SOUTHERN ILLINOIS UNIVERSITY EDWARDSVILLE

Excellence in Undergraduate Education (EUE) Proposal

Project ID# (*leave blank*)

25-09

Project Title

Multi-use stream table to quantify and demonstrate the interaction between stream and in-channel structures

Project Director	ID Number	Telephone	Email
Rohan Benjankar	800630967	618-650-2814	rbenjan@siue.edu

Department	Campus Box	School College
Civil Engineering	1800	School of Engineering

Course or Program

CE415L

Project Co-Director	ID	Department	Email

Student Impact:	>48/year

Priority Rating (If Submitting Multiple Proposals):	

Project Budget

Salary	Wages	Travel	Equip.	Comm	CServ	Auto	Tele	Awards	Total
5435	600		4958						10993

Cost-Sharing

Salary	Wages	Travel	Equip.	Comm	CServ	Auto	Tele	Awards	Total

Prior EUE Support

Project Director	Project Number	Award Amount	Project Dates

Applicable 2024-2025 Priorities (*check all your proposal fits, if any*):

- ☑ Course redesign project that uses inclusive, student-centered pedagogies to address equity gaps, improve student learning outcomes, & enhance retention
- ☐ Project involves courses that have high number of sections, a high ratio of D/F/W grades, or key required courses with high enrollments and opportunities to improve equitable student success

Multi-use stream table to quantify and demonstrate the interaction between stream and in-channel structures

Summary

The success of any academic program depends on its ability to train students, who are a primary part of the teaching process. Students undeniably derive inspiration and encouragement from motived faculty, available resources and teaching mediums. Engineering is an applied field where students learn theory and the fundamental concepts to solve real-world problems and they gain the greatest experiences through hands-on learning. Thus, teaching approaches balancing theory and hands-on training, such as laboratory experimentation, should be emphasized, which allow students to understand the physical phenomena by the theory, to learn through experimentation, to formulate and test hypotheses and to support decision processes and design.

The principle investigator (PI) proposes to modify the existing stream table located in the Fluid mechanics laboratory Civil Engineering (CE) Department, Southern Illinois University Edwardsville (SIUE). The proposed stream table can be used for multi-purpose application including CE 415L: Fluid mechanics laboratory experiment. Furthermore, the proposed project can be used to demonstrate impacts of in-channel structural design on stream bank erosion and sediment transport to K-12 via outreach, undergrad teaching, professional seminars and demonstrations. Also, it can help PI's teacher-scholars activity by providing joint research opportunities on river and ecosystem interactions. This proposal was recommended for SIUE EUE funding in 2020, which shows the significance of the project on SIUE CE undergraduate students, but had not been funded because of COVID-19 impacts on SIUE finances, scholarships and awards.

2. Proposal Narrative

A. Current Situation:

Civil engineering (CE) projects involve designing hydraulic structures (e.g., bridge, culvert, etc.) in natural waterways, such as streams and rivers. Construction of structures change the hydraulic processes in the channel and result in modifications to the stream elements, such as armoring, erosion and deposition of the stream bank or bed and reroute the stream flow in other direction. Regardless of the type of construction, the stream dynamics will be affected by the changes imposed on the stream by constructing hydraulic structure. These types of fundamental processes and changes can be modeled with a stream table and this tool provides useful data and insight into, however, modeling of nature is complex (Bertoldi et al., 2015; Cilliers et al., 2013).

The lab experiments guide students towards learning important skills that supplement engineering problem-solving techniques, such as a teamwork, conflict resolution and technical communication (written and oral) and also offer students the opportunity to understand the difference between the ideal examples presented in the classroom (numerical problem solutions) and non-ideal challenges likely to be encountered in the solving real-world issues. Generally, lab experiments are limited to topics open channel flow and flow rate measurement, pipe flow and head losses, flow over immersed bodies, and fluid statics and dynamic, etc. (Munson et al., 2010). Specifically, lab experiments on impacts of structure design on natural channel hydraulics including erosion/deposition are not part of curriculum of CE in majority of institutes.

The CE and Mechanical Engineering programs SIUE requires all graduates to complete CE315 (cross-listed as ME315) Fluid mechanics course accompanied by laboratory experiments. CE315 is a core course and mandatory for all CE engineering students and followed by

CE415L: Fluid mechanics laboratory. CE415L focuses on experiments on open channel flow energy calculations, hydraulic jumps formation, pipe flow and head losses, centrifugal pump hydraulic and stream and hydraulic structure interaction.

A stream table (Figure 1) is used to perform an experiment to observe interaction between stream and a hydraulic structure. One of the main purposes of this experiment is to initiate a variety of modifications to the stream (model) and to observe and describe how the stream responds to those changes. This experiment is focused on observing the basic erosion-deposition processes qualitatively. These processes are common to many civil engineering river projects.

Figure 1: General difference between existing (left) and proposed stream table (right). (Photo source: https://www.tes.com/lessons/NHnmiCKAE5kvVw/factors-influencing-river-erosion)

The existing stream table (Figure 1) is constructed from timber and marine-grade plywood with dimensions of 72 inches (Length), 36 inches (Width) and 26 inches (Height). This table was constructed in-house at the School of Engineering lab facility about 20 years ago. Because the base of the table is designed with a fixed angle, the slope of stream is constant, thus limited to

the modeling of a specific type of river. A physical model that has a capability of modeling different stream types (e.g., flat sloped low elevated rivers and steep slope mountainous rivers) holds more value for educational purposes. Flow in the current stream table is controlled using manual valves, but the water quantity is not measurable. The water hose is connected to a water line in the lab and after flowing through the existing stream table, the water is simply discharged into the drain. Due to the lack of recycling water and capturing sediment facility, some sediments flow into the drainage system, specifically because lightweight (low density) plastic materials are being used to represent heavier (high density) sand particles. Therefore, sandy materials has to be supplemented frequently, which adds cost for experiments. Furthermore, the existing experiment lacks quantitative analysis of erosion/deposition (change in topography), channel widening, sediment transport and flow measurement. The experiment is performed based on visual observation and judgement, photograph documentations and qualitative analyses.

The stream table experiment is not only used by Civil Engineering students, but also used for demonstration during School of Engineering Open Houses, Previews and High School Summer camps organized by the SIUE. These outreach efforts showed importance of stream lab experiment for prospective future undergraduate students. Since the PI joined SIUE in Spring 2017, the stream table has been used by a total of 336 undergraduate students (at least 48 per year) part of their CE curriculum and has been used for demonstration for 175 High School Summer camp students (25 each year). Furthermore, it has been used to demonstrate riverine processes to prospective students and their parents during School of Engineering building tour in open house and preview events (number of high school prospective students varies).

B. Proposed Project:

PI is proposing to build a new larger stream table, which is able to perform quantitative analyses of stream and structure interaction (e.g., erosion and deposition, bank erosion, sediment transport, surface erosion due to rainfall in watershed, etc.) (Figure 1 and Figure A1 in Appendix). The new stream table will consist measurement of different features such as discharge, channel length (along deepest part of channel), sediment load/transport, and water depths. The dimension of the Table will be 120 inches (L), 40 inches (W) and 26 inches (H) with maximum of 10^0 of manual tilting (longitudinal slope) (Figure A1 in Appendix). This tilting capability will allow the proposed stream table to model varieties of river systems from flat sloped (mid-western rivers) to steep mountainous rivers. Because CE graduates work throughout the United States, it is important they learn how hydrologic process can vary between different types of river systems.

The stream table will also be equipped with a flow control and measurement device including digital display and data logger, which allow students to control and record flow in the experiments. The water depth in the stream will be measured with an Ultrasonic sensor. Water used in the stream table will be recycled and a sediment capture device will be installed such that students could quantify sediment transport or sediment load in the stream. It will be accompanied with 2, 20-gallon polyethylene reservoir tanks and a recirculating pump. Multiple grain size sands (will be used instead of the uniform sand in existing experiments. This change will allow stream table users to visualize size of sand particles that are in motion or transport in the stream. One of the new and advanced feature of the proposed stream table is that it will use mounted digital camera to take pictures of the experiments. Agisoft Metashape software

(https://www.agisoft.com/) will be used to quantify change in stream bathymetry analyzing photographs captured before and after the events. The software performs photogrammetric processing of digital images and generates 3D spatial data, which can be used in used in GIS applications. The software will be installed in one of the existing computers in the lab. The digital image processing requires control points (3 to 8) with known X, Y and Z (elevation reference to datum) coordinates, which will be permanently marked on the stream lab. The following tasks will be performed within one year of project period starting from July, 2024 (Table 1). Therefore, the proposed stream table is significantly different and advanced from existing stream table based on capability to perform experiments and multiple functionality (Table A1, in Appendix).

Table 1: Timeline for completing proposed project (July, 2024 to June, 2025)

Task	J	A	S	O	N	D	J	F	M	A	M	J
Task 1												
Task 2												
Task 3												
Task 4												
Task 5												

Task 1: The PI will consult with a structural engineering faculty member in the CE Department chair (Dr. Nader Panahshahi) for structural design. The PI also intends to visit different institutes where similar stream tables have been used. Based on web search, the flume has been used in CE department, Saint Louis University, MO (https://sites.google.com/slu.edu/cox/equipment-and-resources).

Task 2: Stream table will be constructed in the Fowler Student Design Center, School of Engineering, SIUE. PI will work closely with former School of Engineering Lab manager Mr. Brent Vaughn and a student worker to design and construct the table.

Task 3: The PI is responsible for the testing and verification of stream table and will work with Mr. Vaughn and a RA, before using in CE415L curriculum in Fall, 2025. Furthermore, RAs and teaching assistants (TAs) will be trained for operating the stream table for different experiments.

Task 4: PI will modify existing CE415L curriculum and experiment design. Specifically, stream and structural experiment will be modified focusing on quantified analyses.

Task 5: PI will prepare final report at the end of project period.

C. Evaluation and Dissemination:

Success of the project will be analyzed based on the number of undergraduate students benefiting from the project via course related experiments and other scholarly activities. Furthermore, undergraduate student and high school students, and professionals benefit from proposed project via teaching, demonstration and outreach. Beside for class experiments in CE415L, the stream table can also be used for fundamental and basic research on geomorphology, stream bank erosion and surface erosion in watershed. Additionally, it could be used to demonstrate riverine processes for professionals working in riverine biology and ecosystem, and geomorphologists as well as K-12 students for more advanced demonstrations, research, and teaching. PI's research interest focus on river systems and ecosystem, thus, this proposed project may also enhance hi research interests.

D. References:

Bertoldi, W., M.Welber, Gurnell, A.M., Mao, L., F.Comiti, M.Ta, 2015. Physical modelling of the combined effect of vegetation and wood on river morphology. Geomorphology 246, 178-187.

Cilliers, P., Biggs, H.C., Blignaut, S., Choles, A.G., Hofmeyr, J.-H.S., Jewitt, G.P.W., Roux, D.J., 2013. Complexity, Modeling, and Natural Resource Management. Ecology and Society 18(3), 1-12.

Munson, B.R., Young, D.F., Okiishi, T.H., Huebsch, W.W., 2010. A Brief Introduction To Fluid Mechanics, 5 edition ed. John Wiley & Sons, Hoboken, NJ.

Budget and Budget Justification:

Salaries - $5,435

- 0.25 month of summer salary is requested for the PI. He will be responsible for design stream table, preparing construction drawing, coordinate with former lab manager Mr. Brent Vaughn, verify stream table and train RA/TA for application of the stream table **($2485)**
- 3 month of salary (@40 hour/month with hourly rate of $16) is requested for graduate student during Summer and Fall 2025 (TA/RA). A graduate student hire and work with PI for Verification stream table, and experimental design and operation **($1,950)**.
- 20 hours service charge (@ $50 per hour) is requested for Mr. Brent Vaughn during construction and verification of stream table (Total **$1,000)**.

Student Wages for Summer and Fall 2025 ($600)

An undergraduate student will be hired (40 hours @ $15/hour) to work with Mr. Brent Vaughn, PI, and TA/RA during stream table construction, and verification.

Equipment ($4,958)

- 20 Gallon Molded Polyethylene Tank with Lid & 3/4" FNPT Fitting - 4" L x 12" W x 31" H,
- Construction materials: 1/2" marine and other plywood, metal and other structural members, piping and misc. components, waterproof paint, tilting mechanism (lump sum)
- Flowmeter with digital display and data logger, Variable speed flow pump, Digital camera, software, stream media, Ultrasonic sensor

TOTAL Budget - $10,993

Department Commitment, Cost Share - **$0**

EUE Funds Requested - $10,993

Budget Summary table

Description	Quantity	Unit	Price rate ($)	Total ($)
*Reservoirs	2	each	132	264
**Construction materials	1	set	413	375
Frame, steel	1	set	550	500
[Δ]Flowmeter, digital display, data logger	1	unit	1166	1060
Variable speed flow pump	1	unit	800	800
Tilt mechanism	1	parts	165	165
Digital camera	1	unit	220	200
Software	1	license	604	549
Stream media	100	lb	5.5	550
**** Ultrasonic sensor with display and software	1	set	495	495
Student worker (1 month @25%)	40	hours	15	600
***RA/TA	3	month	650	1950
[α]Brent Vaughn	20	hours	50	1000
PI	0.25	month	9938	2485

Total cost $10,993

*20 Gallon Blue Molded Polyethylene Tank with Lid & 3/4" FNPT Fitting - 14" L x 12" W x 31" H

**Construction materials: Wood, 1/2" marine plywood, piping and misc. components, waterproof paint, tilting mechanism (lump sum)

***RA/TA @ 40 hour/month, total 120 hours $ 16 per hour

****Water Depth Level Measurement Ultrasonic Sensor

[Δ]Model 9092-M3-DG-DAT 1" 2-272 m3/hr Digital Flowmeter with Data Logger without Drill

[α]Former SoE, SIUE lab manager Brent Vaughn will help to consrtruct and verify the stream table

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Edwardsville, IL62026
Phone: 618-650-2814; Fax: 618-650-2555, rbenjan@siue.edu

EDUCATION:

Ph.D., Civil Engineering, Center for Ecohydraulics Research, University of Idaho, 2009

M.Sc., Water Resources Engineering and Management, Institute of Hydraulic Engineering - University of Stuttgart, Germany, 2003

ACADEMIC AND PROFESSIONAL POSITIONS:

Associate Professor, Southern Illinois University Edwardsville, Department of Civil Engineering, Edwardsville, IL, August 2022 – Present
Assistant Professor, Southern Illinois University Edwardsville, Department of Civil Engineering, Edwardsville, IL, January 2017 – August 2022
Research Assistant Professor, University of Idaho, Department of Civil Engineering, Moscow, ID February 2016 – December 2016
Adjunct Faculty, Boise State University, Department of Civil Engineering, Boise, ID, August 2015 – May 2016 (Two semesters)
Postdoctoral Researcher, University of Idaho, Boise, ID, August 2009 – January 2016

HONORS AND AWARDS

- Outstanding Researcher, School of Engineering, SIUE, 2022
- Outstanding Teacher Award, Civil Engineering Department, SIUE, 2019

PROFESSIONAL EXPERIENCE:

➢ **Course development and teaching**

- CE584: River Restoration
- CE583: Hydraulic Structure Design
- CE492: Application of GIS in Hydrologic Analyses
- CE460: Municipal Infrastructure Design
- CE416: Engineering Hydrology
- CE482: Water Resources Engineering and Management
- CE415L: Fluid Mechanics laboratory
- CE/ME315: Fluid Mechanics

PUBLICATIONS (Peer-Reviewed Journals, Selected 2021-2024):

1. Bhusal, A.; Thakur, B.; Kalra, A.; Benjankar, R.; Shrestha, A. (2024). Evaluating the Effectiveness of Best Management Practices in Adapting the Impacts of Climate Change Induced Urban Flooding. Atmosphere, 15, 281. https://doi.org/10.3390/atmos15030281
2. Rood, S. B., Hoffman, G. C., Merz, N., Anders, P., **Benjankar, R.**, Burke, M., Egger, G., Polzin, M. L., & Soults, S. (2024). Collateral benefits: River flow normalization for endangered fish enabled riparian rejuvenation. River Research and Applications, 1–12. Doi: https://doi.org/10.1002/rra.4255.
3. Chen, Q., Li, Q., Lin, Y., Zhang J., Xia J., Ni, J., Cooke, S. J., Best, J., He S., Feng T., Chen Y., Tonina, D., **Benjankar, R.**, Birk S., Fleischmann A. S., Yan H., Tang L., (**2023**). River Damming

Impacts on Fish Habitat and Associated Conservation Measures. Reviews of Geophysics, 61, 1-64. Doi: https://doi.org/10.1029/2023RG000819

4. **Benjankar, R.,** Vidergar, D., Tonina, D., Chen, Q., (**2023**). The role of water management and river morphology on stranding pool formation. Ecological Engineering, 213, 126-134. Doi: https://doi.org/10.1016/j.ecoleng.2023.107101
5. Ashitey. P., **Benjankar, R.,** Morgan, S., Retzlaff, W., Celik, S. (**2023**). Analyses of the Effectiveness of Different Media Depths and Plant Treatments on Green Roof Rainfall Retention Capability under Various Rainfall Patterns. Hydrology, volume 10 (149), 1-13; Doi: https://doi.org/10.3390/hydrology10070149
6. Duffin, J., Yager, E., Buffington, J. M., **Benjankar, R.,** Borden, C., Tonina, D., (**2023**). Impact of flow regulation on stream morphology and habitat quality distribution. Science of the Total Environment, volume, 878, 1-14. Doi: http://dx.doi.org/10.1016/j.scitotenv.2023.163016
7. Tranmer, A.W., **Benjankar, R.**, Vidergar, D., Tonina, D. (**2023**). Identifying failure mechanisms of native riparian forest regeneration in a variable-width floodplain using a spatially-distributed riparian forest recruitment model, 187, 1-11. Doi: https://doi.org/10.1016/j.ecoleng.2022.106865
8. Tonina, D., McKean, J., Isaak, D., **Benjankar, R.**, Tang, C., Chen, Q. (**2022**). Climate Change Shrinks and Fragments Salmon Habitats in a Snow-Dependent Region. Geophysical Research Letters, 49 (12), 1-10. Doi: https://doi.org/10.1029/2022GL098552.
9. Paudel. S., **Benjankar, R.** (**2022**). Integrated Hydrological Modeling to Study the Effect of Different Precipitation Sources on Surface Water and Groundwater Hydrology in a Small Watershed. Hydrology, volume 9, 1-18; https://doi.org/10.3390/hydrology9020037
10. **Benjankar, R.**, Kafle, R., Satyal, S., Adhikari, N. (**2021**). Analyses of Spatial and Temporal Variations of Salt Concentration in Waterbodies Based on High Resolution Measurements Using Sensors. Hydrology, volume, 8, 1-20. Doi: https://doi.org/10.3390/hydrology8020064

GRANTS AND FELLOWSHIPS (Selected 2021-2023):

1. SIUE RET, High Performance Computer to simulate computationally Intensive River and Watershed processes, 2023, **$5,290**, **Benjankar, R.**, SIUE Graduate School
2. "Internship Agreement"**, $4,830** (Fall, 2022); **$4,140** (Spring, 2023), **Rohan M**. **Benjankar** (PI), Sponsored by city of Collinsville, Illinois.
3. At the Confluence: Supporting Critical Transitions for Graduate Students in Sustainable Watersheds Research, August 2022-July, 2027, **$1,500,000.** Martinez, Adriana (PI), Locke, Sharon, **Benjankar, Rohan M**. (Co-PI), Black, Alan, Colaninno-Meeks, Carol, (Funded by NSF), Federal
4. Watershed Hydrology and one-dimensional hydraulic modeling development to analyze flood hazard, May, 2021 – April, 2023, **$77,448**, **Benjankar, R.**, Environmental Protection Agency (EPA) (Funded through **IEPA** and partnership with **Heartlands Conservancy)**
5. SIUE RET, Monitoring scour and deposition at river bed and around bridge piers using low-cost temperature measuring sensors, 2021, **$7,775**, **Benjankar, R.**, SIUE Graduate School
6. SIUE Competitive STEP funding, Study of the role of the lake, wetland, and pond on changing salt concentration downstream, July, 2021 – June, 2022, **$15,212**, **Benjankar, R.**,
7. SIUEInnovation & Excellence in Graduate Education, January, 2021 – June, 2021, **$6,375**, Colaninno, C. (PI), Martinez, A. (Co-PI), **Benjankar, R.**, **(Co-PI)**, Black, A. (Co-PI), Locke, S. (Co-PI), Southern Illinois University Edwardsville (SIUE)

Appendix

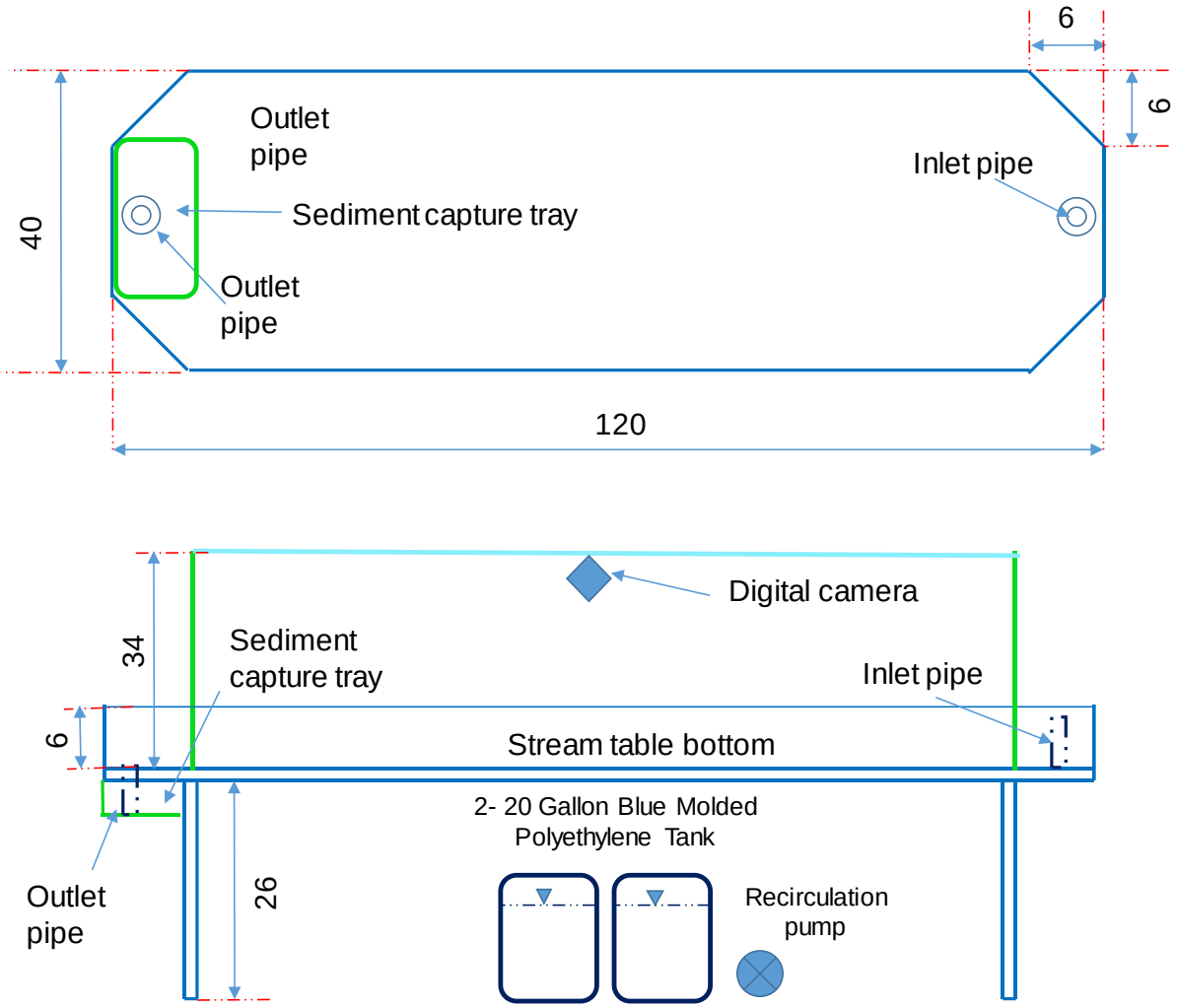

Figure A1: Plan (top) and sectional (below) view of and proposed stream table. The dimensions are in inches.

Table A1: Difference between existing and proposed stream table based on capability and functionality.

SN	Item	Existing	Proposed
1	Interaction between structure and stream processes	Yes	Yes
2	Discharge measurement	No	Yes
3	Sediment capture and transport quantification	No	Yes
4	Color coded grain size	Yes*	Yes*
5	Slope of stream adjustment	No	Yes
6	Quantification of change in stream topography	No	Yes
7	Recirculation tank	No	Yes
8	Sediment capture tray	No	Yes
9	Recirculation pump	No	Yes
10	Stream mounted camera	No**	Yes

*It is possible to use in existing experiment but uniform white sand has been used. Due to cost, we decided to use verities of grain sizes but uniform color

** Photographs are taken by personnel smart phones in existing experiment

Memo to: Excellence in Undergraduate Education, Proposal Review Committee
From: Dr. Cem Karacal, Dean, School of Engineering, SIUE
Date: February 29, 2024
Subject: EUE Proposal, Rohan Benjankar

The School of Engineering (SoE) strongly supports Dr. Rohan Benjankar's proposal for a EUE grant to design and develop a "Multi-use stream table to quantify and demonstrate the interaction between a stream and in-channel structures". The proposed advanced and multi-use stream table is important for the undergraduate Civil Engineering curriculum CE415L: Fluid Mechanics lab. The proposed project helps to ensure students are prepared professionally to apply the knowledge on the interaction between hydraulic structures and riverine physical processes in their future professional careers. The proposed project will improve the CE415L lab and students benefit from the hands-on learning experience. Specifically, students will be able to visualize and quantify the impacts of in-channel structures (e.g., bridges, culverts, etc.) on river dynamics. The proposed project provides benefits to CE Undergraduate students significantly as well as it can be used to demonstrate riverine processes for high school students and professionals working in river management fields.

The PI has demonstrated his dedication to improving undergraduate education in the CE Department, SIUE adopting a teacher-scholar model and integrating hands-on learning experiences. The proposed project will help to advance hands-on and practical learning experiences for students in the water resources management and environment fields of the Civil Engineering curriculum.

SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE

Memo to: EUE Proposal Review Committee Members
From: Nader Panahshahi**,** Chair, Department of Civil Engineering
Date: February 29, 2024
Subject: Dr. Rohan Benjankar EUE Proposal

This memo confirms the strong support of the Civil Engineering Department for Dr. Rohan Benjankar's 2024 EUE proposal entitled, "multi-use stream table to quantify and demonstrate the interaction between stream and in-channel structures."

The proposed project will significantly improve the fluids laboratory for students in our department. The requested equipment, when constructed, will greatly enhance the hands-on learning experience of the CE 415L (Applied Fluids Lab) students. CE 415L is an important required laboratory course in our ABET accredited undergraduate Civil Engineering program. Using the new CE 415L students will be able to quantify their observations, analyze a larger variety of river systems, and the stream table will conserve water by recycling. None of these features are available with our current stream table.

Dr. Benjankar has demonstrated his dedication to continued improvement of undergraduate education, has added new courses to our curriculum, and was selected as the 2019 outstanding teacher in our department. This proposed project is feasible and will have a very positive impact on the Civil Engineering undergraduate curriculum, especially in the water resources area.

Lastly, the proposed stream table can also be used for demonstration purpose during School of Engineering Open Houses, and outreach events such as the future SIUE Engineering Scholars Field Trip and the SIUE Summer Camps.

MEMORANDUM

Date: February 27, 2024

To: Nicole Klein
EUE Coordinator

From: Brent Vaughn
Retired, SIUE Dept of Civil Engineering

Subject: Support for 2024 EUE Project Proposal by Dr. Rohan Benjankar

I am writing in support of the Excellence in Undergraduate Education (EUE) proposal by Dr. Rohan Benjankar to design and build a multi-use stream table for students in our CE program.

I researched, designed and built the original stream table about twenty years ago for the CE415L Applied Fluid Mechanics Laboratory course that I taught for sixteen years. The basic concept that this early stream table version borrowed from, known as micro-modeling, was developed by the U.S Army Corps of Engineers (USACE) Applied River Engineering Center in St. Louis. We incorporated the realistic stream bed materials and the basic model scale used by the USACE into a very simple stream table version. We did not bring in the more sophisticated flow-control and geomorphic surface measurements employed by USACE mostly because of the cost of those technologies.

This stream table lab experiment module was very popular with the students and they seemed to appreciate it because it was a very interactive, hands-on modeling activity. In my observations of the students in the lab and reviewing their lab reports, that experiment module contributed to developing deeper qualitative and intuitive insights. The basic marine-grade plywood construction proved to be very durable, and still does not leak.

The proposal by Dr. Benjankar will provide a far better educational experience for the students because of the increased control of the water flow, angle of tilt range, and longer flow length runs of the streams. Another innovation is the proposed method to do 3D imaging and analysis of the moveable sediment materials to be further visualized and could be quantified in a geographic information system (GIS). In addition, Dr. Benjankar possesses the requisite theoretical and practical experience to make the most of this proposed enhancement to our Applied Fluid Mechanics lab facilities.

As the former CE Lab Specialist and Manager of the Fowler Student Design Center, I have the experience needed to help design, fabricate, assemble and maintain the proposed hardware and related control and analysis systems. Indeed, this will help to fulfill a need that I wanted to bring to our students for many years. Commercially available stream tables with comparable features would typically cost at least twice as much as the proposed project budget.

I am confident that this request for funding the multi-use stream table and materials to provide this greatly enhanced stream modeling will further enhance our students' fundamental understanding of water resources engineering.