



Grantee Information

Project Title: Watershed scale response of agricultural systems to drainage water management in Central Illinois

Institution: University of Illinois

Primary Investigator: Rabin Bhattarai (PI), Richard Cooke (Co-PI)

NREC Project # 2019-4-360624-286

Is your project on target from an IMPLEMENTATION standpoint? Yes No

If you answered "no" please explain:

In our 2021 Renewal Report, we proposed a one-year extension on the project to collect a more robust and more complete series of baseline data. This is a one-year extension in the project timeline based on the 2019 project proposal. We installed the 11th and final monitoring structure in the Fall of 2021 after the finalization of an NRCS terracing project on the Control Watershed. In the Fall of 2021, we will implement a controlled-drainage plan on the treatment watershed.

Is your project on target from a BUDGET standpoint? Yes No

If you answered "no" please explain:

Based on what you know today, will you meet the objectives of your project on-time and on-budget? Yes No

If you answered "no" please explain:

We will not meet the objectives of the project on-time per the initial 2019 proposal. However, we are on-time for the revised one-year extension proposed in the 2021 Renewal Report. We are still on track to meet the objectives on-budget for the revised timeline.

Have you encountered any issues related to this project? Yes No

If you answered "yes" please explain:

We initially encountered issues with site availability and travel restrictions related to the pandemic. More recently, we have experienced a staff shortage and equipment issues which have delayed our water quality data analysis. We are also experiencing ongoing difficulties with varmints at the site that interfere with our surface and some subsurface flow data collection efforts.

Have you reached any conclusions related to this project that you would like to highlight? Yes No

If you answered "yes" please explain:

Have you completed any outreach activities related this project? Or do you have any activities planned? Yes No

If you answered "yes" please explain and provide details for any upcoming outreach:

In the Summer of 2021, the PI presented our research at the Macon County Farm Bureau field day in June 2021. Additionally, we completed a virtual outreach activity through the Shelby County Farm Bureau in the Summer of 2020. A recording of the virtual outreach event can be viewed by following this link: [Link to Shelby County Farm Bureau Virtual Field Day](#). We plan to present our research at the ASABE AIM for the Summer of 2022.

Please write a detailed summary report that includes: Details of each objective and the progress made towards its completion, planned research activities for 2022, major accomplishments, any preliminary findings or data relevant to the project, relevant budgeting, and any publications or outreach accomplished from the research. Please include a one-page summary with relevant data tables or graphs and pictures related to the project that you would like included in the NREC end of the year report.

Objectives and progress made

Objectives for the project remain the same as the initial proposal and mid-year report. The overall goal of this project is to observe and communicate new information about the watershed scale effects of drainage water management (DWM) on water and nitrogen (N) losses, and crop production in Central Illinois. The specific project objectives and our progress towards them are as follows:

1. Monitor the watershed-scale effects of DWM on nutrient reductions, water and N balances, and crop production through a paired watershed experiment. (*Expected completion date: November 2023*)

In 2021, we were able to make significant progress towards this objective. Our team successfully finalized the installation and placement of the proposed monitoring equipment at the project site on both the Control and Treatment watersheds (Figure 1). We have been successfully monitoring weather data from our on-site weather station for nearly two full years. Our continued review of the data for the year, shows that we are receiving similar data to the freely available GRIDMET data. The precipitation data from the weather station is presented on the upper axis for many of the subsequent figures. We have been collecting flow and nutrient measurements at several monitoring stations within the project site since June 2020. Figure 2 shows the water level time series for overland flow monitoring station A. Whereas, measured daily tile flows at stations S3, S4 and S7 are shown in Figures 3, 4, and 5 respectively. Figure 6 shows measured concentration of NO_3 & NH_3 along with precipitation for locations at S1, S2, S3, S4, S5, S6, S7, S8, A, B, C and D.

2. Estimate the long-term environmental and agricultural benefits of DWM through watershed-scale modeling. (*Expected completion date: November 2023*)

We have set up the Soil and Water Assessment Tool (SWAT+) model for the hydrological modeling purpose for our proposed watershed. SWAT+ is a revised version of the SWAT model that provides a more flexible spatial representation of interactions and processes within a watershed. We have used the weather data (i.e. precipitation, temperature, wind speed, relative humidity, solar radiation) from the weather station located in the watershed as input in the model. Further, Digital Elevation Model (DEM) (30m resolution), land use land cover (30m resolution), and soil map are collected from National Elevation Database, National Land Cover Database, and Soil Survey Geographic (SSURGO) respectively which are used to set up the SWAT+ model. We will continue with the model calibration in the upcoming cycle.

3. Communicate results to agricultural community stakeholders through field days and extension events. (*Expected completion date: November 2023*)

In June 2021, the PI presented the general scope and overview of our project at the Macon County Farm Bureau field day. In the Summer of 2020, several members of the project and the landowner(s) gave a detailed presentation of the project site, instrumentation equipment and techniques at the Shelby County Farm Bureau Virtual Field Day.

4. To include a final report at the conclusion of this project to address each of the objectives stated above. (*Expected completion date: November 2023*)

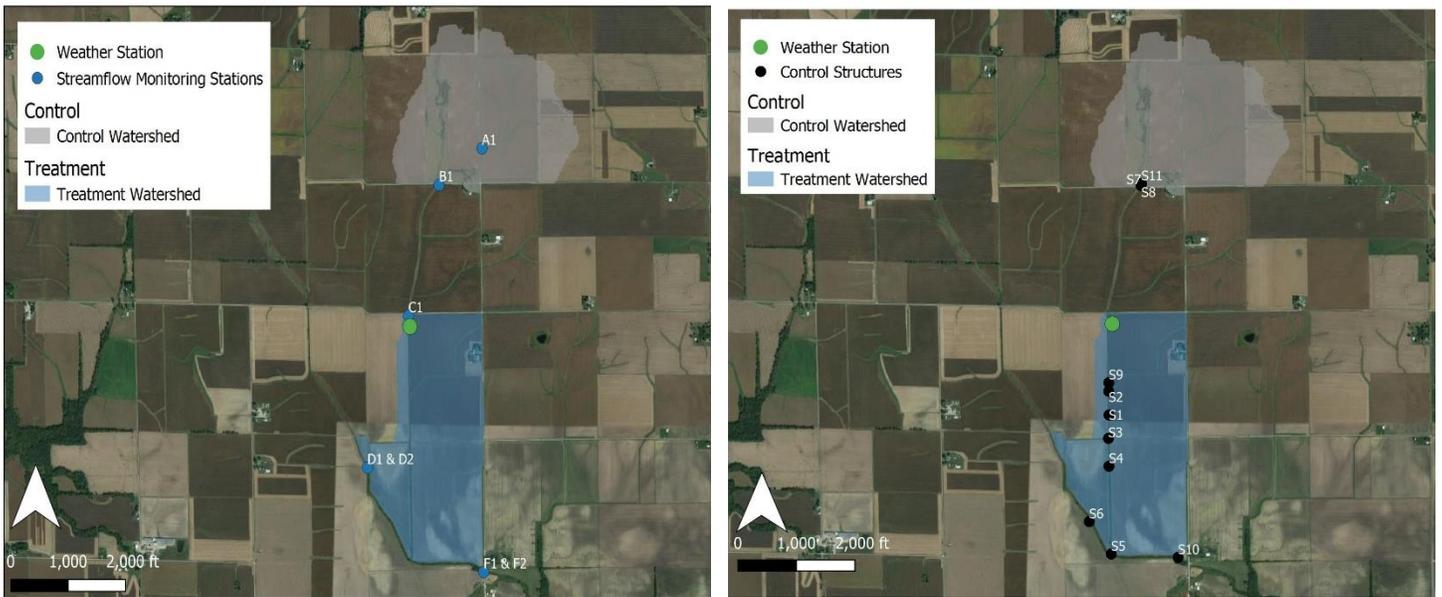


Figure 1. Streamflow monitoring location map (left) and subsurface control structure map (right) for Control and Treatment watersheds

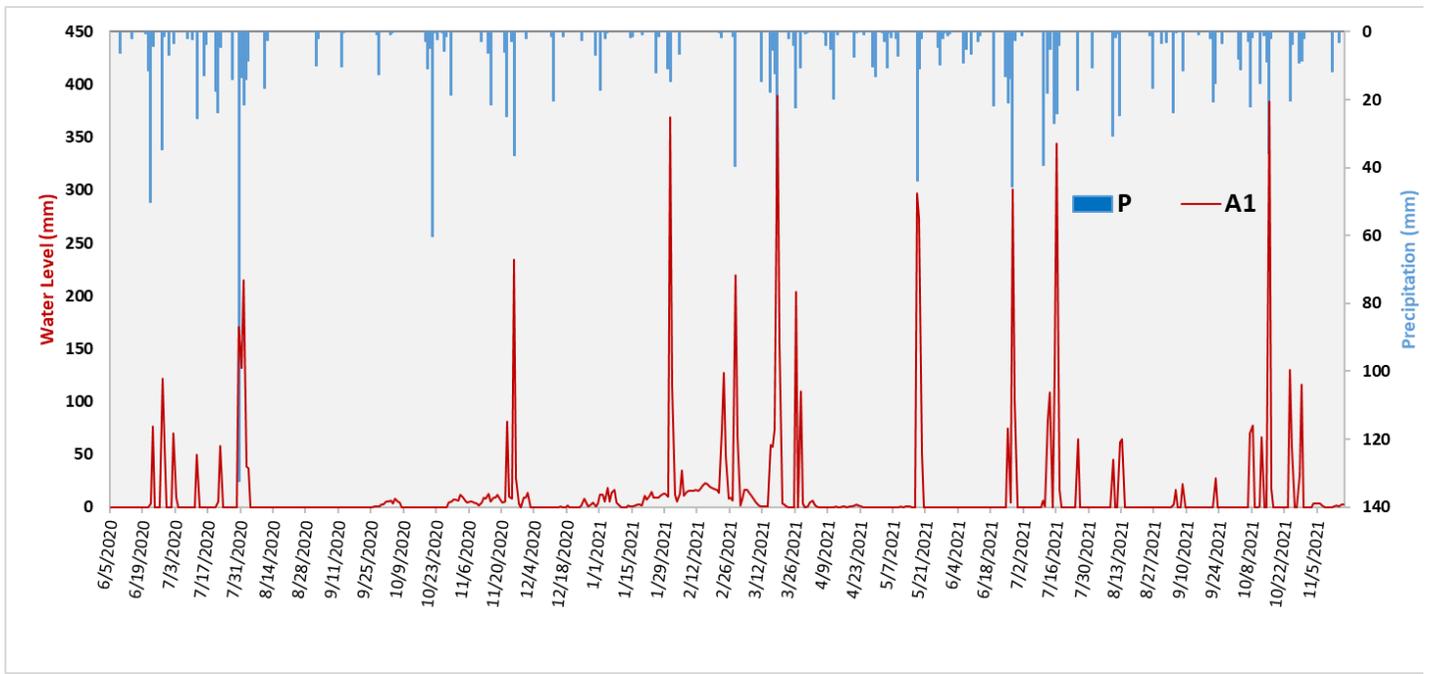


Figure 2. Temporal variation of overland streamflow water level along with precipitation at station A1 located at the upstream point of the Control watershed.

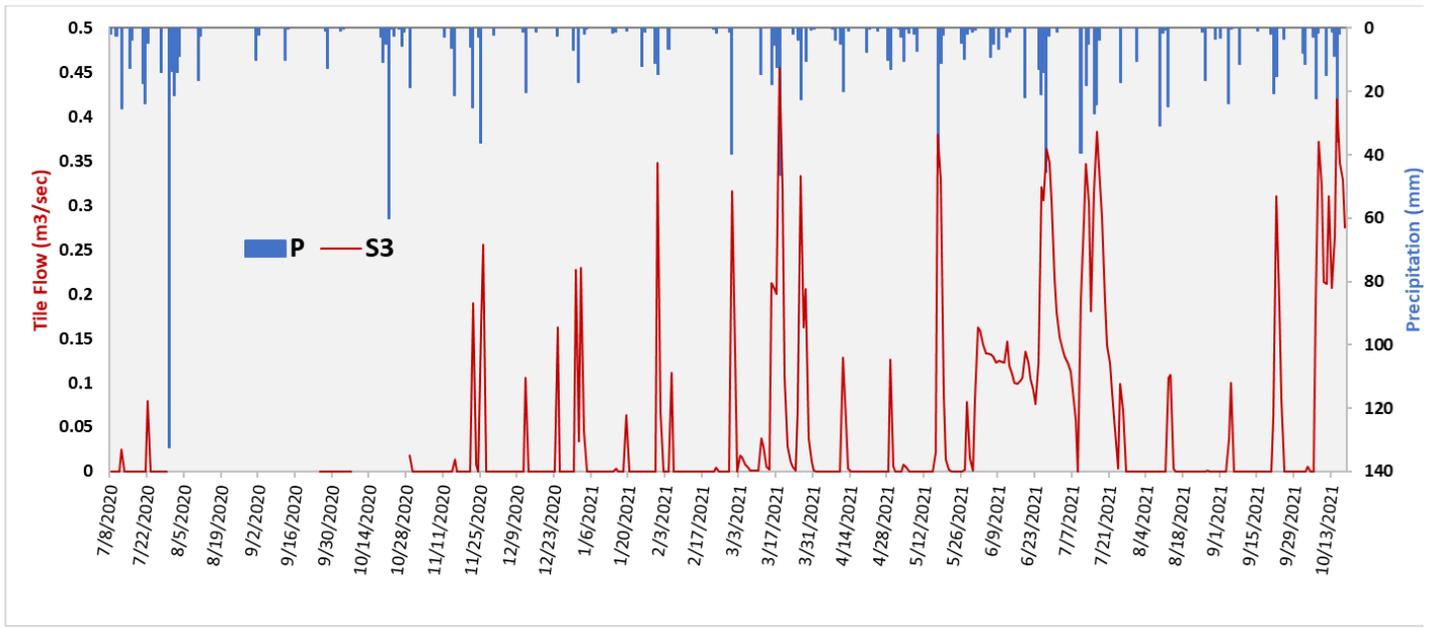


Figure 3. Temporal variation of measured tile flow along with precipitation at station S3 in the Treatment watershed.

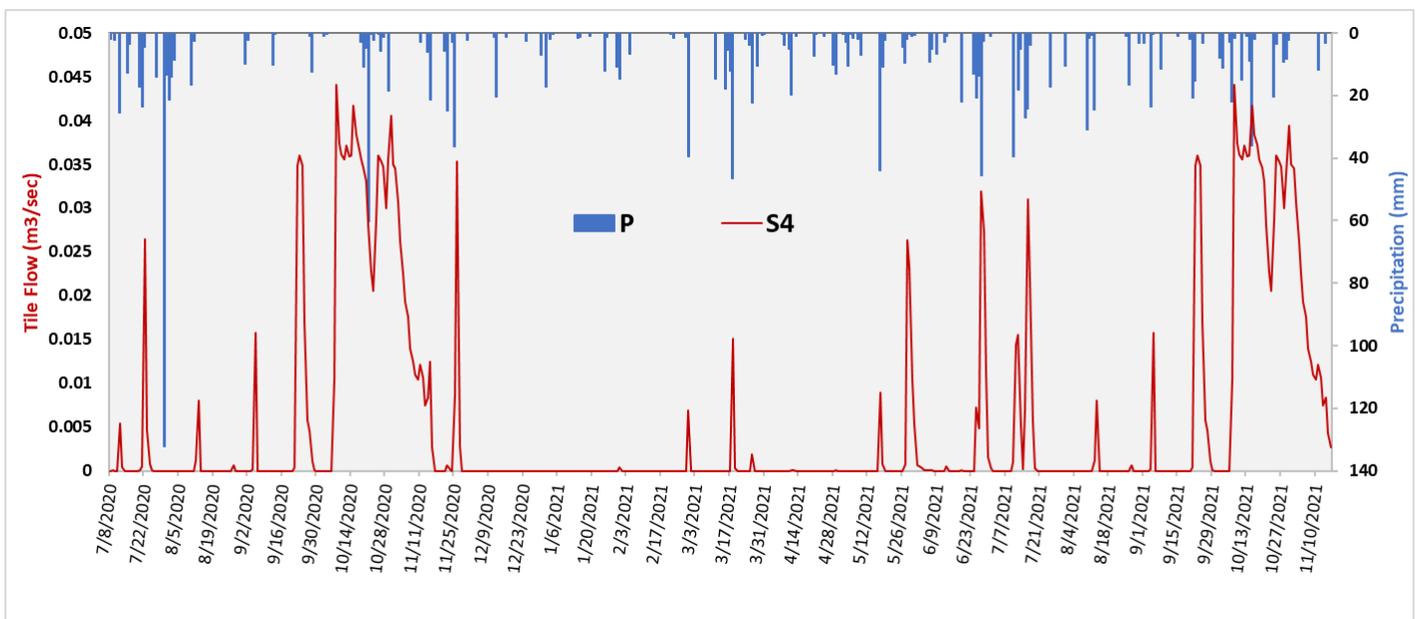


Figure 4. Temporal variation of measured tile flow along with precipitation at station S4 in the Control watershed.

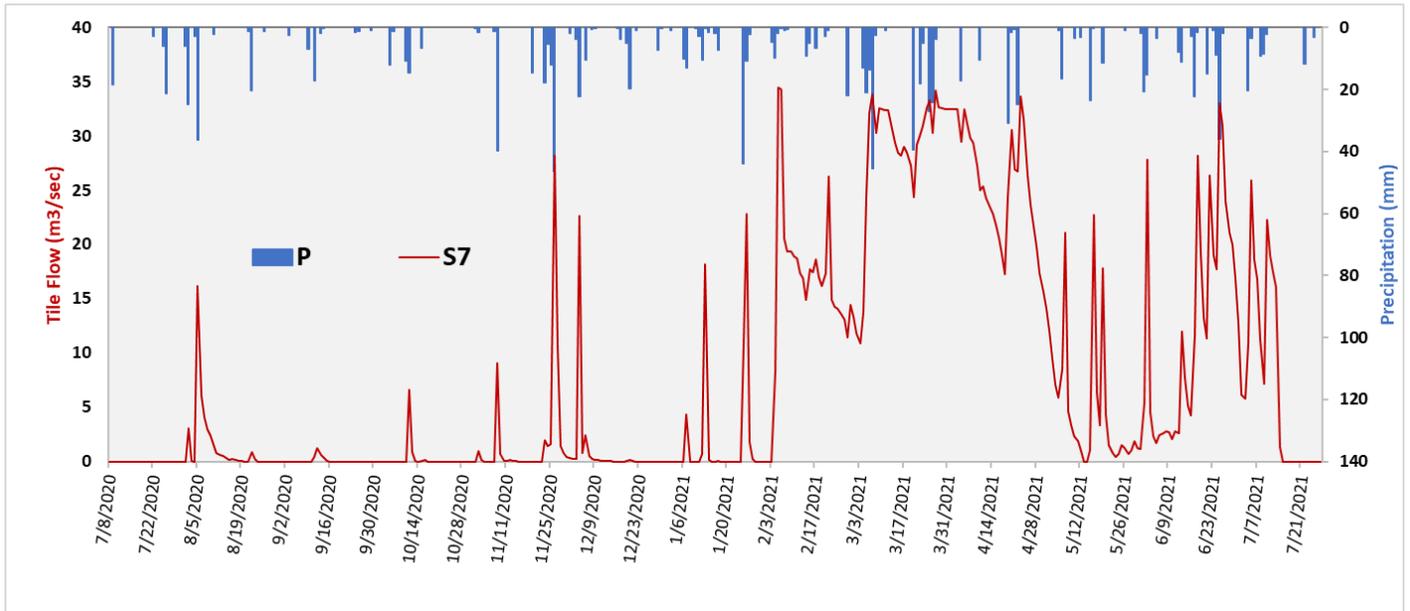


Figure 5. Temporal variation of measured tile flow along with precipitation at station S7 in the Control watershed.

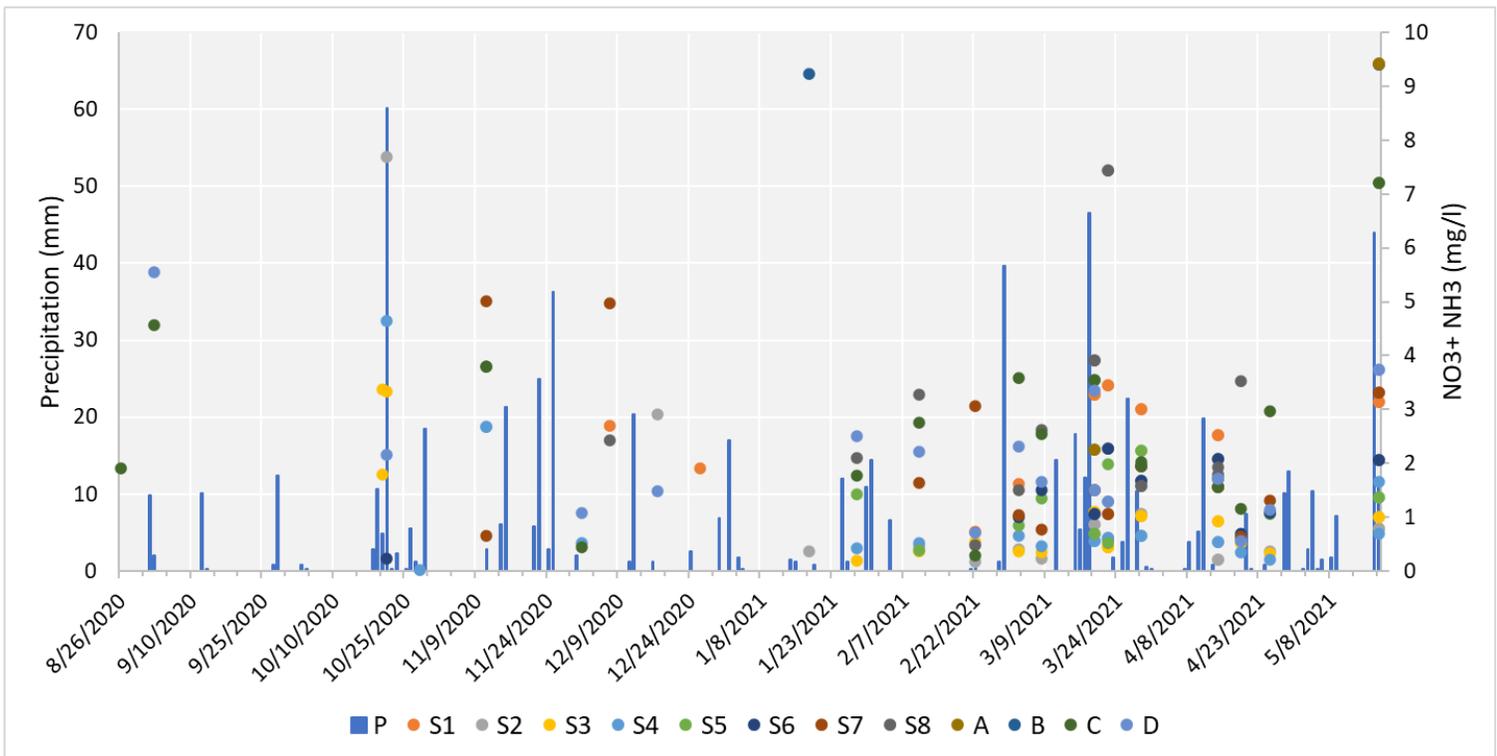


Figure 6. Temporal variation of measured concentration of NO_3 & NH_3 along with precipitation for locations at S1, S2, S3, S4, S5, S6, S7, S8, A, B, C and D.

Planned research activities for 2022

For 2022, we will implement the drainage water management plan on the treatment watershed and begin collecting data for the calibration period. We will also enhance the speed and automation of our water quality and flow data analysis in 2022 as we transition into model development and calibration. We plan to set up a watershed scale model (Soil and Water Assessment Tool) using the collected data from this project along with a field scale model (Root Zone Water Quality Model). Our group will also aim to present preliminary research findings at the 2022 ASABE Annual International Meeting.

Major accomplishment

- Installation of the Onset automatic weather station – completed (Winter 2019)
- Instrumentation to monitor surface and subsurface flow in the Treatment watershed – completed (Summer 2020)
- Collection and analysis of water quality samples – started (Summer 2020)
- Shelby County Farm Bureau Virtual field day – completed (Summer 2020)
- Macon County Farm Bureau Field Day – completed (Summer 2021)
- Instrumentation to monitor surface and subsurface flow in the Control watershed – completed (Fall 2021)

Any publications or outreach accomplished from the research

We have conducted the following outreach activities to disseminate the project findings in 2019-21:

- A poster was presented at Public Field Day at Al Boyd’s DWM Field (Argenta, IL) on August 7, 2019 as a part of ILICA Drainage Workshop.
- We conducted a virtual field day outreach event in Summer 2020. We hope the event will positively impact several farmers in the Central Illinois area, by bringing awareness to Drainage Water Management, as well as other Nutrient Loss Reduction Strategies and Best Management Practices.
- A presentation was given by the Principal Investigator, Dr. Bhattarai, at the Macon County Farm Bureau field day in Summer of 2021 (June 22, 2021).

Relevant budgeting:

The project is under the budget as proposed. The table below provides an overview of project expenses till November 2021 (2019-2021 period). We have a surplus in salary and wages category due to the delay in project site selection in 2019.

Item	Amount requested	Amount spent
Salary and wages	180,810	141,978
Fringe benefits	43,973	38,112
Travel	13,000	7,450
Materials and Supplies	38,119	38,691
Services	42,250	10,988
Indirect cost	35,263	26,302

Summary

The overall goal of this project is to observe and communicate new information about the watershed-scale effects of drainage water management (DWM) on water and nitrogen (N) losses, and crop production in Central Illinois. This experiment is the first of its kind to answer the question: how does DWM affect water and N balances and crop production on a watershed scale? What are the long-term environmental and economic benefits of DWM?

This research project started in 2019. It took a while for the research team to identify a project cooperator (landowner) to implement the project. Initially, we had selected Champaign County as a potential project site. Since we were not able to identify a landowner to implement the project in Champaign County, we identified a potential landowner in Shelby County and selected Strasburg as the project site. Although we are slightly behind the project milestone compared to the original plan, we believe that we will meet the originally proposed project objectives from a budget standpoint but are 1 year behind on implementation and data collection as outlined in our 2021 Renewal Report.

Since the selection of the project site in Strasburg, we have made several site visits to coordinate project details with the landowner, review key elements of the site related to data collection and observation locations, and implement data monitoring equipment. Using a drainage water management plan provided by the landowner, we purchased and installed several control structures in both the Treatment and Control watersheds. We have also installed a weather station and several streamflow monitoring stations. We started baseline data collection at the majority of monitoring stations in the Treatment watershed in the Summer of 2020. We continued to install structures and monitoring equipment through Spring of 2021, and we installed the final structure in the Control watershed in Fall of 2021. We currently have two dozen sensors collecting water level and temperature data for overland flow and subsurface flow.

Each subsurface control structure is fitted with a V-notch weir that allows us to calculate flow through the structure based on the water level data collected by the sensor in each structure. To calculate overland stream flow, we have deployed water level sensors in dedicated drainage ditches and drainage culverts across the site. Overland flow monitoring stations A, B, and C have permanent twin culvert structures that allow surface flow to pass under roadways. By installing water level sensors in each culvert, we can use the measured geometry of the culvert and Manning's equation to calculate flow. We are using a similar technique with Manning's equation to convert stream water level at monitoring stations D and F, although these sites do not have permanent structures. Because we do not have permanent structures at stations D and F, we are conducting topographic survey at these locations every 3-6 months. The stream survey and water level data allow us to reasonably estimate streamflow without installing an in-stream control structure.

