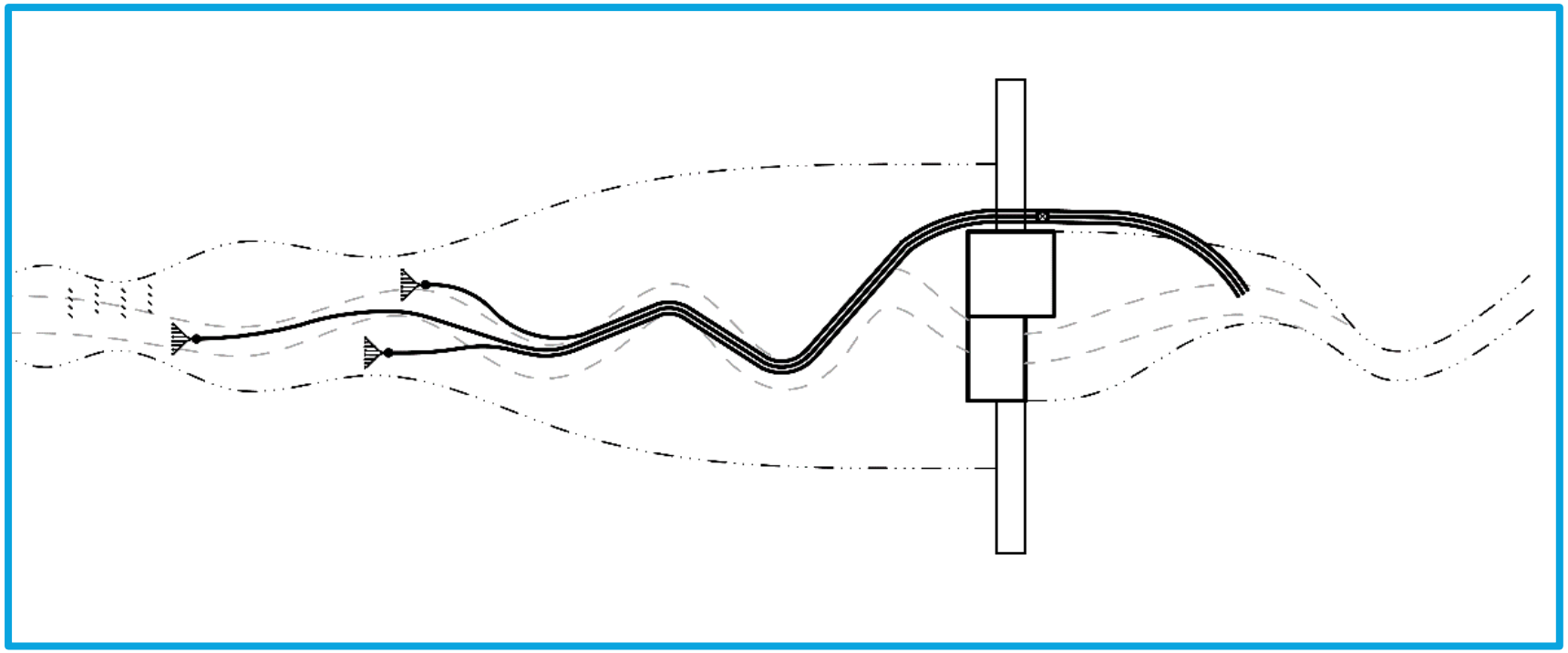
Design for Support of Standard Modular Hydropower



Presenter: Jeff Marr

Organization: University of Minnesota

Email: marrx003@umn.edu

Presentation Date: July 27, 2022

Project Overview

Project Summary

This project advances the conceptual design and performance testing of sediment bypass technology for new hydropower installations.
- Technology meets attributes of the Standard Modular Hydropower program
- System seeks to provide CONTINUOUS bypass of sand
- Advance technology from TRL 2 to TRL 4 over duration of project
- Evaluate opportunities for Advanced Materials/Advanced Manufacturing
- Develop cost estimates for technology and compare to other similar tech.

Intended Outcomes

- Advance conceptual design from early stage through 80% complete
- Provide performance verification of the technology using models and experiments.
- Develop cost estimates for the technology and compare to baseline technologies.

Project Information

Principal Investigator(s)

- M.Guala, L.Shen, J.Gulliver (UMN)

Project Partners/Subs

- William Forsmark – Barr Engineering
- Rick Voigt – Voigt Consultants
- Peter Wilcox – Utah State University

Project Status

Budget Period 1 Complete. Go/No-Go Review assessment underway

Project Duration

- Project Start Date: 05/01/2020
- Project End Date: 12/31/2023

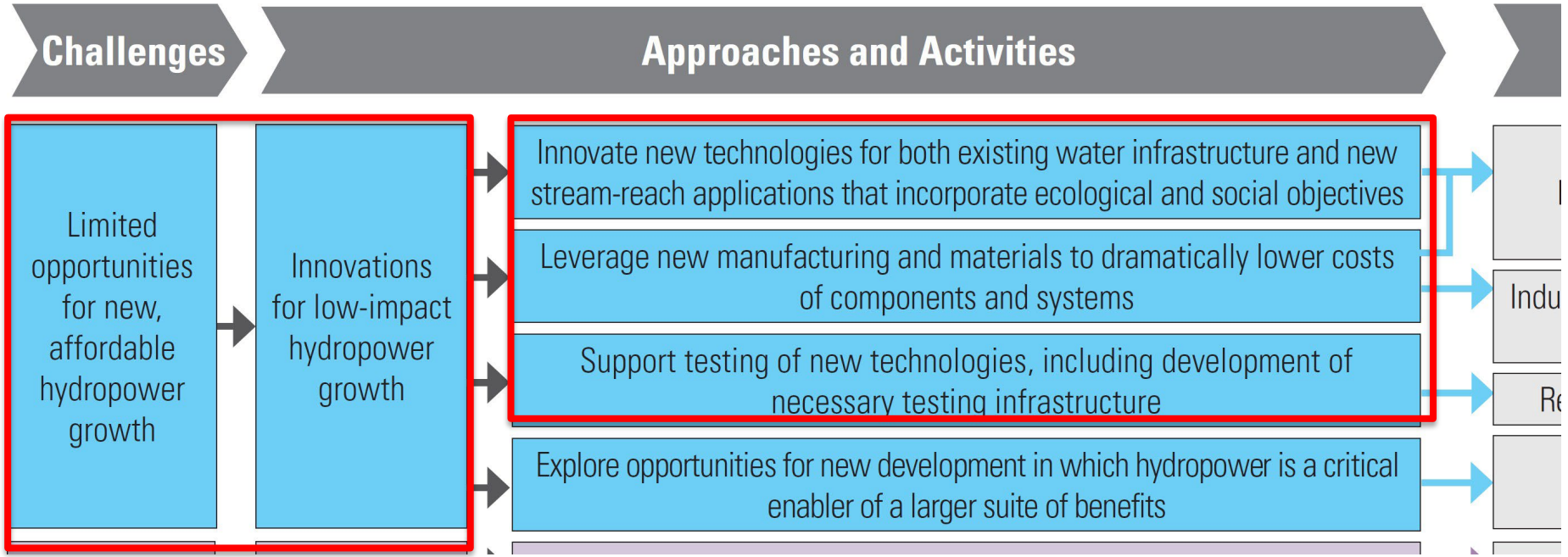
Total Costed (FY19–FY21)

$323,951 of $599,304 (Federal Share of BP1; UMN has met 20% cost share)

Project Objectives: Relevance

Relevance to Program Goals:

- Technologies for sediment bypass are vital for next-generation hydropower to mitigate negative ecological impacts.
- Answers challenges from Hydropower Program Goals and Objectives



Project Objectives: Approach

Advance the design toward a commercializable, cost effective technology

- Broad Technical Team (research engineers, faculty, practitioners, experimentalists, modelers)
- Establish clear design context and performance objectives
- Workflow – Design | Prototyping | Testing/Modeling | Re-Design
- Project Management
  - Monthly/Quarterly check-in meetings with Dept of Energy
  - Rapidly identify and mitigate issues
    - E.g. schedule delays due to Covid 19

Project Objectives: Expected Outputs and Intended Outcomes

Expected Outputs:

- Journal publications related to fundamental research (3 articles to date)
- Possible update to ORNL Exemplary Design Envelope Guidance, Append C (sediment passage)
- Advancement of new technology for sand bypass at dams.

Short-term Outcomes:

- Re-introduces the importance of sediment bypass technologies with hydropower facilities.
- Provides DOE with early-indication of viability of sediment passage technology informing future FOAs.
- Motivates continued development of technology and path to commercialization.

Project Timeline

Budget Period 1 – February 2020 – June 2022

- Task 1- Task 4 – Advancing technology to 40% conceptual design
  - Monthly check in meeting with DOE WPTO project monitors
  - Quarterly report and check-in call including project monitors and WTPO Leadership
- Task 5 – Go/NoGo Review (Conducted June 27, 2022)

Budget Period 2 –June 2022 – December 2023

- Task 6- Task 7 - Advance technology to 80% conceptual design
- Task 8 – Final design report

Project Budget

Total Project Budget – Award Information		
DOE	Cost-share	Total
$1,000K	$252K	$1,252K

FY19	FY20	FY21	Total Actual Costs FY19–FY21
Costed	Costed	Costed	Total Costed
NA	$16K	$453K	$469K

- Project spending has been inline with proposed plan.
- Project experienced substantial delay due to Covid19 preventing progress on work. Spending was also paused during this time.

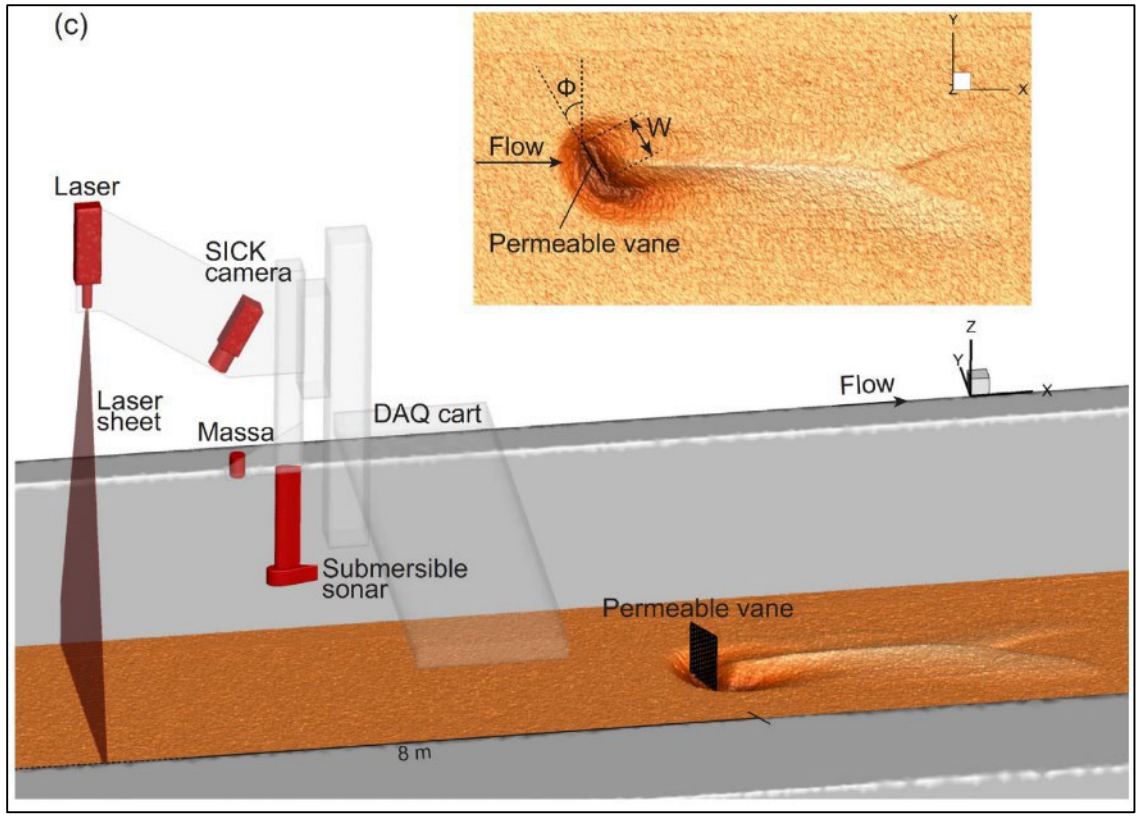
End-User Engagement and Dissemination

- Stakeholders: DOE WPTO, Facility owner and operators, watershed managers
  - Creation of viable sand bypass is essential for new stream-reach development in US. Applicable to NPDs and non-hydro as well.
  - Final report will be developed. Summarizing project and outcomes
  - Project will be presented at NHA Hydropower User Groups meetings and other venues.
  - Commercialization plan will be developed – plan additional steps to advance technology, demonstrate performance, commercialization pathway.
- UMN will seek to further develop design toward a commercialized technology.
  - Funding for next phases is not determined at this time.

Performance: Accomplishments and Progress

Developed passive permeable vane design to optimize sand capture

- Wind tunnel, flume experiments, and numerical models used to optimize design.
  - Structural design
  - Array configuration
  - Measured impact on sand transport pathways



Rendering of small scale flume experiment on vane design

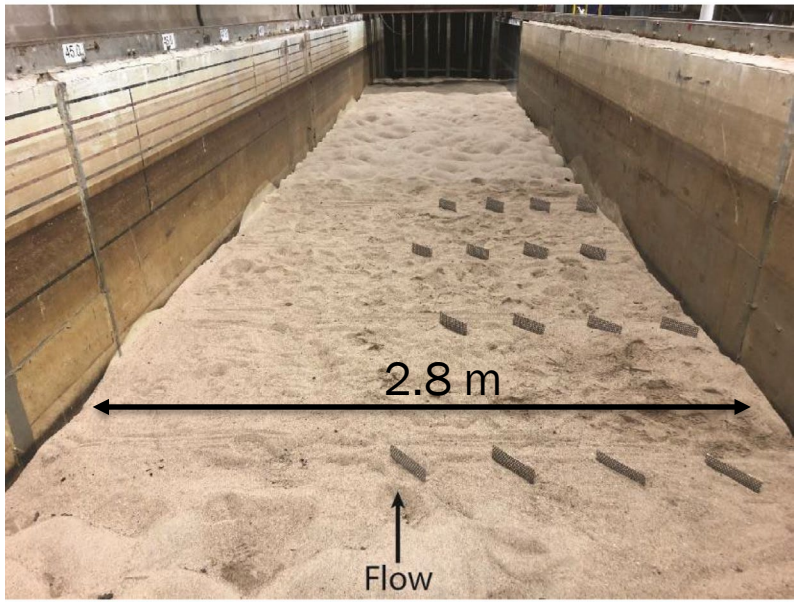


Image from large scale flume experiment of vane array

Performance: Accomplishments and Progress (cont.)

Develop low head-loss intake for sand bypass

- Analytical tools, computation fluid dynamics simulation, flume experiments
- Iterative design
- Exploring advance manufacturing with technical assistance from ORNL.

Image from flume experiments, performance verification

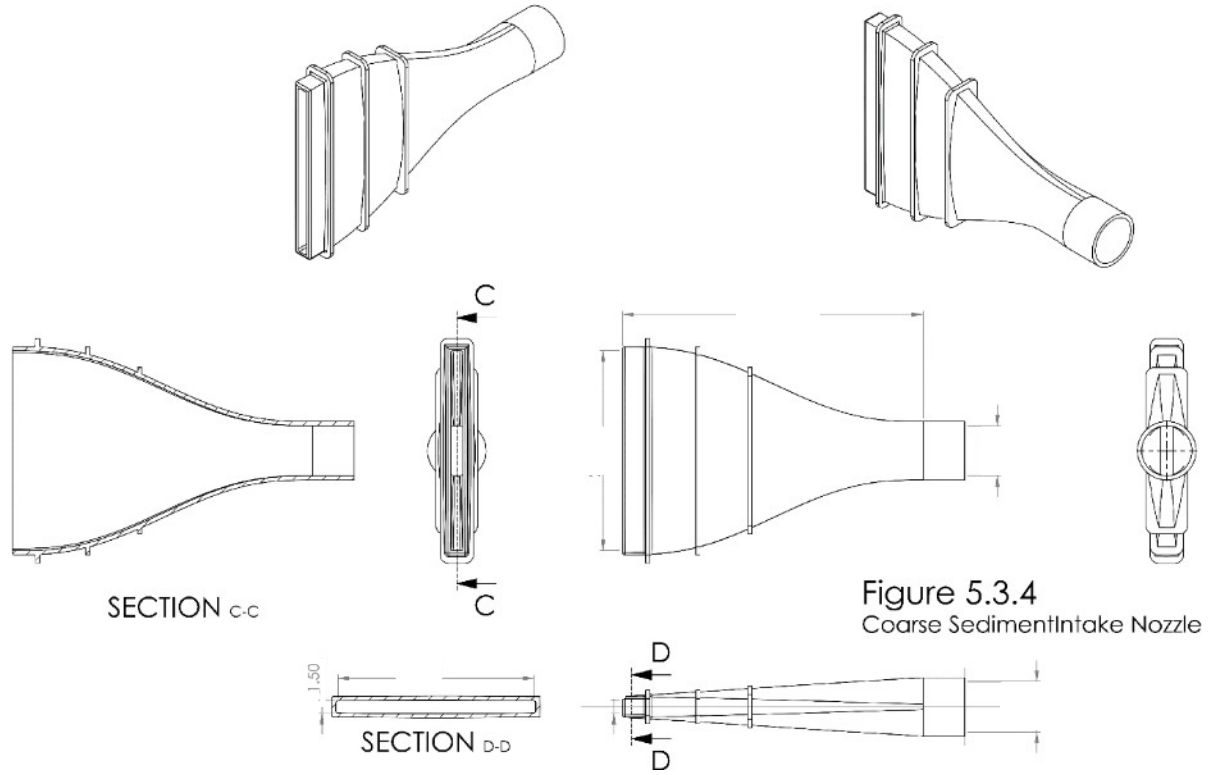


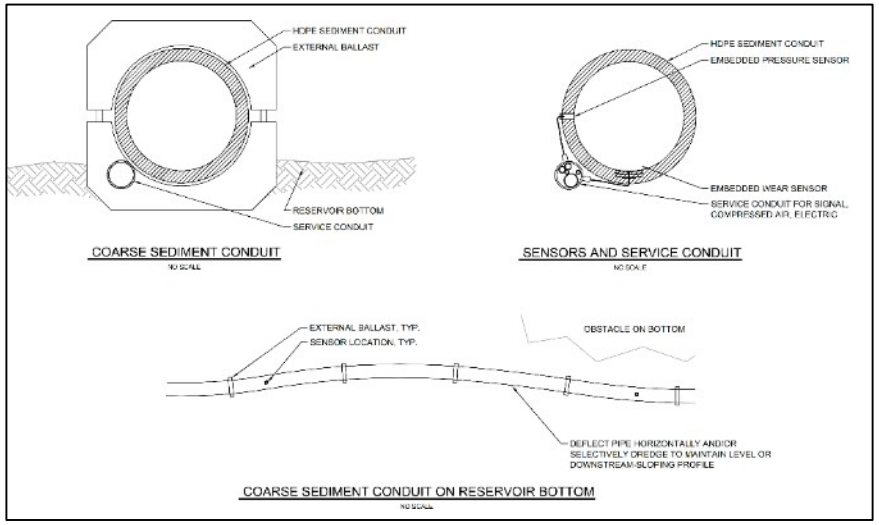
Figure 5.3.4
Coarse SedimentIntake Nozzle

Technical drawings of sand intake

Performance: Accomplishments and Progress

Expanded knowledge-based on sand transport in conduits (pipes) under typical operational conditions.

- Identified lack of information on headloss for low-concentration sand transport in pipes.
- Constructed facility. Conducted tests to generate needed data
- Developed modular conduit design.



Examples from technical design of conduit.

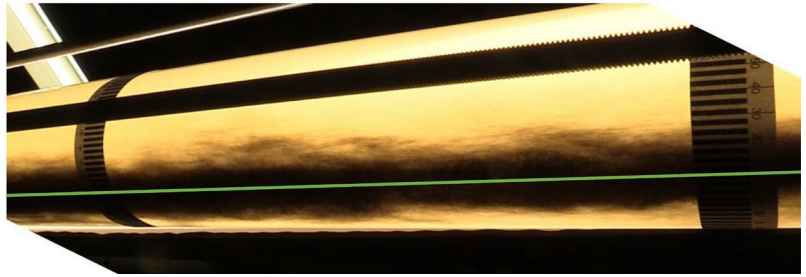


Photo of sand transport in clear pipe

Photograph of conduit test facility

Future Work

- Completion of Budget Period 1 and Go/NoGo Review
  - Review meeting June 27, 2022
  - Feedback provided by review team. Developing revised Budget Period 2 plan
- Budget Period 2 –June 2022 – December 2023
  - Continue advancing technology to 80% conceptual design
  - Demonstrate component integration in large flume experiment
    - Vane-intake array + conduits + downstream discharge
    - System health monitoring and control development
  - Cost Modeling and Baseline cost comparison (with ORNL)
  - Advanced manufacturing and materials of sand intake (with ORNL)
  - Final design report

Q&A