Transportation Pooled Fund Program TPF-5(552) Quarterly Progress Report

Quarter 3, July – September 2025

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TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): _FHWA_______________________________________

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e., SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* *TPF-5(552)*	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☒Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 1 – December 31)

Project Title:		
High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics		
Name of Project Manager(s): *James Pagenkopf*	**Phone Number:** *(202) 493-7080*	**E-Mail** *james.pagenkopf@dot.gov*
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**

Project schedule status:
☒ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**

Project Description:

The Federal Highway Administration established an Inter-Agency Agreement (IAA) with the Department of Energy's (DOE) Argonne National Laboratory (ANL) Transportation Analysis Research Computing Center (TRACC) to get access and support for High Performance Computational Fluid Dynamics (CFD) modeling for highway hydraulics research conducted at the Turner-Fairbank Highway Research Center (TFHRC) Hydraulics Laboratory. TRACC was established in October 2006 to serve as a high-performance computing center for use by U.S. Department of Transportation (USDOT) research teams, including those from Argonne and their university partners. The objective of this cooperative project is to:

- Provide research and analysis for a variety of highway hydraulics projects managed or coordinated by State DOTs.
- Provide and maintain a high-performance Computational Fluid Dynamics (CFD) computing environment for application to highway hydraulics infrastructure and related projects.
- Support and seek to broaden the use of CFD among State Department of Transportation employees.

The work includes:

- Computational Mechanics Research on a Variety of Projects: The TRACC scientific staff in the computational mechanics focus area will perform research, analysis, and parametric computations as required for projects managed or coordinated by State DOTs.
- Computational Mechanics Research Support: The TRACC support team consisting of highly qualified engineers in the CFD focus areas will provide guidance to users of CFD software on an as needed or periodic basis determined by the State DOTs.
- Computing Support: The TRACC team will use the TRACC clusters for work done on projects; The TRACC system administrator will maintain the clusters and work closely with the Argonne system administrator's community; The TRACC system administrator will also install the latest versions of the STAR-CCM+ and OpenFOAM CFD software and other software that may be required for accomplishing projects.

Progress this Quarter:
(Includes meetings, work plan status, contract status, significant progress, etc.)

1: Computational Mechanics Research on a Variety of Projects

1.1. Noise barrier Wall Inlet Modeling

The main goal of the project is to design an 81"-tall noise barrier with drainage window which is meant to be installed along Ohio highways in on-grade and sag conditions. The general parameters for the modeling of hydraulic efficiency, defined as the percentage of intercepted flow to the total flow for an on-grade scenario, are as follows:

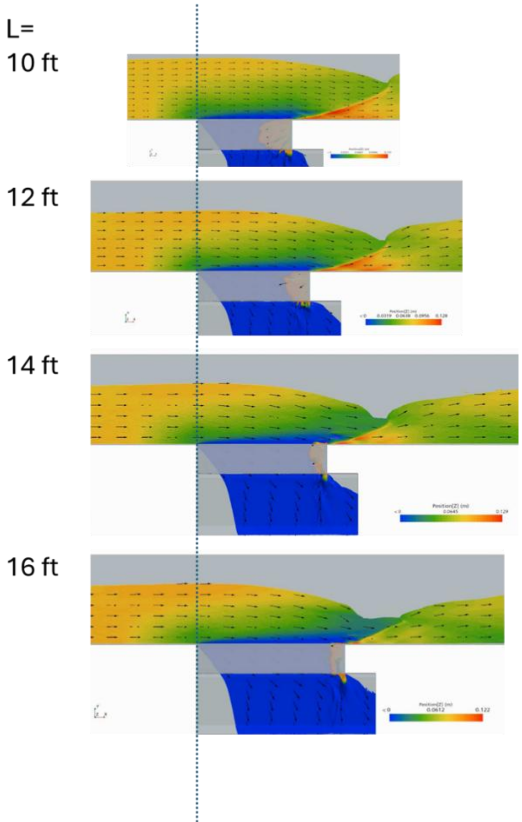
- Shoulder section with a 2-inch depression at the face of the barrier,
- Roadway longitudinal profile grades at the following slopes: 0.25%, 0.5%, 1%, 3%, and 5%,
- Shoulder section width of 4' and 10' at a 4.0% shoulder cross slope and a 1.6% pavement cross slope
- For flow spreads: 2, 4, 6, 8, and 10 feet.

The hydraulic capacity of flow relative to the depth of ponding in a sump condition is analyzed for the following flow depths: 2, 4, 6, 12, and 18 inches.

The scope covers examining varying window lengths and configurations to maximize hydraulic efficiency on grade up to an absolute maximum window length of 20 ft. The opening outlets to a flume behind the wall for conveyance of flow to a roadside ditch section. Varying configurations of the opening to the flume under the wall section to maximize conveyance are evaluated. The minimum height for the window opening at the inlet is set to 4", tapering to an increased height at the outlet to the flume to prevent potential clogging of debris under the barrier section.

The height of the window does not significantly impact the intercepted flow for the considered flow and geometric conditions. A 10-foot-long opening was modeled as 4" and 6" high and the resulting efficiency is 0.36 and 0.37, respectively, for flow rate 7.9 cfs at longitudinal slope 0.05 (considered to be the upper bound in the tested range). Nevertheless, it was decided to adopt the taller window, to reduce the risk of clogging with roadside debris.

The impact of the length of the window on efficiency at the abovementioned scenario is presented in Figure 1. On the left, the top views of the flow patterns in the vicinity of the drain with varying length are shown, and on the right, a plot of the hydraulic efficiency vs. window length is presented. In the tested range, the relationship is linear, and for every 2-foot increase in length, the efficiency increases by about 10%.



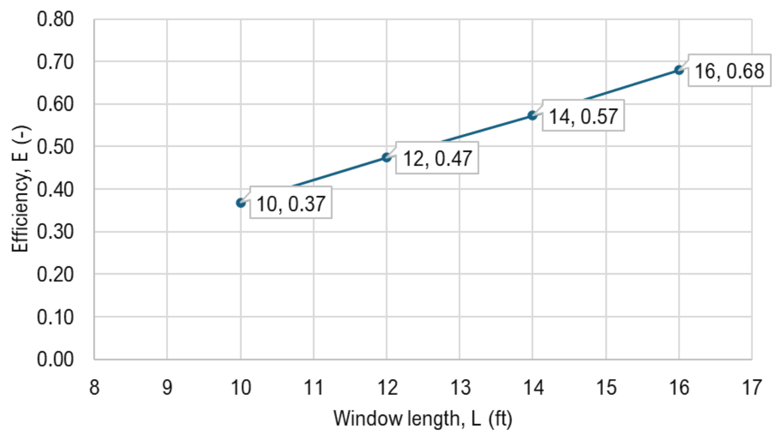
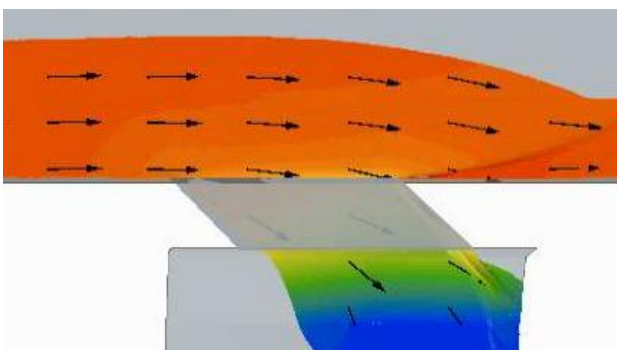


Figure 1. Impact of the varying length, L, of the window opening on the hydraulic efficiency for Q=7.9cfs at longitudinal slope 0.05.



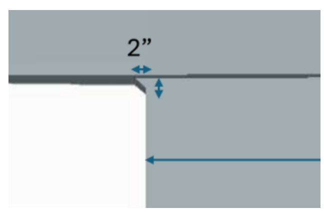


Figure 2. Evaluated changes to the geometry of the window, tapers (left), and chamfers (right).

Additional changes to the geometry of the window consisted of adding tapers to the sides of the opening, and chamfering of the edges on the roadway side. The hydraulic efficiencies varied from 0.36 to 0.37, well within the modeling error), and therefore, the changes were deemed unnecessary to improve efficiency.

Currently, the only variable being analyzed is the window length, in the range from 10 ft to 20 ft. Simulations of the flow are ongoing for varying flow rates and longitudinal grades.

Anticipated work in the next quarter:

1: Computational Mechanics Research on a Variety of Projects

- hydraulic analysis of catch basins on grade and in sump
- culvert hydraulics
- modeling of water film on pavements

2: Computational Mechanics Research Support

This work will continue.

Task 3: Computing Support

This work will continue.

Circumstance affecting project or budget.

(Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None.