THE Water Research FOUNDATION

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REQUEST FOR PROPOSALS (RFP)

Integrating Climate Change Impacts with Wet Weather Management, Capital Improvement, and Stream Network Enhancement (RFP 5176)

Due Date: Proposals must be received by **3:00 pm Mountain Time**
on Tuesday, November 22, 2022
WRF Project Contact: Harry Zhang, PhD, PE, hzhang@waterrf.org

Project Sponsors
This project is funded by The Water Research Foundation (WRF) as part of WRF's Research Priority Program.

Project Objectives
- To enhance precipitation projection and modeling techniques with risk-based criteria to mitigate risks for utilities (e.g., sewer overflows, flooding, stream network deterioration)
- To advance current practices for climate change rainfall statistics and projections by region, and identify research gaps and other areas for refinement
- To advance an integrated and risk-based approach for adapting water infrastructure systems and capital improvement planning to climate change while enhancing the protection of stream networks to meet receiving water quality requirements and mitigate wet weather flows

Budget
Applicants may request up to $200,000 in WRF funds for this project.

Background and Project Rationale
Utilities and communities are being encouraged to assess wastewater, water, and stormwater infrastructure systems (including sanitary, combined, and storm sewer systems) to determine possible threats due to climate change at local and regional scales. Examples include rainfall-driven flooding, snowstorms in both cold and warm regions, hurricanes, and other extreme weather events. Climate change has undermined the basic assumption that past weather patterns are predictive of future weather patterns, impacting the development of strategies, design, and operation of stormwater, combined sewer overflow (CSO), pollution prevention, source water protection, and infrastructure programs. Methods and tools that utilities and communities can use to conduct these assessments are needed to better understand the natural and meteorological threats that could result from climate change, to project and forecast possible effects on their systems, and to design and implement capital improvements and operational changes to protect their infrastructure systems and public safety. Support is often available for communities and utilities to conduct system evaluations and develop proactive measures to reinforce and protect system performance and public safety. However, there is no established best practice model or information source that utilities can use to project future climate

change impacts. It is important to better understand climate change impacts on sewer systems (sanitary, combined, and storm) and stream networks to effectively plan for future infrastructure needs and capital improvements. The utilities need clear guidance on how to integrate capital planning with climate modeling tools and techniques to ensure system-wide solutions so that new projects are resilient in the face of future disasters.

Predicted precipitation projections, such as intensity-duration-frequency (IDF) curves, for wet weather planning are being developed from climate models. There is a wide range of predictions and uncertainty related to these projections. Decisions on selected design practices involve policy, economics, risk, and design life elements. The best design practice may involve the selection of design criteria based on the specific risk that would result should the project design criteria being exceeded. This strategy is already used for some major structures (e.g., dams and bridges). However, the criteria do not generally change within a classification of infrastructure. Several agencies are in the process of deciding on related design criteria, and creative approaches are being implemented. There is a strong need to summarize issues, advance approaches, and synthesize case studies across climate regions for consideration by agencies that set the various design standards for wet weather management and capital improvement planning. Most planning and design tools rely upon historical weather data and statistics.

One related concept is to treat stormwater / wet weather flow as a resource with economic value that can provide local water fit-for-purpose while reducing pressure on both potable and non-potable water sources and decreasing the downstream impacts during wet weather events. In water-abundant regions, the incentives and related practices for stormwater harvesting and decentralized reuse (e.g., for climate resilience and CSO volume reduction) are significantly different from those in water scarce regions. Better integrating stormwater harvesting and reuse, across different climate regions, into utility capital improvement planning and stream network enhancement in a cost-effective manner remains challenging.

The desired outcomes of this research study are: (1) identification and development of best practices for predicting climate change rainfall patterns, especially important for stormwater, flood control, and water quality management agencies; (2) development of new or enhanced methods and approaches for utilities/communities to better forecast future climate change and assess climate change impacts, especially intensified precipitation patterns, on water infrastructure systems and public safety; and (3) improvement of a utility's/community's ability to anticipate climate change so that it can adapt and plan for capital improvement, infrastructure needs, scenario analysis, and planning. The methods developed could include more effectively forecasting changes in the frequency and intensity of rainfall at local and regional scales, sea and lake level rise, and increases in water/air temperature to connect with a utility's capital improvement planning to mitigate climate risks to water infrastructure systems.

Research Approach

Throughout this project, the research team will emphasize how to better integrate future climate projections (under both warm and cold climate impacts) into currently applied planning and design tools relevant to utilities and municipalities. The research team will conduct a comprehensive literature review, including WRF's research efforts to date. In addition, the research team will evaluate the state-of-the-practice and advancement in precipitation projection and modeling techniques, with a focus on how these modeling techniques could be integrated with risk-based criteria to mitigate risks for utilities and municipalities (e.g., sewer overflows, flooding, stream network deterioration). Special consideration should be given to variations among different climate regions, including coastal communities where climate-induced sea level rise and storm surge would pose additional challenges. Different flood types

with regional variations will be considered, for example hurricane-induced extreme rainfalls (such as those that occurred during hurricanes Harvey, Katrina, Sandy, Irma, etc.), localized floods from inland rainfalls (such as in Ellicott City, MD, and Kentucky), flash storms (such as in Arizona and California), and nuisance flooding in many urban areas. Examples of related research questions include: (1) How can wet weather management strategies be better integrated with municipal capital improvement and stream network enhancement programs? (2) What would be a cost-effective approach for meeting both regulatory requirements and design standards for wet weather management (i.e., Municipal Separate Storm Sewer Systems, CSOs, and flooding) under uncertain climate impacts in the future?

The research team will use a combination of online surveys, phone interviews, and other applicable techniques, focusing on the perspectives of utilities and municipalities, with a goal of synthesizing the latest case studies across climate regions. Information on cost analysis and cost-benefit analysis will be particularly helpful. For example, this effort should include: (a) synthesis of current methods for capital improvement planning and related challenges for using climate data as decision criteria by utilities; (b) enhancements to the accuracy of IDF curves that could be used for improving sizing of municipal drainage systems (e.g., without excessive oversizing of infrastructure that causes an unnecessary financial burden on the ratepayers); and (c) more robust projection of annual time series for modeling stormwater runoff and CSOs under both warm and cold climate impacts across seasons in a changing climate. A related research question is what the right balance should be between the willingness to iteratively evaluate the climate risks using more advanced methodologies with supporting data versus the need to oversize the infrastructure (e.g., pipes and treatment capacities) with significantly more capital investment given the uncertainty related to climate change. In addition, available applications of advanced techniques should be included, such as the use of artificial intelligence / machine learning, along with capital improvement planning and stream network enhancement that can support holistic wet weather management.

The research team will connect with, and possibly engage the expertise of, specialists from the National Oceanic and Atmospheric Administration and other related agencies and organizations (e.g., American Society of Civil Engineers) in order to advance research related to best practices for climate change rainfall statistics and projections in both water-abundant and water-scarce regions by collectively considering wet weather management, capital improvement, and stream network enhancement.

The research team will provide an interactive utility-facing ‘‘state-of-the-practice” guidance document, with a synthesis of case studies across different geographic and climate regions. Innovative thinking is encouraged, for example a heuristically based diagram/approach integrating required studies and supporting data towards the goal of improved decision making for holistic wet weather management that considers regional climate variations, different flood types, and different utility sizes. In addition, a chapter should be included summarizing the knowledge gaps, research needs, and preliminary project concepts for recommended research projects. To facilitate feedback, one suggested approach is for the research team to host two invitation-only virtual workshops. The first virtual workshop would likely be held during the early stage of the project (e.g., “Year 1”). The second virtual workshop would likely be held when there has been significant progress made (e.g., “Year 2”). The workshop participants would include the Project Advisory Committee (PAC) members, representatives from participating utilities, WRF’s collaborators and partners, and other invitees recommended by WRF.

For broader community outreach, the research team will conduct two webcasts hosted by WRF and collaborating organizations on the overall findings of this project. The research team should submit at least one open access peer-reviewed journal paper, after the completion of the project. In addition, the

research team should consider additional outreach activities (through the applicant's cost share, if possible), such as presenting project findings at conferences.

Expected Deliverables

- A stand-alone literature review synthesis document, including annotations for the list of publications and resources used.
- Two invitation-only virtual workshops, along with workshop planning and all supporting materials (e.g., agenda, presentations, meeting notes, and workshop summary).
- An interactive utility-facing guidance document.
    - This document will include synthesis of case studies across different climate regions and a decision support framework towards projected future infrastructure needs and capital improvement investment decisions based on climate change considerations.
    - In addition, this document will include a chapter and supporting technical appendix that summarize the knowledge gaps, research needs, and preliminary project concepts for recommended research projects, including recommended means to address those remaining gaps.
- Broader outreach:
    - Webcasts and public outreach materials (e.g., infographics that can help communicate research findings to both utilities and general public).
    - Submitting at least one open access peer-reviewed journal paper and additional outreach products as applicable.

Communication Plan

Please review WRF's *Project Deliverable Guidelines* for information on preparing a communication plan. The guidelines are available at https://www.waterrf.org/project-report-guidelines. Conference presentations, webcasts, peer review publication submissions, and other forms of project information dissemination are typically encouraged.

Project Duration

The anticipated period of performance for this project is 24 months from the contract start date.

References and Resources

The following list includes examples of research reports, tools, and other resources that may be helpful to proposers. It is not intended to be comprehensive, nor is it a required list for consideration.

Bartlett, M. Forthcoming. *Holistic and Innovative Approaches for Flood Mitigation Planning and Modeling under Extreme Wet Weather Events and Climate Impacts.* Project 5084. Denver, CO: The Water Research Foundation.

Cheng, L., and A. AghaKouchak. 2014. "Nonstationary Precipitation Intensity-Duration-Frequency Curves for Infrastructure Design in a Changing Climate." *Nature Sci Rep,* 4, 7093. https://doi.org/10.1038/srep07093.

Cline, S. Forthcoming. *Enhancement of Resilience to Extreme Weather and Climate Events: Proactive Flood Management.* Project 4842. Denver, CO: The Water Research Foundation.

EPA (U.S. Environmental Protection Agency). 2017. *Prioritizing Wastewater and Stormwater Projects Using Stakeholder Input*. Report Number EPA 830-R-17-002.

EPA (U.S. Environmental Protection Agency). 2022. Climate Resilience Evaluation and Awareness Tool (CREAT) and Resilient Strategies Guide for Water Utilities.

Fischbach, J., D. Knopman, K. R. Grocholski, A. Cohn, and J. Brock. 2020. *An Action Agenda for the Water Sector to Advance Methods for Achieving Integrated Climate Resilience.* Project 5001/5058. Denver, CO: The Water Research Foundation.

Harold, E. Forthcoming. *Exploring Cost-Benefit Analysis of Post Long-Term Control Plan Approaches to Wet Weather Management*. Project 4849. Denver, CO: The Water Research Foundation.

Kirezci, E., I. R. Young, R. Ranasinghe, S. Muis, R. J. Nicholls, D. Lincke and J. Hinkel. 2020. "Projections of Global-Scale Extreme Sea levels and Resulting Episodic Coastal Flooding over the 21st Century." *Nature Sci Rep*, 10, 11629. https://doi.org/10.1038/s41598-020-67736-6.

Kourtis, I. M., and V. A. Tsihrintzis. 2022. "Update of intensity-duration-frequency (IDF) curves under climate change: a review." *Water Supply*, 22 (5): 4951. https://doi.org/10.2166/ws.2022.152.

Kulp, S. A., and B. H. Strauss. 2019. "New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding." *Nature Communication*, 10, 4844. https://doi.org/10.1038/s41467-019-12808-z.

Marlow, D., D. Beale, and S. Gould. 2014a. *Practitioner's Guide for Economic Decision Making in Asset Management*. *Part 1: Background*. Project 1725/SAM1R06b1. Alexandria, VA: WERF.

Marlow, D., D. Beale, and S. Gould. 2014b. *Practitioner's Guide for Economic Decision Making in Asset Management. Part II: Guidance*. Project 1726/SAM1R0b2. Alexandria, VA: WERF.

Martel, J., F. P. Brissette, P. Lucas-Picher, M. Troin, and R. Arsenault. 2021. "Climate Change and Rainfall Intensity–Duration–Frequency Curves: Overview of Science and Guidelines for Adaptation." *J. Hydrol. Eng.*, 26 (10): 03121001.

Milly, P. C. D., J. Betancourt, M. Falkenmark, R. M. Hirsch, Z. W. Kundzewicz, D. P. Lettenmaier, and R. J. Stouffer. 2008. "Stationarity Is Dead: Whither Water Management?" *Science,* 319 (5863): 573-574.

National Academies of Sciences, Engineering, and Medicine. 2019. *Framing the Challenge of Urban Flooding in the United States*. Washington, DC: The National Academies Press. https://www.nap.edu/catalog/25381/framing-the-challenge-of-urban-flooding-in-the-united-states.

Neukrug, H., and M. Hacker. Forthcoming. *Holistic Wet Weather Management through Adaptive Volume and Pollutant Source Control at a Community Scale: Finding the Sweet Spot.* Project 5131. Denver, CO: The Water Research Foundation.

Nicholls, R. J., D. Lincke, J. Hinkel, S. Brown, A. T. Vafeidis, B. Meyssignac, S. E. Hanson, J. Merkens, and J. Fang. 2021. "A Global Analysis of Subsidence, Relative Sea-Level Change and Coastal Flood Exposure." *Nature Climate Change*, 11: 338–342. https://doi.org/10.1038/s41558-021-00993-z.

Rasmus, J., and E. Garvey. Forthcoming. *Assessing the State of Knowledge and Research Needs for Stormwater Harvesting*. Project 4841. Denver, CO: The Water Research Foundation.

Sun, N., H. Yan, M. S. Wigmosta, A. M. Coleman, L. R. Leung, and Z. Hou. 2022. "Datasets for characterizing extreme events relevant to hydrologic design over the conterminous United States." *Nature Sci Data*, 9, 154. https://doi.org/10.1038/s41597-022-01221-9.

Thompson, K. Forthcoming. *Designing Sensor Networks and Locations on an Urban Sewershed Scale with Big Data Management and Analytics.* Project 4797. Denver, CO: The Water Research Foundation.

WRF (The Water Research Foundation). 2021. Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC). https://www.waterrf.org/clasic.

Yan, H., N. Sun, M. Wigmosta, R. Skaggs, Z. Hou, and R. Leung. 2018. "Next-generation intensity-duration-frequency curves for hydrologic design in snow-dominated environments." *Water Resources Research*, 54, 1093–1108. https://doi.org/10.1002/2017WR021290.

Proposal Evaluation Criteria

The following criteria will be used to evaluate proposals:

- Understanding the Problem and Responsiveness to RFP (maximum 20 points)
- Technical and Scientific Merit (maximum 30 points)
- Qualifications, Capabilities, and Management (maximum 15 points)
- Communication Plan, Deliverables, and Applicability (maximum 20 points)
- Budget and Schedule (maximum 15 points)

Proposal Preparation Instructions

Proposals submitted in response to this RFP must be prepared in accordance with the WRF document *Guidelines for Research Priority Program Proposals*. The current version of these guidelines is available at https://www.waterrf.org/proposal-guidelines, along with *Instructions for Budget Preparation*. The guidelines contain instructions for the technical aspects, financial statements, indirect costs, and administrative requirements that the applicant must follow when preparing a proposal.

Proposals that include the production of web- or software-based tools, such as websites, Excel spreadsheets, Access databases, etc., must follow the criteria outlined for web tools presented in the *Web Tool Criteria and Feasibility Study for The Water Research Foundation Project Deliverables* at https://www.waterrf.org/project-report-guidelines#deliverables.

Eligibility to Submit Proposals

Proposals will be accepted from domestic or international entities, including educational institutions, research organizations, governmental agencies, and consultants or other for-profit entities.

WRF's Board of Directors has established a Timeliness Policy that addresses researcher adherence to the project schedule. The policy can be reviewed at https://www.waterrf.org/policies. Researchers who are late on any ongoing WRF-sponsored studies without approved no-cost extensions are not eligible to be named participants in any proposals. Direct any questions about eligibility to the WRF project contact listed at the top of this RFP.

Administrative, Cost, and Audit Standards
WRF's research program standards for administrative, cost, and audit compliance are based upon, and comply with, Office of Management and Budget (OMB) Uniform Grants Guidance (UGG), 2 CFR Part 200 Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, and 48 CFR 31.2 Contracts with Commercial Organizations. These standards are referenced in WRF's *Guidelines for Research Priority Program Proposals*, and include specific guidelines outlining the requirements for indirect cost negotiation agreements, financial statements, and the Statement of Direct Labor, Fringe Benefits, and General Overhead. Inclusion of indirect costs must be substantiated by a negotiated agreement or appropriate Statement of Direct Labor, Fringe Benefits, and General Overhead. Well in advance of preparing the proposal, your research and financial staff should review the detailed instructions included in WRF's *Guidelines for Research Priority Program Proposals* and consult the *Instructions for Budget Preparation*, both available at https://www.waterrf.org/proposal-guidelines.

Budget and Funding Information
The maximum funding available from WRF for this project is $200,000. The applicant must contribute additional resources equivalent to at least 33 percent of the project award. For example, if an applicant requests $100,000 from WRF, an additional $33,000 or more must be contributed by the applicant. Acceptable forms of applicant contribution include cost-share, applicant in-kind, or third-party in-kind that comply with 2 CFR Part 200.306 cost sharing or matching. The applicant may elect to contribute more than 33 percent to the project, but the maximum WRF funding available remains fixed at $200,000. **Proposals that do not meet the minimum 33 percent of the project award will not be accepted.** Consult the *Instructions for Budget Preparation* available at https://www.waterrf.org/proposal-guidelines for more information and definitions of terms.

Period of Performance
It is WRF's policy to negotiate a reasonable schedule for each research project. Once this schedule is established, WRF and its sub-recipients have a contractual obligation to adhere to the agreed-upon schedule. Under WRF's No-Cost Extension Policy, a project schedule cannot be extended more than nine months beyond the original contracted schedule, regardless of the number of extensions granted. The policy can be reviewed at https://www.waterrf.org/policies.

Utility and Organization Participation
WRF encourages participation from water utilities and other organizations in WRF research. Participation can occur in a variety of ways, including direct participation, in-kind contributions, or in-kind services. To facilitate their participation, WRF has provided contact information, on the last page of this RFP, of utilities and other organizations that have indicated an interest in this research. Proposers are responsible for negotiating utility and organization participation in their particular proposals. The listed utilities and organizations are under no obligation to participate, and the proposer is not obligated to include them in their particular proposal.

Application Procedure and Deadline
Proposals are accepted exclusively online in PDF format, and they must be fully submitted before 3:00 pm Mountain Time on Tuesday, November 22, 2022.

The online proposal system allows submission of your documents until the date and time stated in this RFP. To avoid the risk of the system closing before you press the submit button, do not wait until the last

minute to complete your submission. Submit your proposal to: https://forms.waterrf.org/222616507996870.

Questions to clarify the intent of this RFP and WRF's administrative, cost, and financial requirements may be addressed to the WRF project contact, Harry Zhang, PhD, PE at (571) 384-2098 or hzhang@waterrf.org. Questions related to proposal submittal through the online system may be addressed to Caroline Bruck at (303) 347-6118 or cbruck@waterrf.org.

5176 Utility and Organization Participants

The following utilities have indicated an interest in possible participation in this research. This information is updated within 24 business hours after a utility or an interested organization submits a volunteer form, and this RFP will be re-posted with the new information. **(Depending upon your settings, you may need to click refresh on your browser to load the latest file.)**

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