastics remain immobile once deposited, and their contamination levels in soil, wind, and water are not typically within a range that would seriously affect plant or consumer health. In contrast, PFAS is mobile in water, soil, and air, making it a more pressing concern. Consequently, we have redirected our focus toward PFAS-related issues. A literature review on PFAS conducted by the project team has identified the most common contamination mechanisms in agriculture. Given the significance of PFAS issues, our contamination scenarios now exclusively revolve around PFAS rather than the PFAS/agroplastic combination. We are using this information to develop guidance for farmers to avoid PFAS issues in food production.

Activity 3
While we have identified overarching mitigation methods for addressing plastics, we are still in the process of examining the specifics of how Minnesota is handling this issue. Progress has been somewhat delayed as we've discovered that each county has a unique organizational structure, environmental services department, and approach to recycling. Our staff has compiled a contact list of counties, and we plan to initiate outreach now that a staff member has returned from leave. We intend to begin with Stevens County as an initial trial of the questions we intend to ask other counties.

Dissemination
The project team has been actively disseminating project findings and engaging in discussions with producers. Project staff attended Farm Fest 2023 in Redwood Falls, MN, which annually draws approximately 23,000 participants. At the event, we had a booth and display in the WCROC tent. Additionally, project staff participated in the 2023 Minnesota State Fair within the Department of Commerce, focusing on energy and environmental issues. Where appropriate, we included written acknowledgments of LCCMR.

Status Update Reporting

Status Update March 1, 2023

Date Submitted: March 9, 2023

Date Approved: March 9, 2023

Overall Update

Early work on the project has developed a library of research studies, popular press articles, and policy/regulation information on PFAS and microplastics. During the last few months, the project team has expanded to include a part time research assistant and a student intern is being hired for work during the summer. This is already helping move the project forward as we build a larger collection of related documentation. Project staff has found that there is an abundance of microplastic and PFAS information, but it is highly technical and made more complex by the thousands of PFAS compounds and plastic polymers that can have different impacts. Distilling this into a product for producers and policymaker and policy makers is likely to be an ongoing effort during the project.

Activity 1

Using USDA data, we have been and are continuing to examine the different agricultural production systems in Minnesota. Each type is likely to represent a different type of plastic/PFAS use case, i.e., row-cropping systems, livestock production, horticultural systems. As we focus on these different use cases, we are developing survey questions that identify how producers in each system purchase, use, and dispose of plastic items and how to best develop strategies to reduce the creation of possible ag system contaminants. We are working on survey questions and are planning to evaluate the PFAS and microplastic questions on WCROC affiliated stakeholders for the different agricultural use cases. The results from these initial evaluations will be incorporated into the final surveys sent to agricultural producers. In terms of milestones, the project team is a bit behind on interviews and surveys. The technician hired for the project is helping to speed up the process and get us back on track.

Activity 2

The project team has spent much of its effort on investigating literature and research findings focused on the potential environmental impacts of PFAS and Microplastics. The primary questions examined were what examples do we have of PFAS or microplastic contamination in agriculture, what levels of contamination were significant, and what the impacts of that contamination might be. While the literature on these contaminants is extensive, it is also very technical and purposely does not offer direct answers to the complex questions we have been examining. Though we have fulfilled the basic tasks for the initial investigatory milestone, a complete analysis will require us to continue working to review and organize this literature as we proceed with the project.

Activity 3

Activity 3: Investigation of strategies for mitigating is ongoing. In terms of plastic contamination, the project team has identified and documented initial plastic recycling options for agricultural plastics. Current PFAS mitigation strategies are limited and appear to center more on not producing food or feed in areas on known or suspected to be contaminated with PFAS. The work to date has fulfilled the activity milestone of “Investigate Current Mitigation Strategies and Limitations”. We are continuing this activity by identify future mitigation strategies that could be useful for agriculture.

Dissemination

Dissemination for the project has begun with initial articles written for local newspapers about microplastic and PFAS contamination. Acknowledgment of LCCMR has been included in these articles. These have been submitted and are expected to be published later this month. The content of these article will be used for the development of the web pages discussing the project and its findings.