Sustainability Fellowship
Roadway Resilience to Flooding – Risk Analysis
UNH Center for Infrastructure Resilience to Climate
Durham, NH

About the Sustainability Fellows Program:
UNH Sustainability Fellowships pair exceptional students from across the U.S. with municipal, educational, corporate, and non-profit partners in New England to work on transformative sustainability initiatives each summer. Sustainability Fellows undertake challenging projects that are designed to create an immediate impact, offer a quality learning experience, and foster meaningful collaboration. Fellows work on-site with their mentors at partner organizations for 10 weeks, supported by a network of Fellows, partners, alumni, and the UNH Team. Graduate students, exceptional undergraduate students, and recent graduates from any accredited college or university are eligible to apply.

A detailed description of one Fellowship follows. To learn more about the other Fellowships offered this year, and for application instructions, see: www.sustainableunh.unh.edu/sustainability-fellows.

About the Fellowship:
Flooding is a challenge for many roadways across New England, yet flooding is often neglected in conventional roadway design. Because floods are the largest and most frequent natural hazards that impact New England, and the risk of roadway flooding is likely to increase, understanding the relationship between flooding and roadway damage is an important and urgent task in New England. Growing evidence, including lessons learned from several severe hurricane events, shows that the costs to mitigate roadway flooding are significant.

In locations that experience frequent flooding, or will as a result of climate change, it’s important to assess the risk of flood-induced damage and adapt road designs accordingly. Such assessment requires information on the frequency and magnitude of local flooding as well as an understanding of the potential damage associated with these floods. In general, flooding of a greater magnitude is expected to do more harm to a roadway.

For decades, FEMA and the US Army Corps of Engineers (ACOE) have used depth-damage functions (quantitative relationships between flood depth and the monetary cost of flood damage) to estimate the damage to civil infrastructure (particularly for buildings) and their contents. These estimates are based on field assessments of actual damage following flooding events. Depth-damage functions for riverine flooding have been codified in the FEMA Hazus tool. However, potential damage to road infrastructure from flooding is clearly missing from these assessment tools. Local damage functions for roadways are necessary to accurately quantify the risks of flood-induced damage.
During flooding, moisture levels in a pavement can increase significantly and weaken the pavement structure. After flooding, high levels of moisture can be trapped in the pavement structure and it can remain weakened for a long time. In those periods when moisture levels are high, the traffic bearing capacity of the roadway can be reduced significantly, and rapid damage can occur. This leads to a reduced pavement service life and an associated economic impact.

The goal of this Fellowship project is to contribute to the further development of our approach to quantify the cost of flooding induced damage on roadways considering both time and depth of flooding. This work will build upon existing research on roadway flooding resilience at the University of New Hampshire Center for Infrastructure Resilience to Climate (UCIRC).

**Outcomes:**
The approach will include a literature survey, data collection, finite element modeling of flooded pavements, and cost assessment. In addition, this study will identify key knowledge gaps and new research that is critical for adaptation of roadways to flooding. The anticipated outcomes include presentations, a final report, and potential peer-reviewed publication(s) to present the findings of this study.

**Impact:**
The Sustainability Fellow will learn how to model flooded pavements using the finite element method (FEM), perform pavement evaluations, and cost assessments. The skills/expertise can be applied to a variety of engineering problems, add will a unique perspective on infrastructure climate resilience to the Fellow’s portfolio.

We expect this project will serve as the foundation to emphasize that urgent changes in roadway pavement design are needed to account for flood resilience. The findings of this project are expected to provide road agents with a tool to project the degree of roadway damage relative to a range of potential flooding events. It is our hope that this work will lead to the routine incorporation of flood resilience into roadway pavement design, and subsequently increase the resilience of New England’s infrastructure to climate change.

**Desired Qualifications:**
- BS degree in Civil Engineering or Environmental Engineering
- Fundamental knowledge in civil engineering materials, geotechnical engineering, and hydrology
- Background knowledge of pavements and finite element method (FEM)
- Experience in multi-disciplinary research
- Ability to work collaboratively and independently
- Good writing and communication abilities
- Programming skills (in R, Python, or VBA) are an advantage but not a must

**Work Location:** Kingsbury Hall, UNH, Durham, NH
**Mentors:**
Dr. Jo Sias Daniel, Professor, UNH Department of Civil and Environmental Engineering
Dr. Cameron Wake, Research Professor, UNH Institute for the Study of Earth, Oceans, and Space

**Compensation:** $6500 summer stipend
(taxable and paid on a two-week payroll cycle over the course of the fellowship term)

**Expectations:**
Fellows are expected to be primarily dedicated to their assigned projects throughout the summer, and also participate in a variety of networking activities, professional development opportunities, and presentations coordinated by UNHSI. Specifically, Fellows are expected to:

- Attend a mandatory orientation at UNH prior to the start of the fellowship term, **May 28-30, 2019**. (Travel scholarships may be available for students traveling from outside New England.)
- Work full-time on-site at the partner organization for 10 weeks, for a total of 400 hours, **June 3 - August 16, 2019** (an eleven-week period, allowing for one week off, as mutually agreed upon with supervisor).
- Complete a fellowship project according to the work plan (with adjustments as necessary).
- Participate in weekly webinars or advisory group meetings.
- Present work at mid-term and final poster sessions at UNH on **July 12** and **August 9**. (Travel support available.)
- Engage in additional professional development, networking, and advisory activities as offered.
- Provide and receive feedback at the end of the fellowship.

**Apply by February 7** at [www.sustainableunh.unh.edu/sustainability-fellows](http://www.sustainableunh.unh.edu/sustainability-fellows).

**Questions** may be addressed to [megan.carney@unh.edu](mailto:megan.carney@unh.edu).