

## **EPSCoR Track 1 Idea: “Innovative Manufacturing of Embedded-Sensor Products to Restore Streams”**

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Overview of Idea: Stream restoration refers to a set of water engineering activities that improve the environmental health of a river while at the same time increasing the aesthetic and monetary value of adjacent property. Stream restoration is a \$25 billion industry that supports 220,000 jobs in the United States. Agricultural and transportation sectors are the two largest monetary consumers of restoration activities. We propose that innovative manufactured, smart materials will assist with stream restoration products. Specifically, embedded sensor fabrics applied on floodplains, streambanks, and within hydraulic structures will allow inexpensive monitoring and in turn improve designs. Biodegradable fabrics, including brush mattresses, erosion control membranes, and semi-permeable geotextiles, are the mainstay of restoration with as much as 200,000 m<sup>2</sup> applied on a typical job. By sensing sediment, chemical, and hydraulic conditions of the river with the fabrics, consumers may provide spatially distributed monitoring of their restoration jobs, remove workers from harm’s way, reduce the need for onsite labor-intensive follow-up assessment, and therefore increase the amount of time allocated to analyzing and assessing data streams afforded by the newly engineered sensor fabrics. In turn, researchers may use the sensing data to improve the design of restored rivers. Embedding sensors within restoration materials is a novel concept that is consistent with advanced and innovative smart manufacturing (e.g., MIT, 2015).

Inputs: We will develop new sensor materials to be used for sensing sediments and fluids (UofL, material science). Concurrently, we will apply an existing material for the design/build out of the products since some material already has been developed.

Design and Process: We will embed sensors into restoration materials and calibrate the materials in the Hydrosystems Lab (UK, UofL). We will test and perform initial verification of the prototypes at field sites using well-developed sensor monitoring systems for comparison. “Proof of Concept” will take place at field sites across Kentucky that represent the breadth of physiogeographic settings for which practitioners commonly apply stream restoration techniques including poorly-developed hyporheic/benthic-dominated streams (UK site), moderately developed hyporheic and immature karst streams (EKU site), and well-developed hyporheic streams (Murray State site). We will analyze data, improve the materials and products as needed, and repeat for optimization. .

Application: Agricultural and transportation sectors (UK, Murray, EKU, industry).

**Broad Infrastructure Deliverables:** “Kentucky Center for Innovative Manufacturing of Embedded Sensor Products” As a technology-based society, we have moved through the computational revolution and are now ending the first phase of the sensor revolution. We now are within a smart-materials revolution

where computational and sensor advancements of the past three decades are inter-woven into the fabric of our lives. Through the creation of this center, we foresee Kentucky as a technological leader that weaves sensor technology and data into engineering products to serve agricultural, health, aerospace, and environmental sectors. The center will foster a collaborative union with industry to build new materials, embed sensors within those engineered materials, monitor the engineered and natural surroundings (in our case, stream and river restorations), and iterate the process to optimize their health and well-being for our society. Some deliverables will be: Creation of a center; shared production equipment; sensor plug-in computational equipment; sensor calibration facilities; and new faculty hires in the data realm.

