Environment and Natural Resources Trust Fund

M.L. 2024 Approved Work Plan

General Information

ID Number: 2024-250

Staff Lead: Lisa Bigaouette

Date this document submitted to LCCMR: June 7, 2024

Project Title: Water Quality and Robots: Experientially Educating Minnesotan Youth

Project Budget: $353,000

Project Manager Information

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Project Reporting

Date Work Plan Approved by LCCMR: June 20, 2024

Reporting Schedule: June 1 / December 1 of each year.

Project Completion: June 30, 2026

Final Report Due Date: August 14, 2026

Legal Information

Legal Citation: M.L. 2024, Chp. 83, Sec. 2, Subd. 05s

Appropriation Language: $353,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to provide opportunities for middle school youth to develop skills for measuring water quality using robotic water-quality sensing kits and communicating results through group study and hands-on projects.

Appropriation End Date: June 30, 2027

Narrative

Project Summary: We propose robotics-based educational activities for middle-school youth on water quality in Minnesota. Youth will gain skills for measuring water quality and communicating results through group study and hands-on projects.

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

While water quality is central to the health of Minnesotan watersheds and the general population, there is a general lack of education on the subject and an absence of inexpensive, accessible tools for water quality sensing. The ubiquity of water bodies across the state, however, and the availability of inexpensive water quality sensors, have created a significant opportunity to expand water quality awareness and to develop monitoring tools accessible to local communities.

We see an opportunity for Minnesota's youth to engage with water quality challenges while investigating innovative ways to measure water quality. Increasingly, young Minnesotans are paying attention to issues of pollution and climate, while educational networks serving youth are well-established statewide. The 4-H program at the University of Minnesota (UMN), for instance, reaches tens of thousands of youth annually, while High Tech Kids, a STEM-focused nonprofit, reaches over 5,000. What is needed is an engaging program delivered through these networks that equips youth to steward Minnesota's water bodies. By combining the networks of our partners in youth outreach with UMN's expertise in water quality sensing and robotics, we are confident that we can help the next generation learn to better understand and care for our natural resources.

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

We propose a multi-faceted learning experience for the youth of diverse backgrounds and demographics centered around water quality issues pertinent to Minnesota. We will leverage virtual communication technology and our partners' network and expertise in youth education to create learning communities that will facilitate student-to-student collaboration and expert-to-student coaching and mentoring on water quality sensing topics. Students will apply the ideas they learn by assembling innovative, low-cost robotic systems and using them to measure the water quality of local watersheds. The application of learning activities to the real world will be accomplished by making the measurement data available to local water quality stakeholders. Field experts at UMN's Minnesota Robotics Institute (MnRI) will use on-campus immersion experiences to further demonstrate to youth the value of underwater robotics and sensing in addressing challenging water quality issues.

As a prerequisite to creating this opportunity for youth, we propose developing an inexpensive robotic water quality sensing kit. Feedback gathered from the student's use of the kits will inform improvements. The goal is to design a kit that empowers citizens to collect high-value water quality data using inexpensive, readily available and easily assembled parts.

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

By engaging youth in authentic water quality issues through this proposed program, we aim to equip 150 young people as citizen scientists with the skills for (i) building innovative, accessible water quality sensing equipment, (ii) measuring water quality indicators, and (iii) sharing water quality knowledge and data effectively with stakeholder audiences. A by-product of these outcomes is a field-tested design of a low-cost water quality monitoring kit that citizens can build and use. These outcomes promote the democratization of environmental data collection and lower the barriers to entry, enabling the concerned citizen to study and care for Minnesota's watersheds actively.

Project Location

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

Statewide

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

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Develop and Plan Educational Hands-on Programs

Activity Budget: $159,583

Activity Description:
We will work with statewide youth educator partners (High Tech Kids/ UMN Extension) to design a free summer program with experience in critical topics and themes connected to current significant water quality challenges. During the design process, we will identify at least 30 viable sampling locations at watersheds statewide as target locations to be visited during hands-on activities. We will then integrate program themes into several topic-specific learning tracks. To prepare for the hands-on part of the program, we will design the water quality sensing kit, select sensor hardware, and create software. We will employ feedback from our youth educator partners to balance system sophistication and usability, write supporting documentation on kit assembly, assemble a bank of kits, and develop kit distribution methods that account for team location and access to technology. The kit will include sensors that measure water temperature, turbidity, and pH, among other parameters, and these parameters will be linked to basic concepts of mathematics, physics, and chemistry. We will train local experience coordinators (teachers/chaperones) in a 3-day workshop on water quality content and the essentials of assembling the sensor kits. Background checks for minor safety will be conducted for all parties involved in youth education.

Activity Milestones:

Description	Approximate Completion Date
Build partnerships, promote program design meetings, identify 30 local data collection sites.	September 30, 2024
Design program structure, identify key topics and learning tracks.	October 31, 2024
Design and validate sensor kit, develop distribution options, procure and assemble kit components.	January 31, 2025

Activity 2: Create Learning Communities

Activity Budget: $105,147

Activity Description:
We will identify and train local experience coordinators (Teachers/Chaperones) through contacts at High Tech Kids and UMN Extension, who will monitor the interactions between students and domain experts (faculty and staff). Their role is critical since they will manage students' learning needs and the technology immersion requirements. The 3-day training workshop will provide materials and resources explaining how to direct the learning communities on water quality and robotic sensing topics. We will also create learning tracks that break down issues and encourage student-to-student knowledge sharing and collaboration.

Robotics is a powerful tool for experiential learning, but there are several obstacles: (i) students from underrepresented groups often do not have easy access to robotics resources; (ii) designing robotic experiments for science-based water quality topics is complex; and (iii) system affordability and accessibility to all students has not always been a priority. Our learning communities will have the flexibility of online content delivery and mailing kits, allowing groups to be reconfigured into subgroups that will execute the different tasks. The requested resources will overcome these obstacles by providing students with access, directions, and hardware to complete the design and implementation of robotics experiments.

Activity Milestones:

Description	Approximate Completion Date

Identify local experience coordinators through educational partners.	December 31, 2024
Provide program information, resources, materials, and learning tracks to students throughout the state.	April 30, 2025
Host a 3-Day Training Workshop for 35 local Coordinators (Teachers and Chaperones).	May 31, 2025
Provide virtual correspondence between learning track groups and domain experts.	June 30, 2025
Facilitate cross-track sharing of studies.	September 30, 2025

Activity 3: Program Implementation and Evaluation

Activity Budget: $88,270

Activity Description:

We will carry out the free summer water quality education programs for the target participation of 150 students to conduct sampling experiments at 30 sites across the state. We will send education materials and sensor kits to local experience coordinators. MnRI robotics and sensing experts will provide coaching on sensory system design and assembly via a flexible combination of face-to-face and virtual communication, according to team location. Before site visits, training will be administered regarding all Minnesota Department of Natural Resources compliance safety procedures and standardized data collection methods.

MnRI will provide the top 5 team students with on-campus opportunities to interact with domain experts and to use the students' sensor kit designs onboard a research laboratory underwater robot. Water quality data collected throughout the program will be aggregated, processed, and made available for documenting water quality. The educational partners will monitor, evaluate, and work with MnRI to improve the methods used. Online surveys of students and other stakeholders will be conducted to provide feedback on the concepts or sensors that excite the students and on the ones that fail. A revised set of activities and sensors will be created and shared with the broader community.

Activity Milestones:

Description	Approximate Completion Date
Supply sensor kit to all participants and local coordinators	June 30, 2025
Host on-campus immersion session for the top 5 teams, AUV interaction, and on-site data collection	August 31, 2025
Aggregate and process measurement data, re-publish to teachers and stakeholders for environmental education.	September 30, 2025
Collect post-experience feedback from students and local coordinators	February 28, 2026
Analyze the post-experience feedback and publish the results	June 30, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Prof. David Mulla	Department of Soil, Water, and Climate, UMN	David is a world-renowned scientist in water quality issues and precision agriculture. Since January 2004, he has been the Director of the Precision Agriculture Center at UMN. He will oversee the project efforts in water quality by selecting the parameters and sensors used by the students.	Yes
Prof. Junaed Sattar	Department of Computer Science and Engineering, UMN	Junaed is an associate professor of Computer Science and Engineering and the founding director of UMN's Interactive Robotics and Vision Laboratory. He specializes in all aspects of autonomous underwater robotics. His underwater robotics student camps gather hundreds of students annually. He will coordinate the underwater robotics aspects of the project.	Yes
Margo A. Bowerman	UMN Extension Center for Youth Development	Margo is the Co-Chair of the Minnesota State 4-H STEM Team, and oversees STEM programming in the northwest region of MN. She has expertise in creating high quality, scaffolded learning experiences for youth from kindergarten to one year past high school. She will review the education activity design.	Yes
Cheryl Moeller	High Tech Kids	Cheryl has worked for nearly 20 years in informal STEM education. She is the Executive Director at High Tech Kids, a Minnesota nonprofit offering K-12 STEM programs in robotics to over 5,000 Minnesota students each year. High Tech Kids will coordinate students and volunteers to participate in the proposed.	Yes
Travis Henderson	Minnesota Robotics Institute, Department of Computer Science & Engineering, University of Minnesota (UMN)	Travis is a research engineer and STEM outreach program coordinator at MnRI. His experience combines work on designing and building robots for environmental monitoring with outreach to youth through developing and leading STEM education efforts. He will have the same roles in this project.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
Tasks in activity 3 of the proposal focus on producing and publishing a corpus of data; these data are the water quality metrics gathered by students through hands-on experiments with water quality sensing kits. These are the steps we will perform to disseminate the data:
1. We will validate the credibility of the data against existing datasets, such as the Minnesota Pollution Control Agency (MPCA), the Minnesota Lake Browser, etc.

2. We will make adjustments based on this validation step,

3. We will create a web-based portal to share the data with the public, with the help of the University of Minnesota's College of Science & Engineering Information Technology staff. In the meantime, we will make sure this portal satisfies the data management requirements/protocols of the University and the state. Access to the portal will be open to the public, without a need for a password or credentials. Our group has significant experience with the dissemination of data to the public (for example, our work in the dissemination to the public of truck stop parking availability data throughout the state of Minnesota and other states).

The funding from the Environment and Natural Resources Trust Fund will be acknowledged through the use of the trust

fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENTRF Acknowledgment Guidelines.

For the long-term implementation, we will make the plans, and bills of materials available to the educational community under open-source guidelines (from Activity 3, and for five years after, the public will be able the access them at a Minnesota Robotics Institute outreach website with no fees through simple authentication protocols).

Long-Term Implementation and Funding

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

We are determined to ensure that the effects of this effort extend far beyond the funding window. The data collected from watersheds across the state will be processed and made available to environmental educators and researchers in relevant institutions for the purposes of developing data-informed educational materials and strengthening watershed scientific models. In addition, the feedback gathered from the program evaluations will be used to improve the sensor kit hardware, software, and system documentation. To encourage statewide democratization of environmental data collection, plans and bills of materials will be made available to the educational community under open-source guidelines.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Nikos Papanikolopoulos- Principal Investigator/Project Manager		Management of the Project and related activities			36.8%	0.04		$38,528
Junaed Sattar- Co-Investigator- Robotics Lead		Coordinate the robotics activities.			36.8%	0.08		$41,434
David Mulla- Co-Investigator - Water Quality Leader		Coordinate the water quality activities.			36.8%	0.04		$26,839
Travis Henderson- Project Coordinator		Assist with robotic hardware design/prototyping; coordinate activity development.			36.8%	0.16		$43,936
Margo Bowerman - Youth Development		Consult for youth-oriented activity development.			36.8%	0.04		$1,087
One Graduate Research Assistant at 25% from CS&E		Assist with water quality sensing kit design.			24.1%	0.3		$54,229
One Graduate Research Assistant at 25% from CFANS		Assist with water quality parameter selection & data processing.			24.1%	0.3		$56,821
							Sub Total	**$262,874**
Contracts and Services								
High Tech Kids	Sub award	Fund the cost of High Tech Kids' Youth Coordination responsibilities in this proposed work.				0.3		$15,295
							Sub Total	**$15,295**
Equipment, Tools, and Supplies								

	Tools and Supplies	The kit includes sensors for temperature, pH, turbidity, and dissolved oxygen. Additional costs include a compute board, electronics protector case, power source, and various consumables necessary for assembly.	Robot kits for 150 students. These will be used by the participating students for data collection.					$63,248
							Sub Total	**$63,248**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel costs associated with milestones in Activity 3: First, 3-day Workshop training - 35 local experience coordinators (2 days will be online training and 1 day will be an in-person building session). Second, we will have - 5 volunteers and 20 youth participants from the top 5 teams for a one day in-person immersion experience at UMN-TC. Allocations (per person-day): Miles: $50 Meals: $50 Lodging: $100	Funds for youth participants and adult volunteers to travel the the UMN Twin Cities campus for two separate events	X				$11,583
							Sub Total	**$11,583**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$353,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel In Minnesota	Miles/Meals/Lodging	Travel costs associated with milestones in Activity 3: First, 3-day Workshop training - 35 local experience coordinators (2 days will be online training and 1 day will be an in-person building session). Second, we will have - 5 volunteers and 20 youth participants from the top 5 teams for a one day in-person immersion experience at UMN-TC. Allocations (per person-day): Miles: $50 Meals: $50 Lodging: $100	The travel cost is generally ineligible but is necessary for the project to (1) train the local experience coordinators and (2) provide travel for students and coordinators to attend the on-campus immersion experience.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Attachments

Required Attachments

Visual Component

File: 9494020c-e82.pdf

Alternate Text for Visual Component

The visual highlights the overarching theme of the proposal, the stakeholders, the water quality challenges, and the project objectives....

Supplemental Attachments

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

Title	File
Budget Justification	482f1bce-7f1.pdf
Approval to Submit Proposal- 1101631 Papanikolopoulos LCCMR	495bd7ba-173.pdf
ECL Letter of Support	7005a3d3-25f.pdf
Northarvest Support Letter	773666cb-436.pdf
4-H State STEM Team Support Letter	e4d78e69-dcf.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

The only change made is the addition of a plan for disseminating the water quality data gathered through this project's activities.

Additional Acknowledgements and Conditions:

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

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

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the UMN Policy.

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

No

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

N/A

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

N/A

Does your project include original, hypothesis-driven research?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

Yes

Do you certify that background checks are performed for background check crimes, as defined in Minnesota Statutes, section 299C.61, Subd. 2, on all employees, contractors, and volunteers who have or may have access to a child to whom children's services are provided by your organization?

Yes