M.L. 2017 Project Abstract
For the Period Ending June 30, 2021

PROJECT TITLE: Water Quality Monitoring in Southeastern Minnesota Trout Streams
PROJECT MANAGER: Neal Mundahl
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2017, Chp. 96, Sec. 2, Subd. 04d as extended by M.L. 2020, First Special Session, Chp. 4, Sec. 2

APPROPRIATION AMOUNT: $500,000
AMOUNT SPENT: $441,782
AMOUNT REMAINING: $58,218

Sound bite of Project Outcomes and Results

Strobin fungicides were detected in most water samples from the Whitewater River in southeastern Minnesota. Many citizen scientists were trained and continue to monitor stream sites. Stream habitats and fish and aquatic invertebrate communities ranged from excellent to poor, based largely on upstream versus downstream location and adjacent land uses.

Overall Project Outcome and Results

Water quality in many trout streams in southeastern Minnnesota has been compromised by rain-event runoff, exposing sensitive trout to mixtures of eroded soils, pesticides, urban stormwaters/wastewaters, and animal wastes. The main goal of this project was to better protect at-risk streams by developing an improved water-quality monitoring infrastructure and network within the Whitewater River system. This was achieved by:

- **Automated Water Sampling** - establishing both continuous and rain-event sampling throughout 3 at-risk trout stream reaches (North, South, Middle Forks of the Whitewater River),
- **Citizen Scientists** - training an action network of citizen scientists to respond to episodic run-off events and to monitor water quality and aquatic life in these and additional trout stream reaches, and
- **Baseline Surveys** - conducting inclusive biotic inventories of fish and aquatic invertebrate communities throughout entire at-risk watersheds for broader, complete delineation of baseline conditions.

Water sampling detected various strobin fungicides in >80% of rain event and low-flow samples, with some concentrations above toxic levels for aquatic life. Strobin concentrations were higher in rain-event samples, but concentrations could not be predicted by rain volume or season. Increased monitoring and better chemical management are needed in these and other watersheds to protect our coldwater ecosystems.

More than 30 citizen scientists have been trained to monitor stream water quality and aquatic invertebrate communities with the Whitewater River and nearby stream systems. They assess their chosen stream sites four times per year, and upload their findings directly to the Izaak Walton League's Save Our Streams web portal. In addition to regular seasonal monitoring, citizen scientists can respond to sudden events (e.g., floods, fish kills) to gather additional information as needed.

Based on surveys at 62 sites, stream habitats and biotic communities ranged from excellent to poor, influenced largely by upstream/downstream location, adjacent land uses, and proximity of springs.

Project Results Use and Dissemination

Results from our project were the basis for two MS theses completed at Winona State University, and a chapter of a PhD dissertation completed at the University of Minnesota. At least two papers reporting our findings will be published in the peer-reviewed scientific literature.

Our 30+ trained citizen scientists have reported and will continue to report their stream monitoring data to the Izaak Walton League's Save Our Streams web portal, where they are continually available to the public.

Project results also have been reported to the scientific community at seven different state, regional, and national science meetings.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan Final Report

Date of Status Update: August 16, 2021

Final Report

Date of Work Plan Approval: 06/07/2017

Project Completion Date: June 30, 2021

PROJECT TITLE: Water Quality Monitoring in Southeastern Minnesota Trout Streams

Project Manager: Neal Mundahl

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Location: Winona, Wabasha, Olmsted, Fillmore, Houston, Goodhue

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$500,000**
	Amount Spent:	**$441,782**
	Balance:	**$58,218**

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 04d as extended by M.L. 2020, First Special Session, Chp. 4, Sec. 2

Appropriation Language:
$500,000 the first year is from the trust fund to the Board of Trustees of Minnesota State Colleges and Universities, Winona State University, to develop a system of biological monitoring for water quality protection of trout streams in southeastern Minnesota. This appropriation is available until June 30, 2020, by which time the project must be completed and final products delivered.

M.L. 2020 - Sec. 2. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2021]

I. PROJECT TITLE: Responsive Water Quality Monitoring: Southeastern Minnesota Trout Streams

II. PROJECT STATEMENT:

This project proposes to develop a more responsive, early-warning system of automated water quality monitoring stations and trained citizen scientists capable of detecting storm-related impairments to at-risk trout streams in the Whitewater River watershed in southeastern Minnesota. SE MN has >700 miles of trout streams. Water quality in many of these top-tier trout streams has been compromised by rain-event runoff, exposing sensitive trout to mixtures of eroded soils, pesticides, urban stormwaters/wastewaters, and animal wastes. Recently, a traditional post-kill investigation of a large, mid-summer, runoff-induced fish kill (>9,000 dead fish spanning >6 stream miles of the South Branch Whitewater River) failed to determine a cause, in part, because of delays in reporting and responding to the kill and the lack of water quality monitoring infrastructure within the impacted reach. Regional land-use practices are changing and the use of new chemicals is expanding rapidly. Environmental monitoring has to adapt to these changes and be prepared to respond immediately to any and all run-off events, especially those within high-risk areas.

The main goal of this project is to better protect the at-risk trout streams in SE MN by developing an improved water-quality monitoring infrastructure and network within the Whitewater River system (>70 miles of trout waters containing brook, brown, and rainbow trout). This will be achieved by:

- **Automated Water Sampling** - establishing both continuous and rain-event sampling throughout 3 at-risk trout stream reaches (North, South, Middle Forks of the Whitewater River),
- **Citizen Scientists** - training an action network of citizen scientists to respond to episodic run-off events and to monitor water quality and aquatic life in these and additional trout stream reaches, and
- **Baseline Surveys** - conducting inclusive biotic inventories of fish and aquatic invertebrate communities throughout entire at-risk watersheds for broader, complete delineation of baseline conditions.

These activities will demonstrate linkages between watershed activities and water quality in these important regional trout streams, distinguishing between sound land management practices and those that have the potential for causing significant harm to aquatic communities. The results of this project can be expanded to additional watersheds and will significantly benefit and protect a sensitive component of Minnesota's environment, and help to sustain an important and highly valuable tourist industry within the state.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of January 1, 2018: Two graduate students were recruited to join the project team, one beginning spring semester 2018 and the other summer 2018. An agreement with the University of Minnesota was developed and approved by both U of MN and WSU to compensate U of MN for services and personnel related to the project. We advertised for bids for 6 monitoring stations, selecting Limno Tech, Inc. to assemble and test the stations and train WSU personnel in station set-up, use, and maintenance. We have selected both likely and alternate locations for deployment of each station. Station delivery and set-up is anticipated during spring (March/April). We also have examined various water testing kits for use by citizen scientists, and serviced/repaired the Garvin Brook monitoring station, in partnership with Minnesota Trout Unlimited.

Amendment Request (03/13/2018): Within our Activity 1 budget (please refer to our Project Budget spreadsheet), we propose to 1) reallocate some funds ($15,000) within the category "Capital Expenditures Over $5,000", and 2) shift some funds ($8,000) from "Capital Expenditures Over $5,000" into "Equipment/Tools/Supplies". Both of these can be accommodated with no change in total budget for Activity 1, as the bid for monitoring stations from a new vendor came in far below previous cost estimates.

Related to 1) above, we request permission to allocate $15,000 toward the purchase of an acoustic Doppler velocimeter. This portable field instrument is used to measure water velocity and calculate discharge at monitoring station locations, to allow for the development of rating curves (stage height versus discharge relationship) for each site. We (WSU) have one of these instruments, but it is 20+ years old, and we are having

difficulty getting its old software to interface with current computer hardware. This instrument would be used for the duration of the current project, as well as every time when monitoring stations are shifted to new stream locations after the project period ends.

Related to 2), we request permission to shift $8,000 into "Equipment/Tools/Supplies", which would allow us to purchase materials and tools necessary for monitoring station deployment, set-up, and maintenance. These would include items such as lumber and fasteners to build platforms on which stations can be mounted in the field, locks and cabling to secure them, and various tools, calibration solutions, and replacement parts to keep stations operating properly for the duration of the project (and beyond).

Amendment Approved by LCCMR 3/26/18

Project Status as of July 1, 2018: Three graduate students have joined the project team, two at Winona State University (Cole Weaver, William Varela) and one at the University of Minnesota (Meghan O'Connor). After some delays due to back-ordered components and software updates, the monitoring stations were delivered in late April, personnel were trained in their use in May, and four of the six stations have been deployed (waiting on permits for placement of remaining two stations). The National Trout Center is recruiting citizen scientists for water quality testing and aquatic invertebrate sampling, with plans for summer training. We have begun baseline surveys for fish, aquatic invertebrates, and habitat, but are being slowed by frequent rain events that have caused high flows and turbid water.

Project Status as of January 1, 2019: Project personnel have been engaged in all aspects of the project. All six monitoring stations were deployed during the field season, collecting continuous water quality data and rain-event-triggered water samples for lab analysis. The National Trout Center partnered with the Izaak Walton League's Save Our Streams program and the MN DNR to recruit and train citizen scientists to monitor water chemistry and sample aquatic invertebrates. Baseline surveys for fish, aquatic invertebrates, and habitat were completed at select sites on all three forks.

Project Status as of July 1, 2019: Project activities continue at an accelerating pace. After making necessary equipment repairs, replacements, and upgrades, as well as software upgrades, during the winter months, the six monitoring stations on the Whitewater River have been deployed for the 2019 field season. Water sample analyses (baseline and rain-event samples), both at the U of MN and WSU, are being conducted on a regular basis. Project co-investigator Dr. Jennifer Biederman travelled to Baltimore, MD, to receive intensive training in the Izaak Walton League Save Our Streams (IWL SOS) stream monitoring protocols. Dr. Biederman is now certified as a Midwest regional trainer for IWL SOS, able to recruit and train citizen monitors. Baseline survey fieldwork for fish, aquatic invertebrates, and habitat have been completed at ~30% of selected sites, with both lab work (e.g., invertebrate identifications, data management and analyses) and additional field work continuing.

Project Status as of January 1, 2020: Project actions on all fronts peaked during the recent 6 months. Multiple rain events provided numerous opportunities to collect run-off water samples for analysis of fungicides at the U of MN and of nutrients and bacteria at WSU. Baseflow samples also were collected and analyzed. Monitoring stations provided continuous recordings of other water quality measures during both rain events and baseflow periods. Graduate students at WSU and the U of MN are performing QA/QC on their datasets and summarizing their findings. Project personnel trained many citizen scientists at the National Trout Center, and assisted them as they monitored (aquatic invertebrates, physical/chemical water quality) their chosen stream sites throughout the region. Baseline survey fieldwork for fish, aquatic invertebrates, and habitat were completed at 60+ stream sites, with invertebrate identifications (now 50% completed) and data management and analyses ongoing.

Project extended to June 30, 2021 by LCCMR 6/18/20 as a result of M.L. 2020, First Special Session, Chp. 4, Sec. 2, legislative extension criteria being met.

Project Status as of July 1, 2020: All water samples for analysis of fungicides were completed by the U of MN, with only the associated sediment samples remaining to be analyzed (lab shut down due to COVID-19). Monitoring stations deployment platforms were removed prior to spring flooding, and were not returned to their locations due to COVID-19 activity restrictions. Graduate students at WSU and the U of MN completed their data analyses and wrote their dissertation/thesis related to data gathered from the monitoring stations. Project personnel did not train any additional citizen scientists due to COVID-19 restrictions, but once restrictions were loosened several citizen scientists were assisted as they monitored (aquatic invertebrates, physical/chemical water quality) their chosen stream sites. Analyses of the baseline survey data for fish, aquatic invertebrates, and habitat were completed at 60+ stream sites, and a graduate student is in the final stages of writing his thesis that details the project findings.

Project Status as of January 1, 2021: Suspended sediments collected along with water samples during 2019 were analyzed for fungicides and four agricultural herbicides by the U of MN. Monitoring station equipment is being maintained in the lab in anticipation of subsequent deployment to new stream sites within SE MN, dependent on future COVID-19 activity restrictions. Project personnel continued their limited work with citizen scientists, working only with a few people at a time at outdoor stream monitoring sites, helping with water quality monitoring and collection/identification of aquatic macroinvertebrates. A graduate student at WSU completed and defended his thesis related to stream habitat and invertebrate/fish communities throughout the Whitewater River system.

Overall Project Outcomes and Results: Water quality in many trout streams in southeastern Minnnesota has been compromised by rain-event runoff, exposing sensitive trout to mixtures of eroded soils, pesticides, urban stormwaters/wastewaters, and animal wastes. The main goal of this project was to better protect at-risk streams by developing an improved water-quality monitoring infrastructure and network within the Whitewater River system. This was achieved by:

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Water sampling detected various strobin fungicides in >80% of rain event and low-flow samples, with some concentrations above toxic levels for aquatic life. Strobin concentrations were higher in rain-event samples, but concentrations could not be predicted by rain volume or season. Increased monitoring and better chemical management are needed in these and other watersheds to protect our coldwater ecosystems.

More than 30 citizen scientists have been trained to monitor stream water quality and aquatic invertebrate communities with the Whitewater River and nearby stream systems. They assess their chosen stream sites four times per year, and upload their findings directly to the Izaak Walton League's Save Our Streams web portal. In addition to regular seasonal monitoring, citizen scientists can respond to sudden events (e.g., floods, fish kills) to gather additional information as needed.

Based on surveys at 62 sites, stream habitats and biotic communities ranged from excellent to poor, influenced largely by upstream/downstream location, adjacent land uses, and proximity of springs.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Establish a network of 6 continuous and rain-event-triggered water quality monitoring stations on 3 trout streams within at-risk watersheds (North, South, Middle Forks Whitewater River; use existing Trout Unlimited-owned station on Garvin Brook as low-risk control; all stations maintained/monitored by professional scientists)

Description: Six stream gauge stations, equipped to monitor weather and water quality, will be established within at-risk sections of 3 streams (2/stream) to gather continuous data and to collect water samples in response to rain events. These streams (North Fork, Middle Fork, South Fork of the Whitewater River; Olmsted and Winona counties, Minnesota) are high-quality coldwater trout streams that lie within an agricultural landscape, and all 3 are at high risk from runoff of agricultural chemicals during strong rain events because of hilly terrain. Monitoring stations will be located at sites potentially at greatest risk because of 1) high proportion of row-crop agriculture within the drainage basin, 2) steep terrain, and 3) large population of susceptible brown or brook trout.

These monitoring stations will provide baseline water quality data, including background (base flow) levels of nutrients, bacteria, and a variety of common agricultural chemicals, and detect any changes in water chemistry in response to rain-induced run-off. Rain-event samples (both stream water and event-deposited sediment) will detect presence/concentrations of potentially harmful chemicals delivered to streams during runoff. Based on weather patterns during recent years, we anticipate sampling during 4 to 5 rain events each year during the project period, once monitoring stations are in place and functional. This activity will provide information on how stream water chemistry changes in response to storm-event runoff, specifically whether concentrations of agricultural chemicals in stream water and/or transported sediments reach levels dangerous to trout during and after these storm events.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 361,750
Amount Spent: $ 322,453
Balance: $ 39,297

Outcome	Completion Date
1. 6 continuous weather/water monitoring stations placed in 3 streams (2/stream)	May 31, 2018
2. Rain-event-triggered (March-Nov) water samplers placed at each station site (#1 above)	May 31, 2018
3. Analyses of rain-event water samples for nutrients, solids, bacteria by Winona State U	June 30, 2020
4. Analyses of rain-event water samples, sediments for pesticides by U of MN	June 30, 2020

Activity 1 Status as of January 1, 2018: A competitive bidding process for monitoring stations allowed us to select a vendor who will provide all equipment and training by the spring season. Tentative locations for station deployment have been selected. An agreement with the University of Minnesota was developed and approved by both U of MN and WSU to compensate U of MN for services and personnel related to the project. Two graduate students were recruited for the project, one joining us spring semester 2018 and other beginning during summer 2018. U of MN personnel are working on developing protocols for assessments of chemicals potentially contained in rain-event runoff within the region.

Activity 1 Status as of July 1, 2018: The six monitoring stations were delivered in late April after some delays, station sites were finalized, and after some software upgrades, four stations were deployed in May and June. Stations in place are currently gathering continuous data for several variables (e.g., stage height, temperature, dissolved oxygen, conductivity, turbidity) and are recording precipitation events. We have just begun using the new acoustic doppler velocimeter (Flow-Tracker) to develop rating curves that will translate stage height data into discharge data at each of our monitoring station sites. Two stations will be placed within state parks, and we are waiting for permits before deploying them. We will begin collecting automated water samples for personnel at the U of MN, as they develop protocols for handling and analyzing samples collected during rain events. Minnesota Trout Unlimited is funding repairs and some equipment replacement for the monitoring station on Garvin Brook.

Activity 1 Status as of January 1, 2019: All six monitoring stations were deployed during May through early July. Weekly visits to each site were used to switch out data cards and to measure discharge with the Flow-Tracker.

The downstream station on the South Fork was shifted ~300 m downstream to facilitate more efficient discharge measurements. Automated water samplers were set to trigger on changes in either turbidity or conductivity, depending on how these variables responded to changes in stage height (or discharge). Rain event samples collected from the stations were transported to the U of MN, where they were subsampled (from either ascending or descending limbs of the discharge profile) prior to analysis for chemicals in run-off.

A few problems arose with monitoring stations. One conductivity probe needed replacement due to factory defect. Two pH probes were broken by flood debris and will be replaced during winter maintenance. One multi-cable was chewed on and severed by muskrats, was repaired temporarily, but will need replacement. One station was damaged by a falling tree during a severe wind storm, but basic, structural repairs to the support platform and temporary repair of the storm box returned it to operational status within a few days. The exterior storm box protected all station electronics from damage, but the solar panel was badly bent and may need to be replaced. The storm box also will need to have holes and cracks in its upper housing repaired. All stations were returned to the lab for the winter months to prevent ice damage to components, and to allow for repair/replacement of damaged parts and software upgrades.

The Garvin Brook water-quality monitoring station is still not operating, with parts to make it operational still on back-order. The initial station vendor has referred us directly to his suppliers to make the necessary equipment repairs/replacements/upgrades. Hopefully, once all parts and upgrades are in place, this station can be reconstructed this winter in the lab and returned to the stream when conditions allow.

Preliminary analyses of nutrients and TSS were made on grab and rain-event samples by WSU personnel. WSU Department of Chemistry personnel are organizing for more efficient analyses of future samples for these variables, plus bacteria.

Activity 1 Status as of July 1, 2019: The monitoring equipment for the six stations on the Whitewater River have had multiple technical difficulties so far this year, some minor and some major. Despite these difficulties, late spring and early summer sample collection has gone well. We were able to sample two storm events: the first event triggered three stations and the second event triggered five stations. In addition to event sampling, we have been collecting weekly base-flow samples at each site. Following are brief descriptions of some of the technical difficulties related to this project that have caused delays or partial data collection at certain sites.

Analyses of our 2018 station data suggested that turbidity was cycling on a daily basis (lower during day, higher at night) at most stations. Closer examination indicated an inverse relationship between turbidity and battery voltage, with battery voltage also cycling (higher during day, lower at night). Since turbidity measurements use a light during measurement, lower battery voltage may have produced a dimmer light, resulting in an artificially (and incorrect) higher turbidity reading. To provide more constant power levels for turbidity readings, we added another photovoltaic panel to each station (now a total of three panels per station) and installed larger, stronger batteries.

Prior to deploying the stations, we ordered some new cables that connect the Mayfly controller to the in-water data sonde. When we tested the new cables in the lab, they shorted out some of the probes on the sondes. After trouble shooting, we discovered that the cables were improperly wired. The sonde manufacturer, Yosemitech, sent new cables and new probes. However, that order was significantly delayed, so two of our sites did not collect sonde data for several weeks after they were first deployed.

We were able to deploy all but one station on either April 19 or April 23. There were significant spring floods this year in southeastern Minnesota, which caused the South Fork of the Whitewater River to change course at our station near Crystal Springs. We had to move this station about 100 meters upstream of where it was previously. The Elba (North Fork) site was delayed because spring flooding had washed a tree onto the site. We contacted the MN DNR and they indicated they had plans to remove the tree. After waiting nearly three weeks, we decided to deploy the Elba station (on 5/16/2019) on the opposite bank of where it was previously.

More recently, in early June, two of our sondes (Whitewater State Park and Elba stations) stopped collecting data from all probes. After trouble shooting, we discovered that there had been a failed seal on the body of each sonde, so water was able to seep inside and corrode the internal electronics. We notified the manufacturer again, and they are shipping two new sonde bodies, which have not yet arrived as of 6/18/19. Our

auto-samplers were programmed to trigger based on turbidity, but because these two sites were without any sonde data, we had to change the trigger to sample on stream height.

Finally, pH probes involve a porous glass ball that needs to be exposed to flowing water. We have lost multiple probes because this glass ball broke when deployed in the stream. We replaced the first two probes that broke, but as more continue to break we will stop replacing them. pH has been found to be consistent in our stream reaches, so continuous collection of pH data is unnecessary given the difficulty maintaining probes.

As of now, 79 baseline and rain-event water samples have been collected for analysis by U of MN personnel. Samples have been filtered and the filters stored so that measurements of strobins in the water and suspended sediment can both be performed. A method extraction of the water samples and detection of the strobins has been tested and used to determine the concentration of 20 of the samples, with appropriate QA/QC procedures. A methanol wash has been added to remove unwanted interference from organics in the samples after solid-phase extraction. A method for extracting the solid particles collected on the filters for strobin levels has been identified and will be tested with real samples shortly. All samples analyzed so far have tested positive for at least one of the 5 strobin fungicides.

Activity 1 Status as of January 1, 2020: The multi-probe sondes that failed at 2 stations due to water infiltration were still under warranty, so the manufacturer quickly replaced them, resulting in a downtime of approximately 3 weeks. However, stations were able to collect water samples during rain events even without the sondes in place, so we did not miss any rain-event sampling during this period.

During the 2019 field season, our 6 monitoring stations recorded from 10 to 18 stormflow events each. We analyzed 108 total water samples collected during 8 of those storm events (multiple water samples collected during different stages of the event run-off hydrograph at each station). At least one fungicide of the 5 examined were detected in 43% of these samples. By comparison, the various fungicides were detected in only 4 to 8% of the 23 baseflow samples analyzed. Maximum observed concentrations were below 10% of the acute aquatic life toxicity standard for all fungicides except pyraclostrobin. We had planned to have more samples analyzed for each rain event/station combination, but the U of MN lab was unable to process a larger number of samples within the requisite time period, owing to insufficient filtration and holding equipment. We also are attempting to estimate fungicide loadings for specific sites and rain events where multiple samples collected throughout the hydrograph allow for these calculations. Two graduate students, Meghan O'Connor at the U of MN and Cole Weaver at WSU, have been performing QA/QC on the chemical data, and are analyzing data for trends and patterns. Preliminary findings indicate large variations in concentrations of fungicides 1) among stations for the same rain event, and 2) among different rain events at the same station.

Activity 1 Status as of July 1, 2020: The analysis of strobin fungicides in the dissolved phase from the collected water samples from the Whitewater River was completed. The complete data set is available online: http://hdl.handle.net/11299/214038. Pyraclostrobin was the most highly detected fungicide, with 82% detections. Azoxystrobin was also frequently detected, with 81% detections. Trifloxystrobin, the least detected strobin, was still found in 44% of samples. Concentrations ranged from 0.01 ng/L with trifloxystrobin to 30.9 µg/L with pyraclostrobin. Concentrations of fluoxastrobin and pyraclostrobin in four and twenty samples, respectively, were above known toxic levels for some aquatic species. Concentrations and detections did not correlate with streamflow, precipitation, or location up or downstream. The Middle Fork contained the highest strobin concentrations, most likely due to the high amount of agricultural land in its watershed. Highest concentrations were detected in summer samples, correlating with likely strobin application. There were roughly equal concentrations in spring and fall samples, showing either groundwater interaction or steady leaching from sediments or soils as this is not their application period. The suspended sediment particles collected along with the water samples are in storage and will be analyzed once the laboratory with the appropriate instrumentation for analysis is fully re-opened.

Activity 1 Status as of January 1, 2021: Monitoring station equipment is being maintained in the lab (batteries and probes being maintained, materials being cleaned) in anticipation of future deployment within SE MN.

Regional DNR and MPCA personnel have suggested several locations where monitoring stations could be placed to gather data on water quality during baseflow and runoff events.

U of MN personnel completed fungicide analyses on suspended sediments collected along with water samples during several dates in 2019. The following is a summary of those findings.

For a subset of the samples, the suspended solids that were collected during filtration were analyzed for the strobin fungicides and selected other agrochemicals (three herbicides, one fungicide). The samples were chosen to represent a large storm event (late June 2019, total rainfall 5.6 in), a small storm event (early August 2019, total rainfall 0.5 in), and a dry period (mid-October 2019). The analyzed samples were also chosen to represent all three forks of the river during the rising, peak, and falling hydrograph periods. During the storm events, total suspended sediment concentrations (TSS) were 100-900 of mg/L, and levels at peak flow in the June event for the south and middle forks greater than 1000 mg/L.

The only two fungicides detected in the suspended sediments were azoxystrobin (two samples in the august event) and pyraclostrobin (nine samples in total, 4 in June, 5 in August). This is consistent with these two compounds generally having the highest levels in the water samples, with pyraclostrobin dominating. Pyraclostrobin is also the most hydrophobic of the compounds.

In the late-June, high-intensity storm, the concentrations of pyraclostrobin in the water were 1000-20,000 ng/L. This indicates that the large amount of water was likely able to desorb/mobilize pyraclostrobin that either had been applied (or was present as residual from the previous year). The concentrations on the solids were in ~1 ng/g. The reason for the high water and low solids concentration could be because the pyraclostrobin was relatively recently applied and thus was able to be readily washed off, the large amounts of solids mobilized in the watershed could have diluted the signal (mixing of sediments without pyraclostrobin), or the large water volume could have desorbed the pyraclostrobin. Interestingly, the more hydrophobic acetochlor (which is applied in larger amounts; sales were 40 times more than pyraclostrobin in 2017) had much higher concentrations on the suspended sediments (10-1200 ng/L).

In the early August, low rainfall event, both azoxystrobin and pyraclostrobin, as well as another fungicide propiconazole were detected. This indicates that there was likely applications of azoxystrobin (concentrations were 2-10 fold higher than in June) and propoiconazole in the intervening period between these storms. The concentration on the suspended sediment (10-85 ng/g total strobins) was higher than the late June event. The lower amount of rainfall may have mobilized sediment particles from a smaller region of the watershed that is more agriculturally impacted, and less dilution of the signal/desorption by the smaller TSS level and water volume could be reasons for the higher detected concentrations.

In the baseflow period, the TSS levels were <17 mg/L (compared to 100s of mg/L in the storm events) and no strobins were detected on the solids. The high detections of picoxystrobin in two of the water samples are likely false positives.

Final Report Summary: Over the period of this project, we were able to collect and analyze water samples from nearly 20 high-flow rain events and several base-flow periods. The collection and analyses were challenging at times, but we were able to achieve most of the project goals.

By purchasing the monitoring stations from Minnesota vendor, we received tremendous support and trouble-shooting expertise during the project period. However, equipment often malfunctioned or failed, and both software and hardware needed more frequent updating and upgrades than we anticipated. At times, we needed to deal directly with the equipment manufacturer in China due to warranty issues, leading to delays in repairs and replacements. Fortunately, we were able to use the expertise of a lab technician at WSU, and he was able to "repackage" and better organize the control systems for the monitoring stations, resulting in more efficient station maintenance and management.

Our initial plans were to collect many (~20) water samples from each station for each of a few (4 or 5) rain events and have them all analyzed for fungicide presence and concentration by U of MN scientists. That would provide us with a better understanding of if/when fungicides might be mobilized and carried into streams. We anticipated having 400 water samples analyzed during the project period. However, U of MN labs were unable to process such a large number of samples from a single rain event due to time-critical procedures and equipment limitations, and the cost per sample was considerably higher than original estimates.

Subsequently, we selected and analyzed three samples per station per rain event (one sample each as stream flow increased, peaked, and decreased) for nearly 20 rain events, plus several base flow samples (131 samples total; complete data are available to the public here http://hdl.handle.net/11299/214038). While this change allowed us to examine far more rain events that expected, it limited us somewhat in assessing any patterns in fungicide concentrations as flows changed.

Fungicide analyses of water samples led to several important findings:

- *One or more strobin fungicides were present in the vast majority (99%) of water samples collected, regardless of season of collection or timing within a given flow event. Lab procedures that enhanced detection ability (i.e., lower detection limits) likely were responsible for these greater frequencies of detection. In addition, instantaneous sampling rather than the composite sampling (96-hour composite) conducted by the MN Department of Agriculture (MDA) likely produced many more fungicide detections and higher concentrations than typically reported by the MDA in recent years.*
- *Strobin fungicide concentrations were higher during storm flows than during base flows, but did not differ among increasing, peak, and decreasing flows produced by rain events. This finding indicates that strobin fungicides are mobilized by rain events, likely carried into streams by surface runoff and eroded soils. Precipitation totals, stream flow volume, and sample timing during flows were not good predictors of fungicide concentrations, suggesting that a variety of other factors (e.g., watershed area, riparian land use, rain event timing after fungicide application, and others) likely are important in understanding the mobilization of strobin fungicides and their conveyance to streams. Far more investigation is required to learn more about how strobins become mobilized.*
- *The Middle Fork contained the highest strobin concentrations of the three stream forks, most likely due to the high amount of agricultural land in its watershed.*
- *Measured concentrations for fluoxastrobin and pyraclostrobin were above toxic thresholds for some aquatic species in 4 samples (3% of all samples collected) for fluoxastrobin, and 20 samples (15%) for pyraclostrobin. The frequent toxic concentrations for pyraclostrobin are particularly concerning. Strobins in the Whitewater River, and potentially in other streams draining agricultural lands in southeastern Minnesota, could be impacting aquatic species within these systems, and merits further study.*
- *The only two fungicides detected in the suspended sediments were azoxystrobin and pyraclostrobin. This is consistent with these two compounds generally having the highest levels in the water samples, with pyraclostrobin dominating. Pyraclostrobin is also the most hydrophobic of the compounds.*

As use of strobin fungicides expands on agricultural crops in Minnesota, our data suggest that these chemicals will be carried into streams and rivers during rain events and potentially have a negative impact on sensitive aquatic species. Our water monitoring stations were successful at collecting water samples throughout numerous runoff events, triggered in response to either increasing flows or increased turbidity. These or similar systems should be deployed at additional sites throughout the region to better monitor stream water quality in response to expanding use of strobin fungicides to boost agricultural output. In addition, state monitoring agencies should consider altering their water sampling and analysis procedures to ensure that their sampling program captures the presence of chemicals that may cause harm to our most sensitive aquatic species.

ACTIVITY 2: Train and deploy citizen scientists to monitor streams in SE MN, sample and analyze water quality after rain events, and immediately notify MN State Duty Officer (Dept. of Public Safety; single contact point for reporting any environmental threat within MN) of any fish kills observed

Description: Citizen scientists will be trained in, and equipped for, basic stream water sampling and analysis. This will enable them to regularly monitor streams in the project area and elsewhere throughout SE MN, and to analyze water quality changes in response to rain-event runoff. Each citizen scientist will receive a surface water testing kit and supplies that will allow them to monitor their chosen stream location within the project area, supplementing the data gathered by the automated monitoring systems. Citizen scientists also will have the option to monitor water quality on other streams in SE MN. These trained individuals also will be an extremely

important group for spotting fish kills immediately, mobilized during and after rain events when runoff-induced fish kills typically occur.

Citizen scientists will receive MN State Duty Officer (Department of Public Safety) information cards for their use and for additional distribution to landowners and the angling public. These information cards will contain instructions for reporting fish kills. This information is greatly needed by the public, as most people are unaware of how, or to whom, to report a fish kill. The MN State Duty Officer provides a single contact available 24 hours/day, who will then notify all other appropriate agencies/personnel that need to respond to the fish kill. The Duty Officer provides a service analogous to a 911 call center, but for reporting environmental threats rather than threats to life and property.

In addition to information cards, signs containing State Duty Officer info will be developed and placed along streams at angler access points within the project area to better inform the general fishing public about the process for reporting fish kills. Cards and signs will include the appropriate QR code for cell phone use.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 43,940
Amount Spent: $ 27,777
Balance: $ 16,163

Outcome	Completion Date
1. Training for 15-20 citizen scientists by National Trout Center, Winona State U	May 31, 2018
2. Development, distribution, placement of MN State Duty Officer contact info, signage	May 31, 2019
3. Distribution, use of water testing kits by citizen scientists	June 30, 2020

Activity 2 Status as of January 1, 2018: We partnered with the Minnesota Pollution Control Agency, Rochester office, to plan for distribution of information cards about fish kills and contact information for the Minnesota Duty Officer. MPCA had produced the cards, and we have purchased information containers to be mounted on posts at angler access sites throughout the watershed, along with additional signage. We have examined various water testing kits intended for use by citizen scientists, and will purchase one model for distribution. We are working on an agreement with the National Trout Center to fund a student intern.

Activity 2 Status as of July 1, 2018: We are developing informational signage (what to do if a fish kill is observed) to place on posts at stream access sites. These same posts will contain the MPCA-produced Minnesota Duty Officer contact info and fish kill informational cards. In conjunction with the National Trout Center, we are recruiting area citizen scientists to assist with water quality monitoring activities (using purchased water testing kits), and the Center is planning a summer training session for these volunteers. We also are partnering with the Izaak Walton League Save Our Streams (IWL SOS) program to solicit volunteers to participate in stream monitoring via aquatic invertebrate sampling. Two project personnel from WSU and a representative of the National Trout Center participated in the SOS training, and are now qualified to train citizen scientists. Our local IWL chapter has applied for additional funding from the national program, to be used for additional sampling gear and a volunteer training program tentatively scheduled for August.

Activity 2 Status as of January 1, 2019: Project personnel participated in Winona Water Day during late August, a collaborative effort between public and private groups within the Winona region to communicate with the public about important issues concerning surface and ground water quality. During the day-long event, local citizens had the opportunity to visit displays, listen to speakers, and particpate in stream monitoring in a local trout stream. Several prospective citizen science volunteers participated in Winona Water Day events, and agreed to participate in later training.

After consultation with project personnel and National Trout Center staff, Izaak Walton League Save Our Streams (IWL SOS) program coordinator Samantha Briggs returned to Winona to conduct two training sessions for citizen scientists on October 6 and 7. Two additional Trout Center staff and three additional WSU personnel participated in the training, along with 25+ citizens from the region. These sessions were given specifically to attract and train citizen scientists to monitor regional trout streams for both water chemistry and aquatic

macroinvertebrates on a regular basis (up to 4 times per year, once each season). Session attendees included local property owners interested in learning more about the stream flowing through their properties, members of several Trout Unlimited chapters, university students, and area citizens wanting to participate in environmental monitoring. In addition, they will be supplied with materials to examine water chemistry after rain events. The IWL SOS national office has developed a list of materials and vendors who can provide quantity discounts for groups participating in the IWL SOS program.

National Trout Center staff, along with regional IWL SOS personnel, met with citizen science organizers from the MN DNR to discuss collaboration and reduce duplication of effort. MN DNR staff are developing an app for mobile electronic devices, to be used to record, manage, and upload field data during stream monitoring. This app hopefully would complement the data-entry software for the IWL SOS program, and provide an additional level of usefulness for the field data gathered by citizen scientists.

Activity 2 Status as of July 1, 2019: Project co-investigator Dr. Jennifer Biederman was one of a small group of individuals nation-wide selected by the Izaak Walton League to receive IWL SOS "trainer" training. She travelled to Baltimore, MD, for multi-day training to become a certified IWL SOS citizen stream monitor trainer. Her focus area will be the Midwest US, and she will use her expertise to train additional area citizens for involvement in our project. Her travel and training expenses were paid in full by the Izaak Walton League.

The National Trout Center will be using their internship funding from this project to compensate two individuals to engage with citizen volunteers to monitor their chosen stream sites in southeastern MN. These interns will work with Dr. Biederman to make certain that all volunteers have been trained according to IWL SOS protocols, and interns will assist volunteers as they begin and continue their monitoring efforts.

Simple signs describing how to report a fish kill, and containing contact information for the Minnesota Duty Officer, were developed. These were combined with all-weather notecard holders to display and dispense more detailed fish kill reporting directions on notecards printed and supplied by the Minnesota Pollution Control Agency. Signs and notecard holders are being placed at angler access points throughout the Whitewater River drainage.

Activity 2 Status as of January 1, 2020: Expanding efforts were directed toward citizen science during the past 6 months. During September 2019, we hosted two open houses to inform prospective citizen scientists about the volunteer stream monitoring portion of our project, one at the National Trout Center in Preston and the other at the Whitewater State Park Visitor's Center. These were arranged and hosted under cooperation with personnel from the National Trout Center and Caroline van Schaik, Driftless Area Coordinator of the Upper Mississippi River Initiative, Minnesota Izaak Walton League. During October, the National Trout Center hosted an Izaak Walton League Save Our Streams citizen stream monitor training session led by project co-investigator Dr. Jennifer Biederman, assisted by project intern Olivia Graziano and graduate students Will Varela and Cole Weaver. Training for the 24 attendees included classroom instruction, aquatic invertebrate indentification, and field instruction at a nearby stream location. Five complete sets of monitoring gear (e.g., physical/chemical testing supplies, invertebrate collecting and sorting equipment and supplies), as recommended by the IWL SOS program, were purchased and made available to citizen scientists for their monitoring efforts. Many citizen scientists, individually and in small groups, have been conducting monitoring efforts to date, supervised during their initial fieldwork by project personnel. These citizen scientists have included Trout Unlimited members, school groups, and other interested citizens. The physical/chemical and biological results from their monitoring efforts have been reported directly to the IWL SOS Clean Water Hub website (https://www.iwla.org/water/save-our-streams/clean-water-hub).

Activity 2 Status as of July 1, 2020: To keep citizen scientists who attended the October 2019 Save Our Streams workshop engaged, we invited participants to attend a winter social in February 2020. Twenty citizen scientists attended the gathering, which was held at one of the volunteer's homes on Cedar Creek in Winona County. During the social, we shared data that were collected from fall and early winter sampling events, and discussed plans for spring sampling. The WSU student intern, Olivia Graziano, and graduate student, Will Varela, assisted in planning and leading the event, along with Caroline Van Shaik of the Izaak Walton League.

Although no sampling was carried out in March and April due to COVID-19 restrictions, small groups of team members did conduct sampling in May, June and July. Masks and social distancing were utilized, and care was taken to not to share tools.

- May/June – Monitors sampled three of the four original sites sampled in Fall of 2019, including Cedar Valley Creek, Gribben Creek, and Whitewater River, engaging 10 adults and 3 children.

- June – Monitors sampled a new site on Pine Creek in far southern Winona County, engaging 2 adults.

- July – Monitors sampled in Rochester, the fourth of fall 2019's original locations but at a new and much safer site itself, Cascade Creek, engaging 3 adults (including two undergraduate students from Saint Mary's University).

- July – Monitors sampled (chemical data only due to the lateness of the season) a new site at Diamond Creek, engaging 3 adults.

In addition, this work led to the submission of a modest proposal to conduct a community education event in summer 2021 aboard the (docked) Cal Fremling Floating Education Classroom. During this event, it is proposed that volunteer citizen science members will help Will Dilg (Izaak Walton League) chapter members host learning stations on issues of water quality, agriculture, and river history. The proposal includes funds for 2 additional Save Our Stream (SOS) kits and certification training. The Winona Farmers Market and Will Dilg chapter are partners.

Volunteer participants also worked with the staff of the Izaak Walton League/Upper Mississippi River Initiative (UMRI) to present on citizen science organizing as part of a national SOS webinar, in June 2020: https://www.youtube.com/watch?v=Ps3fkcoo9LE&feature=youtu.be.

WSU was named as an important partner in successful water quality-driven citizen science efforts in the Driftless region.

Between December 2019 and July 2020, volunteers also partnered with staff of the UMRI to maintain ongoing communication with a list of citizens who have either already engaged as citizen scientists or expressed interest to participate in the future. In light of Covid-19 restrictions, National SOS staff has designed an on-line certification program. It is expected that a half-day, COVID-safe in-person training, at the first possible opportunity will be provided in the fall.

Activity 2 Status as of January 1, 2021: Between July and December 2020, project personnel continued assisting citizen scientists as they monitored stream conditions at various sites throughout SE MN. Dr. Jennifer Biederman, intern Olivia Graziano, and Caroline Van Shaik (Driftless Area Coordinator of the Izaak Walton League) met with individuals and small groups (outside only, with social distancing) as they conducted water chemistry and aquatic macroinvertebrate assessments. Their results subsequently were uploaded to the IWL SOS website for analysis and comparison with previous data.

Twelve teams headed out in September through December, carrying out Save Our Streams water quality monitoring on 9 sites in teams of 2 to 5 people, totaling 26 volunteers. All participants wore masks, divided up tasks and tools to maintain physical distance, and drove separate cars to maintain safety during Covid-19 pandemic.

During this period, we sampled two new stream sites and added 3 new volunteers, which suggests that steady outreach combined with safe conditions can provide opportunities even during a pandemic. The Izaak Walton League's Driftless Area Coordinator continues to assist with team and site coordination, data tracking, program promotion, and kit updates. Many participants have completed online water quality monitoring

training through Save Our Streams and an in-person training session is planned for spring 2021 (contingent on Covid-19).

Also, some citizen science participants and project partners have worked to secure a grant from the Izaak Walton League to promote engagement in water conservation in the form of a public event, which will take place in Winona in summer of 2021.

Dr. Biederman also became the liaison between the area Trout Unlimited Chapter (Win-Cres) and Trout Unlimited's Driftless Area project utilizing the WiseH2O App to assist citizen scientists as they monitor regional trout stream conditions. She is soliciting monitoring participants from the Win-Cres Chapter and has engaged with students from Saint Mary's University to assist with the effort. She is providing participants with summary information about the App and the 2019 pilot project (conducted by the Kiap-TU-Wish Chapter in Pierce County, WI), as well as providing assistance on 1) downloading the App; 2) completing on-line training; 3) obtaining water chemistry test kits; and 4) creating a local monitoring plan.

Final Report Summary:

Activities from January 1 to June 30, 2021:

- Teams sampled in May-June 2021 on all 8 sites in southeastern Minnesota, involving 26 citizen scientist units including 3 children. Several days after sampling Mill Creek, one of those children asked what we were going to do with the frozen bugs. He saw the ice cube trays but not the part about us dumping them back into Mill Creek and so a couple days later this question was still on his mind!
- We plan to gather socially in August 2021 in combination with some data sharing and good food.
- Stream team members will be part of some water education events being planned in conjunction with the Winona Farmers Market for this summer/early fall.
- Partner staff with UMRI (Izaak Walton League/Upper Mississippi River Initiative) maintain ongoing communication with a list amassed through these shared efforts of people interested in stream monitoring and citizen science. In light of Covid-19 restrictions, National SOS staff has designed an on-line certification program and we hope we can offer the final piece, a half-day in-person training, by this fall. Separate funding continues to cover UMRI staff, additional stream monitoring kits, chemical replacement, and the water education events.

Project summary: Our initial goal for this activity was to train citizen scientists to respond to rain events by monitoring water quality at select stream sites throughout the watershed, basically a "first response" team to collect data that might be useful should the rain event lead to a fish kill. We soon realized that citizen scientists preferred a broader role in stream monitoring, and responding to every rain event would be logistically impossible for many of them. Consequently, we shifted the role of citizen scientists to that of longer-term stewards of their chosen stream site, collecting data at their stream site in a consistent form over several seasons per year.

With Dr. Jennifer Biederman and the National Trout Center as activity leads, we explored what type of training and equipment/materials were needed for citizen scientists to monitor streams. After meeting with personnel from various state agencies already engaged in citizen science, and participating in a nation-wide citizen science program (Izaak Walton League Save Our Streams [IWL SOS]), we decided to partner with the IWL SOS program that would allow us to 1) use an established citizen training program, 2) take advantage of a nation-wide, web-based data reporting and viewing system (https://www.iwla.org/water/stream-monitoring), and 3) leverage additional funding and training opportunities through IWL.

The project hosted an IWL SOS trainer to present several initial training workshops, and Dr. Biederman was subsequently selected to become an official IWL SOS trainer for the upper Midwest region (her training as funded by the IWL). Dr. Biederman presented several training workshops for citizen scientists at various sites throughout the region (e.g., National Trout Center, Whitewater State Park), assisted by interns and other project personnel. We also benefited from the services of Caroline Van Shaik (Driftless Area Coordinator of the Izaak Walton League), who assisted with all aspects of training workshop planning, advertising, training, and follow-up outreach to citizen scientists. To date, over 50 citizen scientists have completed IWL SOS training and the majority are actively monitoring stream locations throughout the Whitewater River systems and elsewhere within southeastern Minnesota.

Initial plans were to provide citizen scientists with basic individual kits (for basic physical/chemical measurements) to monitor stream sites. When we switched to using the IWL SOS protocols, we purchased five, more comprehensive kits (more extensive physical/chemical measurements plus equipment for aquatic macroinvertebrate collection and identification). These kits circulate among groups of citizen scientists as needed, and expendable supplies are replenished as needed. IWL has provided additional kits and materials to support the effort, with the local IWL chapter being instrumental in obtaining funding for kits and materials.

All citizen scientists are aware of the need to contact the State Duty Officer if a fish kill is observed by them in any stream within the southeastern Minnesota region. They have the training and kits to allow them to take basic water chemistry measurements at fish kill sites. In addition to citizen scientists receiving State Duty Officer contact information during training, further information about reporting fish kills is posted at angler access points throughout the Whitewater River system.

As a result of this activity, we now have a network of dozens of citizen scientists actively engaged in stream monitoring in southeastern Minnesota. The information they gather is now reported directly to the web and accessible immediately to the general public. In addition, we are expanding opportunities for citizen scientists to become more involved in stream monitoring activities. Dr. Biederman became the liaison between the area Trout Unlimited Chapter (Win-Cres) and Trout Unlimited's Driftless Area project utilizing the WiseH2O App to assist citizen scientists as they monitor regional trout stream conditions.

ACTIVITY 3: Conduct baseline surveys of fish and aquatic invertebrates throughout streams within high-risk watersheds

Description: Without adequate baseline information on stream fish and aquatic invertebrate communities, the full effects of potentially lethal runoff events can never be determined. In this activity, fish and aquatic invertebrate communities in at-risk trout streams (North Fork, Middle Fork, South Fork of the Whitewater River) will be surveyed at regularly spaced reaches (1 site/mile, each site 150 m or more) throughout each stream to determine species presence and relative abundance. Fish will be identified and counted on site before being returned alive to the stream. Invertebrates will be preserved for later identication and counting in the laboratory at WSU. If a fish kill occurs, this baseline information can be used in a "before/after" comparison to assess the effects of the kill.

In conjunction with the systematic sampling described above, additional aquatic invertebrate collections will be made by citizen scientists, providing more baseline info for additional streams/locations. Citizen scientists will be trained in proper collection techniques and provided with collecting equipment and supplies. Collections will be returned to WSU for identification and counting.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 94,310
Amount Spent: $ 91,552
Balance: $ 2,758

Outcome	Completion Date
1. Survey and identify fish in multiple stream reaches per stream (~1 reach/mile)	June 30, 2020
2. Survey and identify aquatic invertebrates in each stream reach (#1 above)	June 30, 2020
3. Identify aquatic invertebrates collected from other sites by citizen scientists	June 30, 2020

Activity 3 Status as of January 1, 2018: We have purchased some of the equipment and supplies needed to conduct baseline surveys beginning in summer 2018. Both graduate students are scheduled to work on these surveys. Many tentative survey sites have been selected and private landowners are being contacted for permission to access stream sites.

Activity 3 Status as of July 1, 2018: We have begun collecting baseline surveys at various stream locations throughout the project area, all on public lands to date. Sampling conditions have not been ideal, with seasonal rains producing higher stream flows and turbid water that have inhibited some fish and all habitat surveys. To

date, we have completed three fish surveys and collected aquatic invertebrate samples at nine stream sites. Rainy days have been spent in the lab sorting and identifying aquatic invertebrates. We expect improved stream conditions as summer progresses, so contacts are continuing with private landowners to obtain permission to access streams for surveys.

Activity 3 Status as of January 1, 2019: Baseline surveys of fish, aquatic macroinvertebrates, and habitat have been completed at many stream sites, including several in each river fork. We concentrated on sites nearby each of our water-quality monitoring stations, plus the upstream reaches of each fork (clearer water during rainy conditions). All macroinvertebrate samples have been sorted and await final identifications. Fish collections to date have documented the presence of 17 species. Habitat surveys have been completed at the fewest sites, due to the need for clear water during surveys.

During October-November, spawning surveys of brown trout were conducted in multiple, 100-m reaches of each of the three river forks. Overall, spawning redd (nest) counts for the three forks averaged 7.4 redds/100 m, four times higher than counts by the MN DNR in the South Fork during 2012. These counts were similar to those made in a nearby stream, Garvin Brook. However, spawning redds in the Whitewater River made significantly less use of overhead cover (e.g., overhanging banks, vegetation, tree branches, or instream boulders or logs) than those in Garvin Brook, making spawning trout in the Whitewater potentially more vulnerable to predators (e.g., bald eagles, belted kingfishers, and a variety of mammals) during spawning.

Activity 3 Status as of July 1, 2019: We continue to survey stream sites throughout the watershed. Private landowners have very graciously allowed us to access streams on their property. Depending on site conditions and weather, we typically can survey fish, aquatic invertebrates, and stream habitat at two sites each day. We have surveyed 30% (18 sites) of the 60 sites that we plan/hope to survey on the three forks of the Whitewater River. To date, our surveys have encountered 20 species of fish representing eight families.

On days when field work is not possible, we have sorted all aquatic invertebrates from the organic matter in each sample, and are counting and identifying invertebrates as time allows. We expect to follow this approach during the remainder of the summer: collecting invertebrates and sorting them shortly after collection, then counting and identifying later. We also have been summarizing stream habitat data shortly after it has been collected, preparing it for data entry and preliminary analyses as appropriate.

Activity 3 Status as of January 1, 2020: The frequent rain events that allowed our monitoring stations to collect many water samples for testing inhibited field work for baseline surveys for fish, invertebrates, and stream habitat during summer and autumn months. Despite the high-water delays, we were able to survey 61 stream sites: 21 sites along the North Fork, 19 sites along the Middle Fork, and 21 sites along the South Fork. Fish data have all been entered into spreadsheets for future analyses. Fish collections included 9974 individuals representing 21 different species. Brown trout were collected at 51 of the sites surveyed. Stream habitat data also have been entered into spreadsheets for analysis. Over half of the invertebrate samples collected have been sorted and identified, with the remainder to be completed within the next few weeks.

Activity 3 Status as of July 1, 2020: We detected both similarities and differences in variables across each fork of the Whitewater River with respect to habitat, invertebrates, and fish. Percent fines, gravel abundance, run abundance, pool area, substrate embeddedness, and total fish cover differed among river forks. There were no differences in macroinvertebrate community scores across forks. However, there were differences in stonefly abundance and abundance of long-lived invertebrates. Invertebrate community scores ranged from 5 (very poor) to 38 (fair), with 19% of all sites rated as very poor, 74% of sites rated poor, and 7% rated as fair. Fish community IBI scores ranged from 0 (very poor) to 105 (excellent), with 25% of all sites rated as very poor, 38% rated as poor, 28% rated as fair, 8% rated as good, and 2% rated as excellent. Overall, there is evidence to suggest habitat is dominated by fine sediments, which impairs systems. In general, there was dominance by tolerant species of invertebrates and fish species and a lack of intolerant species.

Activity 3 Status as of January 1, 2021: William Varela completed and defended his thesis entitled "Assessing Biotic Integrity and Stream Habitat of a Coldwater Catchment in a Karst, Agricultural Environment" (thesis included along with this report). His thesis examined relationships among instream and riparian habitat variables and the macroinvertebrate and fish communities at 60+ sites throughout the Whitewater River system. The following is the abstract from his thesis.

The Whitewater River flows within a karst landscape influenced by underlying sandstone and limestone bedrock and dominated by agricultural activities. Decades of disturbances from intensifying storms caused by changing climate and coupled with agriculture can have deleterious effects on riverine catchments. My study focused on analyzing overall stream health using multiple characteristics (riparian and instream habitat, macroinvertebrates, and fish) to identify system impairments within the Whitewater River watershed. Twenty-four stream habitat variables were inventoried across multiple sites (57). Fish (61 sites) and macroinvertebrate communities (58 sites) were examined within the Whitewater River catchment (one site ~every mile along North, Middle, and South forks) by electrofishing and kick sampling, respectively. I detected similarities and differences in variables among forks with respect to habitat, invertebrates, and fish. Percent fines, percent gravel, percent run, percent pool, percent cover, and embeddedness differed significantly among forks. There were no significant differences in macroinvertebrate B-IBI scores among forks. I further analyzed habitat variables using three modeling techniques (PCA, Multiple Regression, and Canonical Correlation) to detect possible relationships among variables. Canonical Correlation modeling detected significant correlations between instream and riparian variables. I assessed invertebrate communities using a benthic IBI (B-IBI) calculator and individual B-IBI metrics; there were differences among forks in the number of Plecoptera taxa and long-lived taxa. Invertebrate IBI ratings generally were poor across the catchment, with no differences among forks. Fish coldwater IBI ratings differed among forks, with ratings ranging from very poor to excellent; the majority of ratings were in the very poor and poor categories. Relative abundance was analyzed and differed significantly among forks within the catchment. Additionally, brown trout relative weight was analyzed and did not differ across forks within the watershed. Habitat, macroinvertebrate, and fish characteristics were modeled using stepwise regression, k-means algorithm to cluster characteristics into similar groups, and PCA to describe relationships among variable clusters. Kruskal-Wallis was used to test for differences across cluster medians and determined there were significant differences across cluster groups. Overall, there is evidence to suggest that habitat is dominated by system-impairing fines, and there is an increase in tolerant invertebrates and fish species. All characteristics analyzed were effective in describing stream health. It is recommended that areas in need of improvements (riparian and instream) be identified and measures implemented to improve overall stream health. Additionally, BMPs need to be re-addressed, and a multi-agency collaboration focused on these improvements would benefit the catchment.

Final Report Summary: Baseline surveys of fish, aquatic invertebrates, and stream habitat were conducted at 60+ stream sites throughout the Whitewater River system. We now have an up-to-date inventory of the biota and habitats throughout all three forks of the Whitewater River, as a standard for comparison to future surveys. If the system experiences any pollution or other episodic event in the near future, we will now have data to contrast with post-event data.

Surveys were conducted mostly as planned, although we had more site gaps than desired along both north and south forks, largely due to access difficulties (i.e., no roads) and prolonged high-flows and turbid water produced by rain events. Most of these gaps occurred within the lower reaches of the two stream forks, where sampling at other sites indicated the best stream habitats and aquatic communities to be located.

Baseline surveys were both labor-intensive and time-consuming. Field surveys required a minimum of three workers at each site to accomplish all required tasks in a timely fashion. For example, nearly 10,000 fish were collected and identified during field work. In contrast, lab-based sorting and identification of preserved macroinvertebrate samples could be undertaken by individuals, but triplicate samples per site and complete counts of entire samples often required several hours of work per site (many sites exceeded 500 organisms).

We initially intended to train citizen scientists to sample and preserve aquatic invertebrates at their monitoring locations, then transfer those preserved samples to Winona State for identification. However, when we switched citizen scientist training to follow the Izaak Walton League Save Our Streams protocols (see Activity

#2 above), which included training to count and identify aquatic invertebrates in the field, we no longer needed to preserve and identify those samples. This eased the burden of sample processing and allowed us to handle and analyze our own samples more efficiently.

Analyses of all baseline monitoring data highlighted several features of the stream habitats and biotic communities within the Whitewater River. Stream habitats and biotic communities were highly variable in all forks, ranging from very poor to excellent. In general, poorest habitats and biotic communities were located in the middle sections of all forks, in those areas draining large proportions of agricultural and small urban areas. Improved habitats and biotic communities typically were located in downstream sections of each fork, adjacent to forested parks and wildlife management areas. Good stream habitats were strongly correlated with good biotic communities, and poor habitats were associated with poor fish and invertebrate communities. These results indicate that stream habitat protection and/or restoration is a precursor to healthy biotic communities within the Whitewater River. The presence of a permanent, vegetated riparian buffer (recently mandated by MN law) is important for limiting rapid runoff to streams and providing important habitat (overhanging vegetation, fallen logs/trees) and nutrients (leaves, insects) to the stream environment. We expect that stream habitats in the Whiewater River will improve as newly added riparian buffers "mature" and better protect stream habitats.

V. DISSEMINATION:

Description: Products resulting from this project will be disseminated via a web site, training workshops for citizen scientists, news releases, community presentations, on-site signage at stream access sites, and presentations at regional science meetings. These diverse methods are intended to reach a variety of audiences, allowing us to share information with local and visiting anglers, citizen scientist volunteers, the broader regional citizenry, and the scientific community.

A web site to be developed for the project (http://course1.winona.edu/nmundahl/WhitewaterProject.htm) will provide a key link between the project and the interested public. The web site will provide a source for all information about the project, from schedules of proposed activities to photos, videos, and reports of project happenings. Links will be provided for connecting with project personnel, to access news releases, and to volunteer as a citizen scientist.

News releases will be produced and disseminated through the Winona State University Communications and Marketing office. This office prepares and distributes information and news items to regional newspapers, radio, and television, as well as preparing web content and a periodic news magazine.

Project updates and community presentations will be prepared and delivered by project personnel throughout the project cycle and beyond. These updates and presentations will be directed at citizen scientists, regional Trout Unlimited chapters, the Minnesota Trout Association, the National Trout Center, and other interested members of the regional community.

Finally, the scientific findings of the project (e.g., water quality data, linkages between land use and water quality, patterns in baseline survey data, citizen scientist participation and findings) will be presented at regional science meetings by project leadership and graduate and undergraduate students. Potential venues may include state meetings of the American Fisheries Society, the Mississippi River Research Consortium, and undergraduate science symposia hosted by Winona State University, Saint Mary's University of Minnesota, and Viterbo University. Ultimately, we hope to produce one or more scientific manuscripts describing any linkages that we may discover between watershed activities and water quality in these important regional trout streams.

Status as of January 1, 2018: I have met twice with WinCres Trout Unlimited Chapter members to solicit their participation as citizen scientists, monitoring various stream sites for water quality and invertebrates. On-site signage is being developed to accompany MN Duty Officer information cards at angler access sites. I have been interviewed via telephone by a reporter for the Rochester Post-Bulletin, and a more in-depth interview and a potential field site visit are being planned during deployment of monitoring stations. Content for the project web site is being compiled and the site is expected to go live during April/May 2018.

Status as of July 1, 2018: I and representatives from the National Trout Center have continued contacting area residents to participate in stream monitoring as citizen scientists. An article and photographs about our project appeared in the Rochester Post-Bulletin in April. We also have been interviewed by a writer for the publication "Environmental Monitor" for a future article about the project. The project web site is still not active, but should become so during the summer.

Status as of January 1, 2019: The project web site became active in late summer, with basic background information about each project activity, updates and announcements, and several photos and basic data. We soon hope to provide links to our monitoring station data after more thorough examination and verification. Invertebrate, fish, and habitat data will be added throughout the winter months.

Since this project is somewhat unique in using customized electronics and open-source software for our monitoring stations, we developed and presented a poster on station set-up and initial data acquisition at the Geological Society of America annual meeting meeting in Indianapolis November. Undergraduate Carlton Folz and graduate student Cole Weaver were the presenters, supported by Dr. Dylan Blumentritt.

We have begun organizing and analyzing some of the monitoring data collected this past summer, for presentation at several regional science meetings this coming winter and spring. These meetings will include the annual meeting of the Minnesota Chapter of the American Fisheries Society, the Driftless Area Trout Symposium, the Mississippi River Research Consortium, and the WSU Ramaley Research Celebration. We also have been asked to participate in the 100th Anniversary Celebration for Whitewater State Park in April, presenting displays and information on the Whitewater River and its fisheries to the public.

Status as of July 1, 2019: We have been posting project updates and photos on the WSU Biology Department Facebook page, because it has much greater regional "traffic" than the project web site created last year. We will continue to post info on the project web site, but will use the Biology Facebook page for more frequent posts.

We analyzed, organized, and presented project data as two posters during spring 2019. Both posters were presented to the general public at the 100th Anniversary Celebration for Whitewater State Park (Elba, MN), and to the aquatic science community at the 51st Annual Meeting of the Mississippi River research Consortium (La Crosse, WI). We also had plans to present the poters at the joint annual meeting of the Minnesota and Dakota Chapters of the American Fisheries Society (Fargo, ND), but a blizzard and closed roads prevented us from traveling. One poster was titled "35 Years of Land Management: Is the Whitewater River in SE MN Still Impaired by Total Suspended Sediment?" For this poster, graduate student Cole Weaver used turbidity data collected at the six monitoring stations during 3 to 8 run-off events per station during 2018 to estimate the exposure of salmonids to potentially harmful levels (concentration X duration) of suspended sediments. He concluded that some sites within the Whitewater River still experience suspended sediment that can cause moderate to major physiological stress to salmonids. A second poster was titled "A Survey of Brown Trout Spawning in the Whitewater River and Garvin Brook in Southeastern Minnesota". For this poster, grad student Will Varela compared Brown Trout spawning redd data from the three forks of the Whitewater River near our water monitoring stations with redd data from nearby Garvin Brook. He concluded that trout redds in the Whitewater River were placed in faster and deeper water, and were less likely to be under cover, compared to those in Garvin Brook.

In addition to those two meetings, project personnel (Cole Weaver, Will Varela, Neal Mundahl) attended the Driftless Area Trout Symposium (La Crosse, WI) organized by Trout Unlimited. We were able to connect and interact with personnel from multiple state and federal agencies, and discuss our on-going Whitewater River project with individuals from the Minnesota DNR, Minnesota Pollution Control Agency, USFWS, Trout Unlimited, Wisconsin DNR, and others.

Status as of January 1, 2020: We have continued posting project updates and photos on the WSU Biology Department Facebook page. Posts have included information and photos from field work, citizen scientist training and fieldwork, and public outreach.

During autumn 2019, U of MN graduate student Meghan O'Connor analyzed, organized, and presented project data in a poster at two separate meetings. Her poster was titled "Detection of Strobin Fungicides in Aquatic Environments", and was presented in October at the Water Resources Conference in St. Paul, and again in November at the 34th Annual Conference on the Environment in Minneapolis. Her poster focused on fungicide concentrations within the Whitewater River, comparing fungicide concentrations between baseflow and rain events, among stream locations, and among rising, peak, and falling stages of each run-off event. She concluded that fungicide concentrations were higher during rain events, that different fungicides were higher in some river forks than in others, and that there was no pattern in fungicide concentration relative to run-off stage.

WSU graduate students Cole Weaver and Will Varela gave an informal, public presentation on their project work during "Island City Science" in December at Island City Brewing Company in Winona. Cole spoke about his work on fungicides during rain events in the Whitewater River, and Will talked about his work on fish, invertebrate, and stream habitat surveys in the various river forks. Both students focused on the rationale for the project and gave preliminary results.

Project personnel have been invited to give presentations at the Driftless Area Symposium being planned and organized by Trout Unlimited for early February 2020 in La Crosse. Tentative titles for the presentations are "Does Current Agricultural Fungicide Use Present a Threat to Driftless Area Streams?", to be presented by Cole Weaver, and "Fish Communities and Habitat Assessment at the Reach Scale in the Whitewater River System", to be presented by Will Varela.

Cole Weaver currently is writing his Master's thesis, focused on fungicide concentrations and other data collected by our 6 monitoring stations within the Whitewater River. He hopes to complete and defend his thesis during February or March 2020.

Status as of July 1, 2020: We have continued posting project updates and photos on the WSU Biology Department Facebook page. Posts have included information and photos from field work, citizen scientist training and fieldwork, and public outreach.

Volunteer citizen scientists also worked with the staff of the Izaak Walton League/Upper Mississippi River Initiative (UMRI) to present on citizen science organizing as part of a national Save Our Streams (SOS) webinar, in June 2020:

https://www.youtube.com/watch?v=Ps3fkcoo9LE&feature=youtu.be.

Project personnel gave oral presentations at the Driftless Area Symposium (organized by Trout Unlimited) during February 2020 in La Crosse, WI. Titles for the presentations were "Does Current Agricultural Fungicide Use Present a Threat to Driftless Area Streams?", presented by Cole Weaver, and "Fish Communities and Habitat Assessment at the Reach Scale in the Whitewater River System", presented by Will Varela.

Cole Weaver wrote and defended his Master's thesis, focused on fungicide concentrations and other data collected by our 6 monitoring stations within the Whitewater River, during February 2020 (his thesis is included as an attachment along with this report).

U of MN graduate student Meghan O'Connor completed her analyses of water samples as part of her dissertation research, and completed and defended her dissertation juring June 2020. Chapter 4 of her dissertation described her results (Chapter 4 of her dissertation is included as an attachment along with this report). The complete data set is available online: http://hdl.handle.net/11299/214038.

Drs. William Arnold and Dylan Blumentritt will be taking the lead on the development of two or more manuscripts (for submission to peer-reviewed scientific journals) based on the fungicide results from this project, using Meghan O'Connor's dissertation and Cole Weaver's thesis as templates.

Status as of January 1, 2021: William Varela wrote and defended his Master's thesis, focused on relationships among instream and riparian habitat variables and the macroinvertebrate and fish communities at 60+ sites throughout the Whitewater River system, during October 2020 (his thesis is included as an attachment along with this report).

After discussion between WSU and the U of MN, it was decided that Cole Weaver, assisted by Drs. Dylan Blumentritt and Neal Mundahl, will lead the effort to develop one or two manuscripts combining his fungicide research results with those of Meghan O'Connor (paper[s] will focus on widespread presence of fungicides during all seasons and the lack of pattern between fungicide concentrations and stream discharge). That effort has begun, with a goal of submitting to an environmental management journal by March/April. Will Varela also is working on the first of two possible manuscripts from his thesis (paper will focus on lack of relationships among macroinvertebrate communiites and stream habitat variables, suggesting past loss of sensitive species and a failure to recolonize after habitat improved over time).

Final Report Summary: Products resulting from this project have been disseminated via web sites, training workshops for citizen scientists, newspapers, community presentations, on-site signage at stream access sites, presentations at regional science meetings, two Master's theses, and a chapter in a PhD dissertation. Manuscripts for possible publication in peer-reviewed scientific journals are being written for future submission.

Project activities have been posted for public viewing on two different web sites. Initially, early project accomplishments and notices were posted to a stand-alone project website: (http://course1.winona.edu/nmundahl/WhitewaterProject.htm). Later, to expand viewership, project activities were posted to the Winona State University Biology Department Facebook page: (https://www.facebook.com/biologyWSU).

After two training workshops by Izaak Walton League staff for citizen scientists to learn stream monitoring procedures for the League's Save Our Streams program, project staff offered two additional training workshops, one at the National Trout Center and the other at Whitetwater State Park. Collectively, these training sessions certified >50 citizen scientists to monitor streams for basic physical, chemical, and biology variables.

A newspaper article and photographs about our project appeared in the Rochester Post-Bulletin in April 2018. Additional articles including final project outcomes are anticipated.

WSU graduate students Cole Weaver and Will Varela gave an informal, public presentation on their project work during "Island City Science" in December 2019 at Island City Brewing Company in Winona. Cole spoke about his work on fungicides during rain events in the Whitewater River, and Will talked about his work on fish, invertebrate, and stream habitat surveys in the various river forks. Both students focused on the rationale for the project and gave preliminary results. Will Varela also gave an informal presentation on his stream monitoring research from his Master's thesis to the Win-Cres Chapter of Trout Unlimited in October 2020, focusing on relationships among instream and riparian habitat variables and the macroinvertebrate and fish communities at 60+ sites throughout the Whitewater River system.

We developed and posted information signage about fish kills and how to report them to the MN State Duty Officer at stream angler access sites throughout the Whitewater River system. Postings also included information card hand-outs which have been replenished as needed.

Project personnel made presentations about the project findings at the following scientific meetings:

- November 2018: Annual Meeting of the Geological Society of America (Indianapolis, IN)
- April 2019: 100th Anniversary Celebration for Whitewater State Park (Elba, MN) - 2 presentations
- April 2019: 51st Annual Meeting of the Mississippi River Research Consortium (La Crosse, WI) - 2 presentations
- October 2019: Water Resources Conference (St. Paul, MN)
- November 2019: 34th Annual Conference on the Environment (Minneapolis, MN)
- February 2020: Trout Unlimited Driftless Area Symposium (La Crosse, WI) - two presentations

Four posters presented at some of these meetings can be accessed via links on this website: http://course1.winona.edu/nmundahl/WhitewaterProject.htm

Graduate students working on the project produced three documents devoted to project findings. These included two Master's theses at Winona State University and a chapter in a PhD dissertation at the University of Minnesota. These documents have been submitted via email along with this final report. In

addition, information from these documents currently is being summarized for inclusion into manuscripts for possible publkication in peer-reviewed scientific journals.

VI. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview:

***This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.**

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 176,750	- Neal Mundahl, Project Manager (84% salary, 16% benefits); 3 weeks each summer for 3 years ($29,250) - Jennifer Biederman, Aquatic Ecologist (84% salary, 16% benefits); 3 weeks each summer for 3 years ($21,750) - Dylan Blumentritt, Hydrologist (84% salary, 16% benefits); 3 weeks each summer for 3 years ($21,750) - 2 Winona State University Graduate Research Assistants, field work and data collection (58% salary, 42% benefits); 50% FTE each for each of 2 years ($104,000)
Professional/Technical/Service Contracts:	$ 149,000 $ 7,200	- U of MN Dept. of Civil, Environmental, and Geo-Engineering (graduate research assistant for 2 years [$90,000], faculty supervision [$19,000], pesticide analyses of water & sediment samples [$40,000]) - National Trout Center intern (citizen scientist training, oversight)
Equipment/Tools/Supplies:	$ 20,280	Surface water testing kits and supplies ($8,000), and invertebrate sampling gear ($2,000) for citizen scientists; waders and invertebrate sampling supplies for baseline stream surveys ($2,280); supplies/tools for monitoring station set-up and maintenance ($8,000)
Capital Expenditures over $5,000:	$ 97,000 $ 9,780 $ 15,000	- Water quality/weather monitoring/sampling stations (6 stations @ $16,167 each – competitive bid to select vendor) - Backpack electrofishing combo - Acoustic Doppler velocimeter to determine velocity, discharge, and rating curves at monitoring sites
Printing:	$ 2,940	Informational cards (State Duty Officer info for reporting fish kills); informational signs for stream access points
Travel Expenses in MN:	$ 7,050	Mileage (maintain monitoring stations, transport samples to Minneapolis for analyses, coordinate citizen scientist activities, conduct baseline surveys)

Other:	$ 15,000	WSU Southeast Minnesota Analytical Services (water quality analyses: nutrients, solids, bacteria)
TOTAL ENRTF BUDGET:	**$ 500,000**	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000:

- Water quality/weather monitoring/sampling stations (6 stations @ $16,167 each): These stations will be established during the first year of the project and will continue in service throughout the project period and beyond. Oversight and maintenance after the project period will be provided by staff from WSU, with possible assistance from MN DNR and USDA-NRCS staff. Equipment may be relocated to other streams as needed after the project period to provide additional data on other watersheds.
- Backpack electrofishing combo: This equipment will be used throughout the project period and beyond for fish surveys within the project area. After the end of the project period, fish surveys will continue within the project area to keep baseline data updated and current. These continuing surveys will be conducted by WSU staff and students as class activities and undergraduate/graduate student research projects. Equipment likely will be used outside of the project area for similar surveys, providing additional basline data for streams within other watersheds.
- Acoustic Doppler velocimeter: This equipment will be used throughout the project period to measure stream velocity, calculate stream discharge, and develop rating curves (stage height versus discharge) at each monitoring site. These measures are required to properly calibrate monitoring station gage height measurements and translate them into discharge estimates. Measurements will be conducted by WSU staff and students. After the project period, equipment will be used as monitoring stations are relocated to additional sites either within or outside of the project area.

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2.3 FTE

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 1.4 FTE

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
TU Win-Cres Chapter (in-kind)	$ 15,000	$ 15,000	Full use of Garvin Brook water monitoring station
National Trout Center (in-kind)	$ 10,000	$ 10,000	Citizen scientist volunteers
TU Hiawatha, Win-Cres Chapters (in-kind)	$ 40,000	$ 40,000	Citizen scientist volunteers
State			
WSU Project Manager (in-kind)	$ 26,000	$ 26,000	Graduate student supervision
TOTAL OTHER FUNDS:	**$ 91,000**	**$ 91,000**	

VII. PROJECT STRATEGY

A. Project Partners

Partners Receiving ENRTF funding

- Neal Mundahl (Aquatic Ecologist, Professor of Biology, WSU Department of Biology), $29,250, program manager, graduate student supervision

- Jennifer Biederman (Aquatic Ecologist, Assistant Professor of Biology, WSU Department of Biology), $21,750, field crew & citizen scientist training and oversight
- Dylan Blumentritt (Hydrologist/Geomorphologist, Assistant Professor of Geoscience, WSU Department of Geoscience), $21,750, monitoring station installation, maintenance, and sample collection
- WSU graduate students (PSM program, WSU Departments of Biology and Geoscience), $104,000, field work, sample & data collection
- WSU Southeast Minnesota Analytical Services (WSU Department of Chemistry) $15,000, water sample analyses: nutrients, solids, bacteria
- Intern (National Trout Center [Preston, MN]), $7,200, citizen scientist training and oversight
- University of Minnesota, Department of Civil, Environmental & GeoEngineering, $40,000, pesticide analyses: water & sediment
- U of MN graduate student (U of MN Department of Civil, Environmental & Geo-Engineering), $90,000, pesticide sample processing and analyses
- William Arnold (Environmental Chemist/Engineer, U of MN Distinguished McKnight University Professor and Joseph T. and Rose S. Ling Professor, U of MN Department of Civil, Environmental & Geo-Engineering), $19,000, graduate student supervision and pesticide analysis oversight

Partners NOT Receiving ENRTF funding

- TU Win-Cres and Hiawatha Chapters (Minnesota Trout Unlimited), providing citizen scientists and full access to Garvin Brook monitoring station
- MTA members (Minnesota Trout Association), providing citizen scientists
- Area landowners (Whitewater River Watershed Project), providing citizen scientists
- Minnesota Duty Officer (Minnesota Department of Public Safety), providing call center for environmental threat reporting

B. Project Impact and Long-Term Strategy: The trout streams of SE MN, along with those in neighboring states within the Driftless Area, have a $1.1 billion annual economic impact on the region. Protecting these resources from contaminated run-off is imperative. Better understanding the threats to these streams and then managing to reduce or eliminate those threats is a critical need not being addressed by present-day stream monitoring and post-kill investigations. This project will develop and test a model for improved environmental risk detection and management. If successful, this framework can be expanded to include a wider geographic area and provide other governmental and private agencies with a better system for stream monitoring and resource protection.

Winona State University, the National Trout Center (Preston, MN), the Win-Cres and Hiawatha Chapters of Trout Unlimited, and the Minnesota Trout Association are committed to protecting the valuable coldwater stream resources of southeastern Minnesota by developing an improved approach for environmental risk detection and management for these streams. Using the Whitewater River system as a "prototype" model, project partners will apply information and methodology gained from this project to assist other regional natural resource agencies in their efforts to protect similar waters within their jurisdiction. Monitoring stations will be maintained in their original locations by WSU staff (with possible assistance from MN DNR and USDA-NRCS staff), or relocated as needed to other at-risk streams to gather additional data for other watersheds. WSU classes (e.g., Fishery Biology, Ichthyology, Watershed Science) and undergraduate and graduate research projects will be able to continue modest monitoring and management efforts on a regular schedule beyond the project period. Citizen scientists will be able to continue their water quality and stream invertebrate monitoring efforts, assuming that project partners can aquire modest funding for supplies from other sources.

C. Funding History: N/A

VIII. REPORTING REQUIREMENTS:

- **The project is for 4years, will begin on 07/01/17, and end on 06/30/21.**
- **Periodic project status update reports will be submitted January 1 and July 1 of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2021**.

IX. VISUAL COMPONENT or MAP(S): Photos of the various activities associated with this project can be accessed at this website: http://course1.winona.edu/nmundahl/WhitewaterProject.htm

Environment and Natural Resources Trust Fund
M.L. 2017 Final Project Budget

Project Title: Water Quality Monitoring in Southeastern Minnesota Trout Streams
Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 04d
Project Manager: Neal Mundahl
Organization: Winona State University
M.L. 2017 ENRTF Appropriation: $ 500,000
Project Length and Completion Date: 4 Years, June 30, 2021
Date of Report: August 5, 2021

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised Activity 1 Budget 03/13/2018	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	**Establish monitoring stations**			**Train and deploy citizen scientists**			**Conduct baseline surveys**				
Personnel (Wages and Benefits)	$73,750	$69,981	$3,769	$21,750	$15,062	$6,688	$81,250	$81,028	$222	$176,750	$10,679
Professor Neal Mundahl, Project Manager: $29,250 (84% salary, 16% benefits); 3 weeks each summer for 3 years											
Professor Jennifer Biederman, Aquatic Ecologist: $21,750 (84% salary, 16% benefits); 3 weeks each summer for 3 years											
Professor Dylan Blumentritt, Hydrologist: $21,750 (84% salary, 16% benefits); 3 weeks each summer for 3 years											
2 Winona State University Graduate Research Assistants, field work and data collection: $104,000 (58% salary, 42% benefits); 50% FTE each for each of 2 years											
Professional/Technical/Service Contracts											
William Arnold, U of MN environmental chemist: $19,000 (75% salary, 25% benefits); 2 weeks for each of 2 years	$19,000	$19,000	$0							$19,000	$0
1 U of MN Graduate Research Assistant, sample processing and analyses: $90,000 (57% salary, 43% benefits); 50% FTE for each of 2 years	$90,000	$90,000	$0							$90,000	$0
National Trout Center (Preston, MN) Intern, citizen scientist training and oversight: $7,200 (90% salary, 10% benefits); 25% FTE for 20 weeks for each of 3 years				$7,200	$2,442	$4,758				$7,200	$4,758
U of MN Dept. of Civil, Environmental, & Geo-Engineering (pesticide analyses: water, sediment, 400 samples @ ~$100/sample, with 6-10 chemicals screened/sample): $40,000	$40,000	$23,550	$16,450							$40,000	$16,450
Equipment/Tools/Supplies											
Surface water testing kits and supplies for citizen scientists (20 kits @ $400 each)				$8,000	$7,174	$826				$8,000	$826
Invertebrate sampling gear for citizen scientists (20 sets @ $100 each)				$2,000	$1,378	$622				$2,000	$622
Waders for baseline stream surveys (2 @$135 each), invertebrate sampling supplies for baseline stream surveys (2 Hess samplers @$625 each, 20 gallons ethyl alcohol preservative @$190/5 gallons)							$2,280	$2,079	$201	$2,280	$201
Supplies for monitoring station placement (e.g., platform construction materials) and supplies/tools for monitoring station set-up and maintenance	$8,000	$2,210	$5,790							$8,000	$5,790
Capital Expenditures Over $5,000											
Water quality/weather monitoring/sampling stations (6 stations, continuous & rain-event-triggered @$16,167 each - competitive bid to select vendor)	$97,000	$94,419	$2,581							$97,000	$2,581
Acoustic doppler velocimeter (for measuring current velocity, calculating discharge, and develop rating curves [stage height vs. discharge] at each monitoring station site @$15,000 - obtain multiple bids to select vendor)	$15,000	$10,004	$4,996							$15,000	$4,996
Backpack electrofishing unit combo (Smith-Root LR-24 electrofisher, electrodes, 2 batteries, charger) @$9,780							$9,780	$7,446	$2,334	$9,780	$2,334
Printing											
Printing informational cards (State Duty Officer info for reporting fish kills): 1000 cards for $60; informational signs for stream access points: 60 sign/post combos @ $48 each - $2,880; both to include QR code for cell phones				$2,940	$1,088	$1,852				$2,940	$1,852
Travel expenses in Minnesota											
Mileage (To maintain monitoring stations, transport water/sediment samples to Minneapolis for analyses, coordinate citizen scientist activities, conduct fish/invertebrate surveys; ~15,000 miles @ $0.47/mi)	$4,000	$4,000	$0	$2,050	$632	$1,418	$1,000	$1,000	$0	$7,050	$1,418
Other											
Winona State University Southeast MN Analytical Services (nutrient, solids, bacteria analyses, 500 samples @ $30/sample)	$15,000	$9,289	$5,711							$15,000	$5,711
COLUMN TOTAL	**$361,750**	**$322,453**	**$39,297**	**$43,940**	**$27,777**	**$16,163**	**$94,310**	**$91,552**	**$2,758**	**$500,000**	**$58,218**