Task 1. Request for Proposals:
Stormwater Management for Community Resilience

2024

Task proposed and developed by:
- EPA Office of Research and Development – Silver Sponsor
- New Mexico Space Grant Consortium – Diamond Sponsor
- NASA SMD Earth Science Division
- CDM Smith
- Souder, Miller, & Associates

Task:
Your team is challenged to develop an innovative stormwater management project that will mitigate the effects of extreme wet weather events while providing social, environmental, and economic co-benefits to disadvantaged communities. Solutions should be low cost and empower marginalized communities by providing sustainable assets that support community well-being and resilience. Nature-based solutions that can manage large flows while providing passive treatment are encouraged.

Background
Climate change is resulting in increasingly extreme weather events, and the water infrastructure of many municipalities was not built to handle these large quantities of water [1]. As a result, surface runoff during wet weather events can threaten our water security through challenges related to both water quantity (e.g., flooding, erosion) and quality (e.g., degradation of surface waters [particulates, contaminants, etc.], and combined sewer overflows [CSOs]).

These impacts of climate change fall disproportionately on low-income communities, warranting the need for Environmental Justice (EJ) and Climate Justice (CJ). Disadvantaged communities are often located near urban waterways with impervious surfaces and nearby contamination sources (e.g., industrial sites, parking lots, highways, sewer overflow structures, waste water treatment plants). As such, they are particularly vulnerable to storm impacts, while also being poorly positioned to address these issues, given limited resources and other competing challenges.

Teams should seek an innovative low-cost system that focuses on practical implementation and minimal land-use disruption. That said, consider that the ideal stormwater management project will also provide community co-benefits such as increased green space for social and recreational activities, heat island mitigation, reduced neighborhood blight, and/or economic redevelopment opportunities. The Water Environment Federation's recently updated report that outlines their vision for US stormwater management may be helpful when developing stormwater management plans [2].

<u>Site Identification</u>
Teams will identify a stormwater issue of concern based on their own local needs or on the needs of a selected community that could most benefit from their solution. Important location considerations include the technical stormwater parameters; the historical stormwater challenges and needs of the targeted community; the preservation of local waterways; and the potential social, environmental, and economic benefits and co-benefits of the planned solutions to a community with EJ/CJ concerns. Implementation plans should incorporate low-cost, high-impact solutions with consideration to the cost/benefit ratio of the solution, potential resources available to the community, and practicality of implementation by that community.

The technical aspect of site assessment requires collecting and evaluating data for the area of interest to address the nature, scale, and frequency of storms and the local conditions that create challenges during storms. Calculations should address representative storm events for both routine and extreme conditions [3], and may include estimating the percent area of impermeable surfaces, determining the flow rates/volume of water and the potential amounts of contaminants that may affect community infrastructure and receiving waterways. Necessary information also includes local site characteristics (e.g., space availability for green infrastructure projects) and their potential for realizing the direct benefits of flow management and/or treatment of contaminants as well as additional co-benefits (i.e., social, environmental, and economic improvements).

When selecting a site, there is no one-size-fits-all solution to water security—every community faces unique demands, infrastructure, geography, and environments. For example, coastal regions are challenged by numerous issues from storm surges, high tides, and sea-level rise, and downstream effects can include hypoxia (dead zones) from nutrient run off, CSOs and effects on fisheries. Towns in arid climates face different challenges as infrequent severe storms combined with lean, compacted topsoil results in large volumes of water runoff and severe erosion during storm events. In towns with combined sewers, overflow during a storm event releases mixed stormwater and sewage into local waterways and can cause sewer backups in low-lying homes.

See the Appendix for resources that may be helpful for assessing the issues outlined above with respect to the team's chosen community.

Innovative Stormwater Control

Since every community requires unique stormwater solutions, teams are given the freedom to design a management system that will address the needs of an EJ/CJ community in their own region or another region of interest to them.

A management system would ideally have the ability to quickly treat a large volume of water using a nature-based system or a simple engineered device that can be deployed at stormwater intakes (e.g., street drains) to remove pollutants (if applicable) and then divert the flow to a separate storm sewer system (MS4), surface water, or aquifer without negatively affecting base-line quality of the receiving water. Designs may also include an innovative buffering component to slow or temporarily store water to accommodate stormwater flows that exceed treatment capacity (note that merely adding an auxiliary tank or pond is not an innovative solution). Teams may wish to consider, but not limit themselves to, hydroinformatics approaches (see Appendix).

The goal of the task is a low-cost, high-impact solution. Keep in mind that renovating stormwater infrastructure or implementing known remedies like restored or artificial wetlands is extremely expensive and challenging, given the land use and financial constraints many municipalities face. Although an innovative, larger-scale low-cost solution may be possible, teams may wish to consider small-scale solutions that can be duplicated in multiple areas. It is also important to address the overall resiliency of a management system to future climate scenarios.

Beyond the physical issues of stormwater management, the social, environmental, and economic co-benefits of the proposed solution to the local community should be assessed. These may include, but are not limited to, economic development, providing community spaces, green spaces, heat island mitigation, watershed management, managed aquifer recharge, wetlands conservation/restoration, riparian buffers, development opportunities, agroforestry and sustainable agriculture, reduced sewer backups/overflows, improved freshwater resources, air quality improvements, etc.

Teams will develop a community engagement plan that involves the community in decision-making and addresses their needs and concerns. Plans should foster community involvement and support for the project by emphasizing its potential local benefits.

Problem statement

Your team will research, evaluate and design an innovative, low-cost stormwater management system that is resilient to future climate scenarios that can be implemented in a selected area that is challenged by EJ/CJ issues. Solutions should be able to treat large volumes of water quickly and be practical to implement within a chosen EJ/CJ community.

Design requirements

Your proposed design should provide specific details and outcomes as follows.

- Select a community for the stormwater management system, with consideration of local stormwater needs and the relationship between demographic and risk factors.
- Design a system to handle storm-related flows and potential contaminants for the area of interest during both routine and extreme precipitation events, with consideration of the trade-offs between cost and the severity of precipitation that the system can manage.
- Present a solution that minimizes environmental impact, cost, and waste generation.
- Identify locations where the solution could be effectively sited in the selected community with minimal disturbance to infrastructure or existing land uses.
- Provide a diagram illustrating the features of the project. Diagrams may include site map(s) with dimensions and specifications and/or process-flow diagrams that include mass and energy balances of the treatment process(es), water flows, etc., as applicable.
- Quantify the local benefits of the proposal, including both direct physical improvements and any social, environmental, and economic co-benefits, to demonstrate that the needs of the targeted community and its local waterway are preserved.
- Develop an appropriate community engagement plan.
- Discuss project implementation, including permitting, safety, and regulatory compliance.
- Present a Techno-Economic Assessment and Analysis (TEA) to construct your proposed stormwater project. Target the stormwater management solution towards community needs, with the community or local government being the customer. Consider capital expenses and operating expenses, according to typical costs in the community you are addressing and include a cost/benefit analysis to assess the potential benefits to the community. Inviting a business/economics major as part of a multi-disciplinary team may be helpful as you draw up economic plans for full-scale implementation.
- To be considered for the WERC P2 Award, in a separate section of the report (titled "Pollution Prevention"), document success in improving energy efficiency, pollution prevention, and/or waste minimization, as it applies to your project.
- Address safety aspects of handling stormwater and any waste products. Safety issues for the full-scale design should be addressed in the written report. Safety issues for the bench-scale demonstration should be addressed in both the written report and the Experimental Safety Plan (ESP).

Bench Scale Demonstration

Bench-scale demonstrations will serve to illustrate the design considerations listed above and will consist of a three-dimensional scale model and/or a digital/virtual simulation to demonstrate functionality of the solution. The bench-scale demonstration will illustrate the selected stormwater issue, the proposed stormwater management system, and the system's effect(s) on the community.

<u>Teams will provide at contest</u>

A three-dimensional scale model, and/or equipment needed to display simulation(s). If the apparatus will remove contaminants from the water, teams will provide the contaminant materials, subject to ESP approval.

Provided at contest

Although teams will provide the majority of items needed for the bench-scale demonstration, WERC can provide bulky items such as kiddie wading pools, 18L-carboys of water, etc. to aid the teams in their demonstration. Submit requests to WERC by March 1, 2024 for items needed to run the bench-scale demonstration at the contest. (See Team Manual).

Analytical Testing of the Bench-scale Demonstration

If your team would like to demonstrate removal of any contaminants during the bench-scale demonstration, WERC can provide analytical testing as requested. The ESP (see below) and 30% Project Review should outline testing needed at the contest.

30% Project Review

Submission date: March 1, 2024 (you may submit earlier if you wish to receive feedback sooner).

Submit the 30% Project Review as early as possible. It should not exceed four pages. Although the review is not scored, your team will receive feedback from the judges for improving your project. You are allowed to change your plans after submitting it. Include as many items listed below as possible. The more detail provided in your review, the better direction you will get from the judges. (See Team Manual for more information.)

As available, please include:

- ***Table of Contents*** planned for the technical report (place topics in order, one line per topic)
- ***A brief description of your project:*** One bulleted list outlining: planned solution to the problem and any anticipated drawbacks.
- ***The current schematic of your planned process flow or block diagram*** with mass and energy balances, as available.
- ***Preliminary data and/or calculations that support the proposed design.*** This might include expected chemical reactions (reactants, reaction times, etc.), flow volumes and rates, etc.
- ***Any cost estimates that show feasibility of the project.*** This will give your team and the judges a chance to consider modifications that might improve feasibility of the project.

Experimental Safety Plan (ESP)

Submission date: February 15 - 24, 2024

The ESP outlines your team's plans for safely operating your bench-scale demonstration at the contest. This document is submitted in February (see dates below). Instructions are provided in the team manual. The Team Leader, or a designated team member, shall attend a mandatory short course that outlines the ESP process. Teams will not be able to run a bench-scale demonstration if the ESP is not received by the deadline. Your team should follow your school's safety procedures while conducting tests prior to attending the contest.

Evaluation Criteria

Each team is advised to read the 2024 Team Manual for a comprehensive understanding of the contest evaluation criteria. As described in the manual, there are five events: a written report, a formal oral presentation, a demonstration of your technology using a bench-scale representation, a poster presentation, and a Flash Talk. Evaluation criteria used by the judges are described in the Team Manual.

For a copy of the Team Manual, Public Involvement Plan, and other important resources, visit the WERC website: Guidelines | werc.nmsu.edu

Judges will evaluate your team's response to the problem statement, with consideration of:

- The effectiveness of your bench-scale demonstration in communicating your team's solution and how it integrates into the chosen community.
- Broader contextualization within a community project that utilizes technology to improve socioeconomic conditions and enhance resilience.
- Potential for real-life implementation (ease of operation and maintenance, affordability, etc.).
- Thoroughness and quality of the technical analysis.
- Thoroughness and quality of the economic analysis.
- Originality and innovation represented by the proposed technology.
- Other specific evaluation criteria that may be provided at a later date (watch the FAQs online).

Short Courses

WERC is offering two short courses:

- ***Mandatory:*** Preparing the Experimental Safety Plan. The Team Leader, or a person assigned by them, must attend the course prior to submitting the ESP (and before February 20, 2024).
- ***Optional:*** Environmental Health and Safety (EH&S) Topics. The course is designed to prepare teams to complete the EH&S portion of their technical report. Course fees will be waived for contest-registered students, faculty, and judges. Watch the WERC website for schedules and registration information. Individuals who complete the course can earn a digital badge to add to their professional development portfolio.

Dates, Deadlines, FAQs (*dates subject to change—watch website FAQs*)

- Today: Email us to let us know you are interested in this task. We will contact you with breaking news.
- October 15, 2023 - December 31, 2023 – Early Bird Registration (discount applies).
- December 1, 2023 - March 31, 2024: Optional On-demand Course: WERC Safety and Environmental Topics. See Team Manual for more information.
- December 1, 2023 - February 20, 2024: Mandatory On-demand Course: Preparing the Experimental Safety Plan. See website and Team Manual for information.
- February 15, 2024: Submit requests for water and ancillary equipment to werc@nmsu.edu
- February 15 - 24, 2024: Experimental Safety Plan (ESP) due.
- March 1, 2024: 30% Project Review due.
- March 8, 2024: Final date to register a team.
- March 31, 2024: Technical Report due
- Weekly: Check FAQs weekly for updates:
    - Task-specific FAQs: 2024 Tasks/Task FAQs
    - General FAQs: 2024 General FAQs
- All dates or task requirements are subject to change. Check FAQs for updates online.

References

[1] What is an "extreme event"? Climate.gov. October 2020. What is an "extreme event"? Is there evidence that global warming has caused or contributed to any particular extreme event? | NOAA Climate.gov

[2] Rainfall to Results: The Future of Stormwater. Updated July 2023 *https://stormwater.wef.org/2023/07/updated-rainfall-to-results-report-plots-course-for-future-of-u-s-stormwater-sector/*

[3] Extreme weather. USDA Climate Hub. https://www.climatehubs.usda.gov/content/extreme-weather

Appendix:

Resources

Although the list below is not all-inclusive, the resources below can help your team quantify the benefits and co-benefits of stormwater solutions as you begin your site search.

1. EJ/CJ tools to assess relationship between demographic factors and storm-risk factors:
   a. EJ Screen. Environmental screening and mapping tool: https://www.epa.gov/ejscreen
   b. EnviroAtlas: https://www.epa.gov/enviroatlas

2. Remote Sensing tools:
   a. MODIS: https://modis.gsfc.nasa.gov/data/
   b. LANDSAT: https://landsat.gsfc.nasa.gov/
   c. Additional Tools: See NASA's Earth Observing System Project Science Office page NASA's Earth Observing System

3. Stormwater management tools to assess impervious area, runoff volumes, and siting grey or green infrastructure features:
   a. National Stormwater Calculator: https://swcweb.epa.gov/stormwatercalculator/
      ii. Simplest and best stormwater runoff calculator with future climate scenarios
      iii. Good cost estimates
   b. Green Values Stormwater Management Calculator: https://greenvalues.cnt.org/index.php
      i. Provides a rudimentary approach to stormwater runoff calculations, but more in-depth cost and benefit estimates (e.g., adding property value in a neighborhood)
   c. EPA's Stormwater Management Model: https://www.epa.gov/water-research/storm-water-management-model-swmm
   d. FEMA Flood Maps: https://www.fema.gov/flood-maps

Hydroinformatics

Teams interested in incorporating hydroinformatics approaches can consider: remote sensing technologies; Biofabrication for ecosystem restoration; AI and machine learning approaches to optimize the placement and sizing of different green-infrastructure technologies; Intelligent and autonomous systems that adaptively operate different green infrastructure technologies to meet different rainfall event or water quality objectives; or Bio-engineered systems for passive surface water treatment.