



HYDRAULICS LABORATORY FACT SHEET

Research that is Essential, Indispensable, and Connected to our Customers.

PURPOSE

The Hydraulics Laboratory provides a means of testing the hydraulic performance of highway drainage structures and stream crossings. To ensure economical design of drainage structures and safety to the traveling public, the laboratory works to solve hydraulic and stream stability problems and supports operational engineers with design guidance and tools.

DESCRIPTION

The Hydraulics Laboratory consists of a physical modeling component and a numerical modeling component that work in tandem; results are extrapolated from one and verified and calibrated by the other:

- The physical modeling facility features a 1.8-meter-(m) wide by 21.3-m-long (6-feet-(ft)) wide by 70-ft-long) tilting flume capable of simulating 13 percent longitudinal and cross-slopes. The flume has a sediment recess for local scour modeling and a sediment trap that can be connected to a sediment recirculation pump for limited livebed scour studies. It has a total pumping capacity of 22,712 liters per minute (L/min) (15 feet cubed/second (ft^3/s)) with variable-frequency drives capable of simulating in-flow hydrographs. The facility also includes a culvert test facility, a multihazard test flume and a small scale junction loss test facility.
- The numerical modeling capability features a three-dimensional (3D) sediment transport model capable of reproducing scour results that can be extended to field conditions. The 3D model is a very effective research tool for extrapolating laboratory results to limits that are difficult to achieve with a physical model study.

MAJOR COMPONENTS

The physical modeling facility includes:

- 1.8-m-wide by 21.3-m-long (6-ft-wide by 70-ft-long) tilting flume.
- Culvert testing facility for evaluating culvert hydraulics with moveable walls in the headbox to simulate various approach channel widths and velocities in the culvert headwater pool.
- A multihazard test flume for investigating structural dynamics under coincident hazards including seismic and flooding events.
- A small scale facility for evaluating conceptual procedures to estimate junction losses in access holes for storm drain systems. This facility utilizes the particle imaging velocimetry (PIV) system described below.
- Two pumps with a total pumping capacity of 22,712 L/min (15 ft^3/s) and with variable frequency drives capable of simulating in-flow hydrographs.
- Unique flow visualization capability to illustrate the complex flow patterns around bridge piers and to evaluate potential scour countermeasures.
- A customized small-scale PIV system including a laser light source and high-resolution digital cameras with capabilities to measure complex flow patterns in an entire section of flow. Software has been developed to produce flow animation and streamlines to facilitate visualization and quantification of flow patterns around hydraulic structures.
- Fully automated and programmable instrument carriages to facilitate data acquisition for all experiments.
- Eight desktop computers, two National Instruments™ PCI eXtensions for Instrumentation (PXI™) systems with LabVIEW™ Application Builder® software for Real Time data acquisition and processing and a Local Area Network system for transferring data between computers.

ACCOMPLISHMENTS

- Conducted several forensic investigations of major bridge collapses, including the 1989 Hatchie River bridge failure in Tennessee and the 1995 I-5 bridge collapse in California.
- Investigated bridge scour countermeasure ideas and development.
- Developed criteria, currently in the Federal Highway Administration's (FHWA's) Hydraulics Engineering Circular (HEC)-23, for protection of piers and abutments from scour.
- Collaborated with researchers from the University of Florida to developed guidelines, currently in FHWA's HEC-18, for estimating scour around piers with complex geometries.

The Turner-Fairbank Highway Research Center (TFHRC) has more than 24 laboratories for research in the following areas: safety; operations, including intelligent transportation systems; materials technology; pavements; structures; and human centered systems. The expertise of TFHRC scientists and engineers covers more than 20 transportation-related disciplines. These laboratories are a vital resource for advancing this body of knowledge created and nurtured by our researchers. The Federal Highway Administration's Office of Research, Development, and Technology operates and manages TFHRC to conduct innovative research to provide solutions to transportation problems both nationwide and internationally. TFHRC is located in McLean, Virginia. Information on TFHRC is available on the Web at ***www.tfhrc.gov****.*

- Developed junction loss routines for storm sewer analyses. Currently conducting small-scale PIV experiments to evaluate proposed modifications to those routines.
- Conducted model studies (physical and numerical) for scour evaluation of the Woodrow Wilson Bridge, which spans the Potomac River between Virginia and Maryland.
- Conducted a model study for a proposed bridge over the Milwaukee River where a major sanitary line could be undermined by bridge scour.
- Conducted culvert entrance loss studies for Iowa, South Dakota, and the Federal Emergency Management Agency (FEMA).
- Conducted scour in bottomless culverts studies for the Maryland State Highway Administration (SHA).

EXPERTISE

Laboratory expertise includes:

- Laboratory manager with more than 30 years of experience in hydraulics and hydraulic research.
- Laboratory co-manager with a doctorate in fluid mechanics and more than 15 years of laboratory experience.
- Research engineer (contract) with a doctorate in computational hydroscience and engineering and more than 15 years of numerical modeling experience.
- Electronic engineers (contract) with contemporary experience in instrumentation and data processing.
- Expertise in fluid measurement techniques, including a hydrogen bubble technique (HBT) for flow visualization and high-speed digital photography of illuminated flow sections using a high energy pulsed laser for PIV.
- Access to professionals experienced in systems analysis, risk analysis, urban drainage design, and numerical modeling.

Laboratory Managers:
Sterling Jones
E-mail: sterling.jones@fhwa.dot.gov
Voicemail: 202–493–3043

Kornel Kerenyi
E-mail: kornel.kerenyi@fhwa.dot.gov
Voicemail: 202–493–3142

LABORATORY PARTNERS

The Hydraulics Laboratory has partnered with the Iowa Department of Transportation (DOT), Maryland SHA, Pennsylvania DOT (PennDOT), South Dakota DOT, Texas DOT (TxDOT), and FEMA.

FHWA-HRT-05-061
HRDI-07/07-05(1M)E