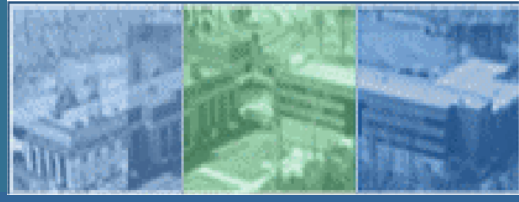
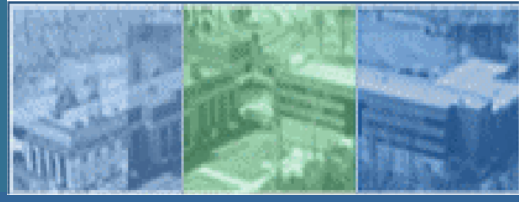


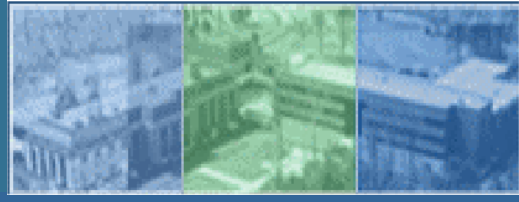
Monitoring Countermeasure Performance Using Sonar

presented by
Jerry Shen
on behalf of
Frank Jalinoos
at the
National Hydraulics Engineering Conference
Thursday, August 21, 2014
Iowa City, IA



Objectives

- Gaining confidence in countermeasure usage.
- Basis for design guidelines/specifications.
- Providing guidance for field installations.
- Long-term performance monitoring.
- Potentially changes in design philosophy.



Approaches

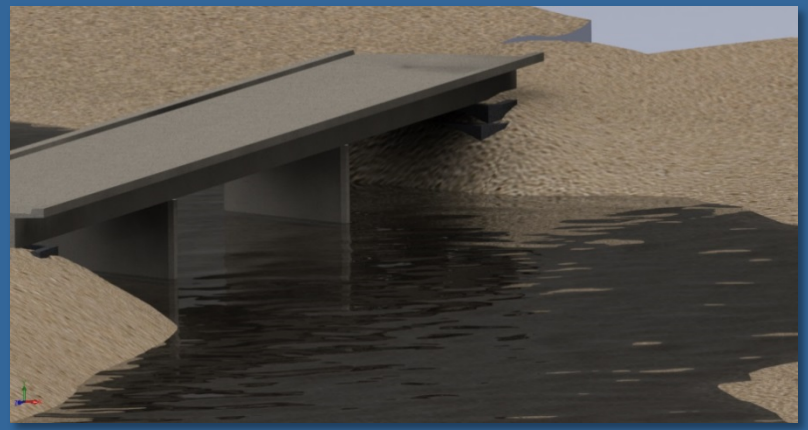
- Physical Modeling (Flume Experiments)
  - Erodible Bed Experiments
  - Fixed-Bed Experiments
- Computational Modeling (Coupling CFD/CSM)
  - Lab Calibration
  - Field Application

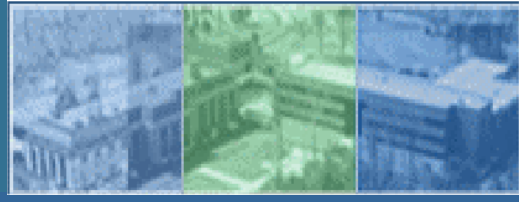
Physical Modeling

Physical Modeling: Shear Failure and Edge Failure

Field Application

- Capture the field condition of pier riprap
- CFD simulation of riprap stability
- Simple procedure for ease of implementation
- Both design verification and quality assurance



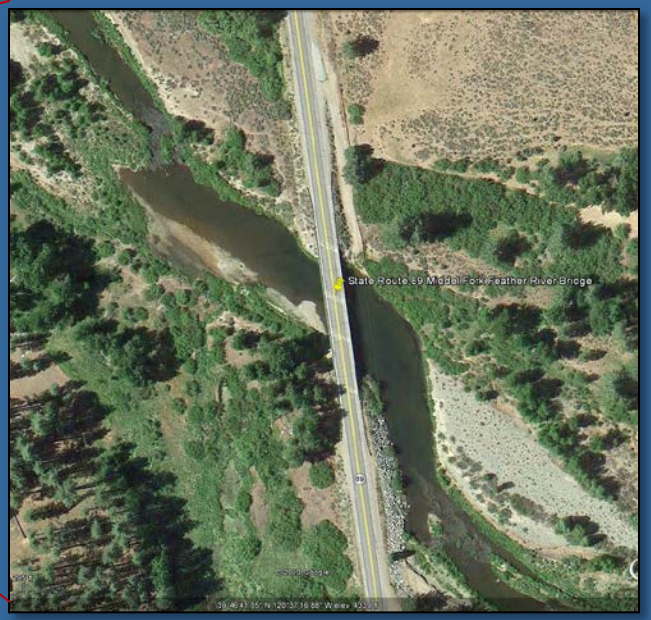


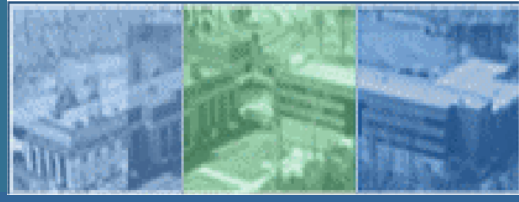
Requirements

- High resolution bathymetry data
- Options for rock placement in CFD
  - Resolve individual rock
  - Envelope surface
- Coordinates referenced to structure

Candidate bridge site

- Bridge on CA Rt. 89 over Middle Fork of Feather River
- Riprap visible from the deck

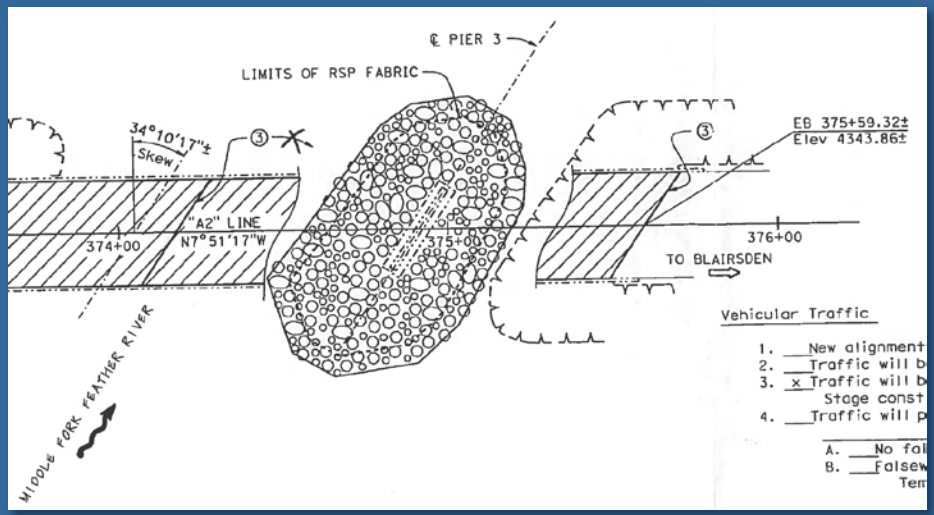


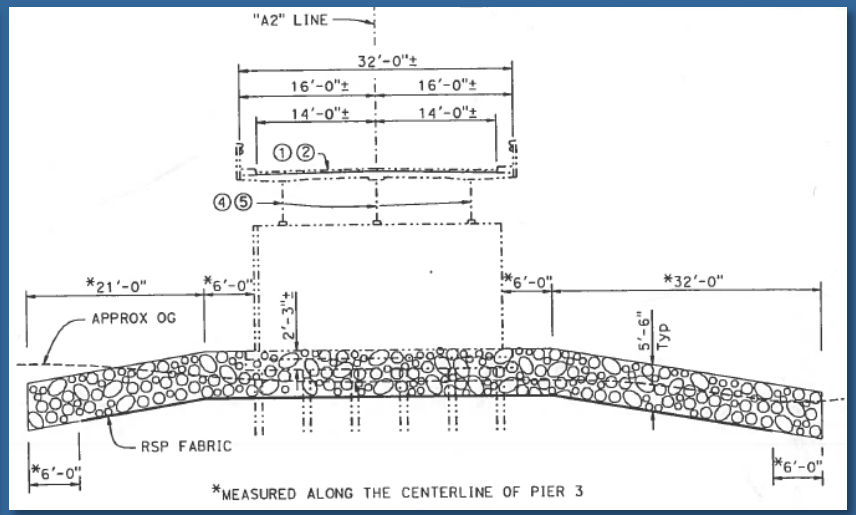


Basic information

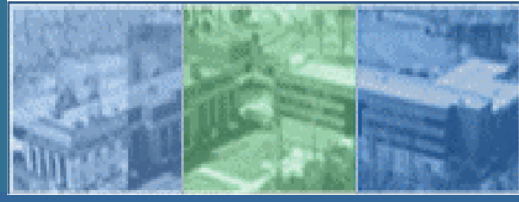
- Year built: 1955
- Span length: 19.7 m, 26.4 m, 19.7 m
- Deck width: 9.8 m
- Skew: 34°
- Freeboard: approx. 7 m
- Channel: Sand, gravel and cobble channel. Rock riprap placed around Pier 3 in 2012 scour mitigation.
- Visible pile cap and riprap through clear water.
- The riprap is estimated 5.5 ft to 7 ft thick.
- Depth: 4’~7’ to top of riprap

Pier 3 riprap layout





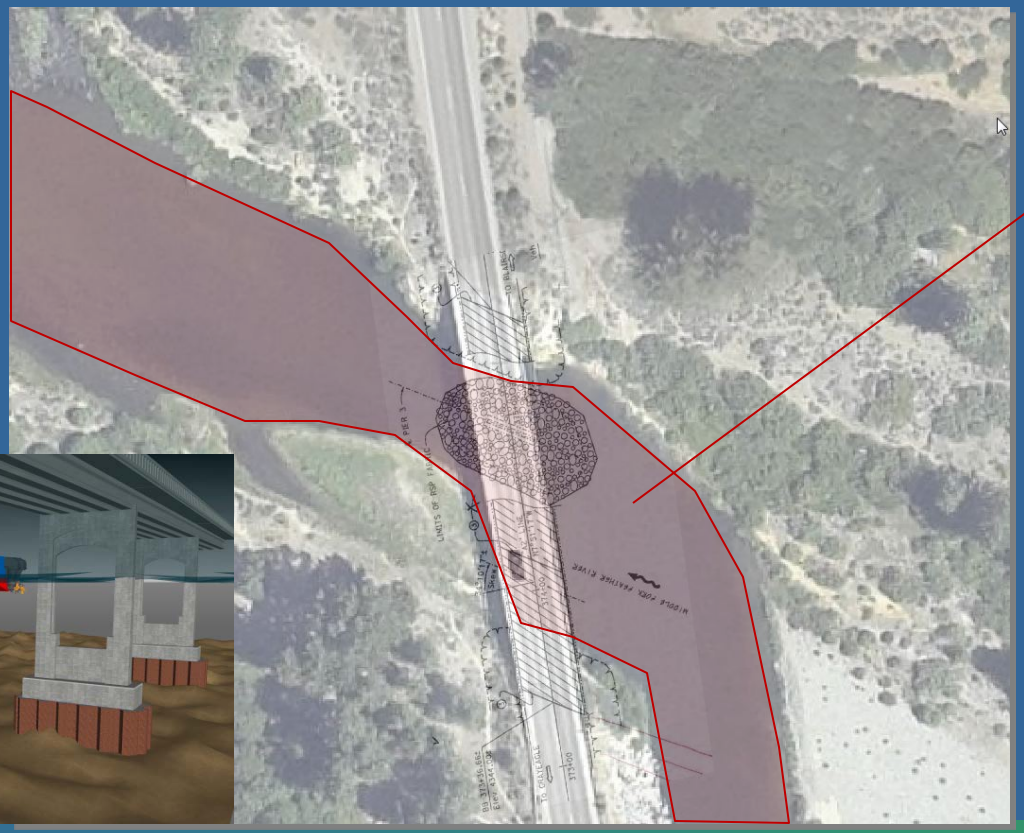
Installation and recent photo



Select Approaches

- Complete 3-D Imaging
- Stationary Near-site Profiling
- 2-D Imaging with 1-D Profiling

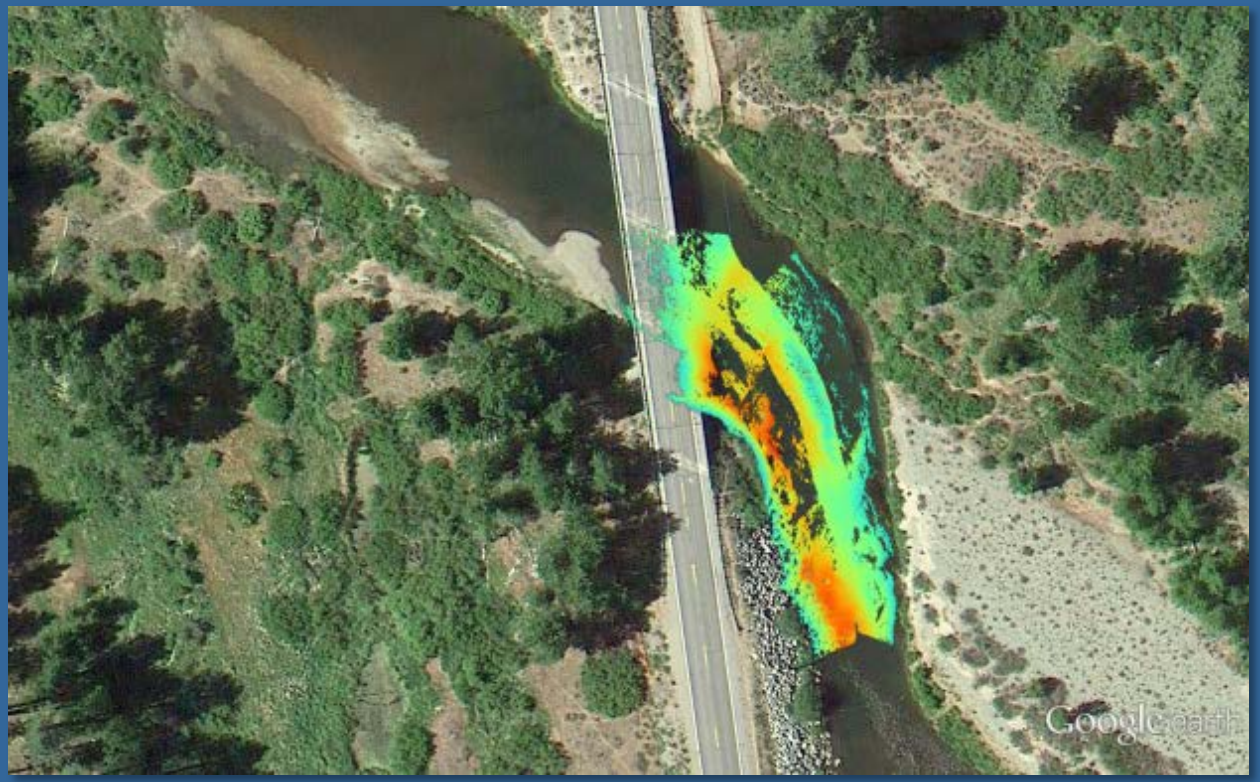
Approach 1 Complete 3-D Imaging



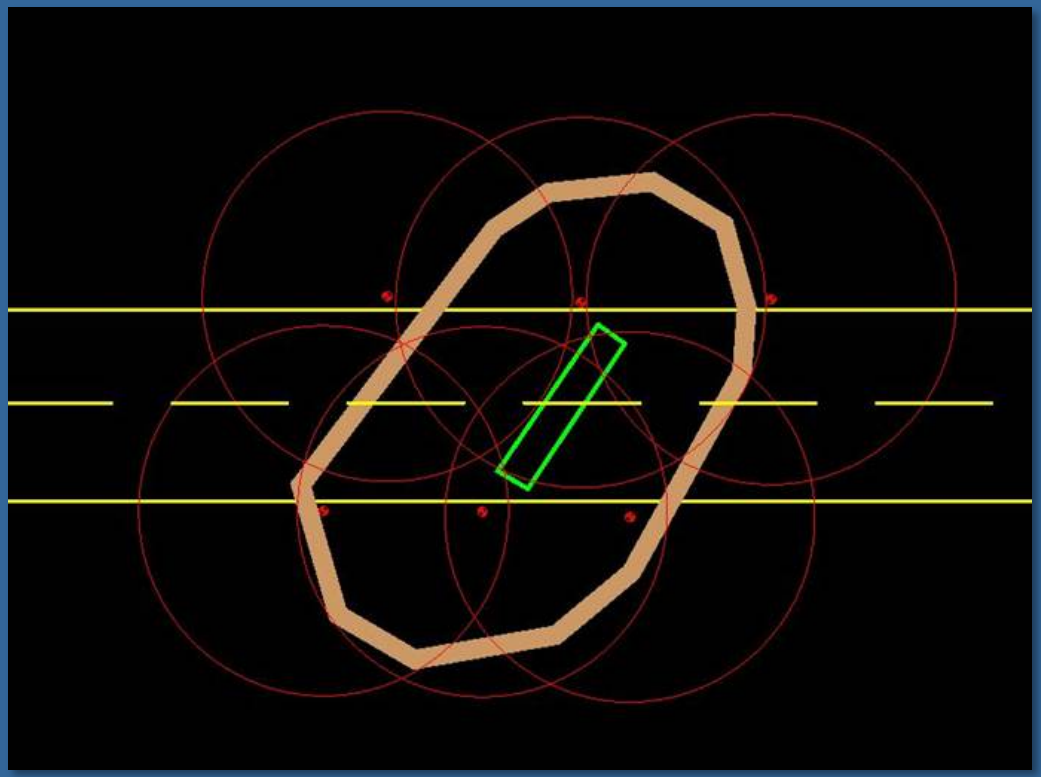
Area of interest

Complete 3-D Imaging (cont'd)

Complete 3-D Imaging (cont'd)

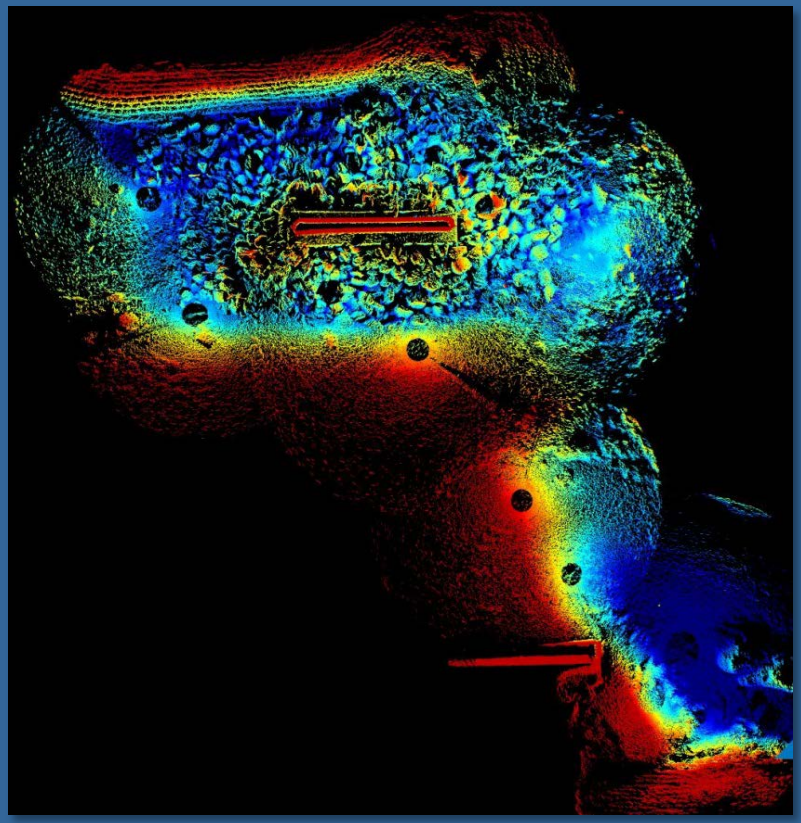


Approach 2 Stationary Near-site Profiling

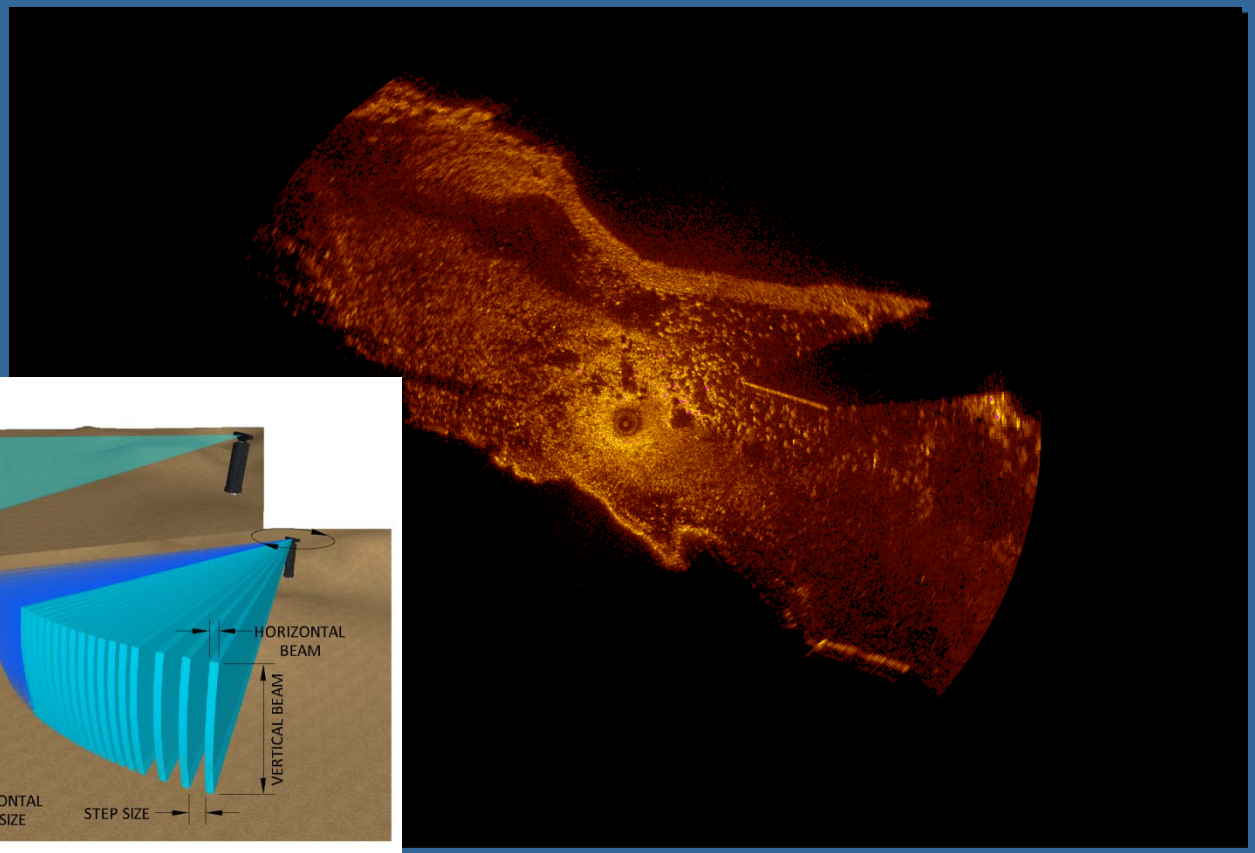


Stationary Near-site Profiling (cont'd)

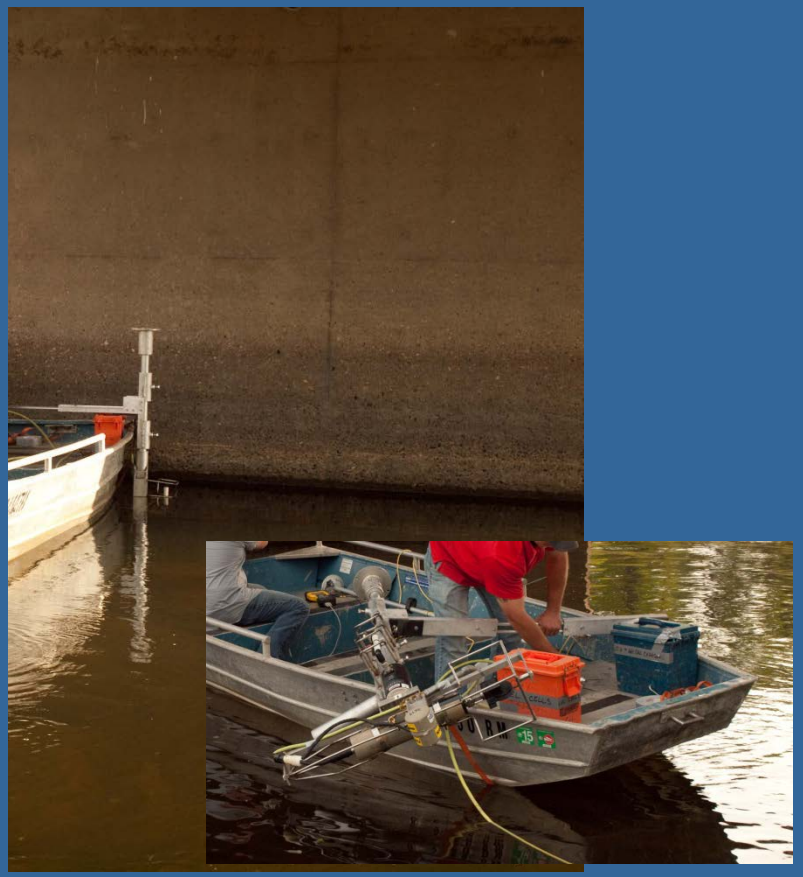
Stationary Near-site Profiling (cont'd)



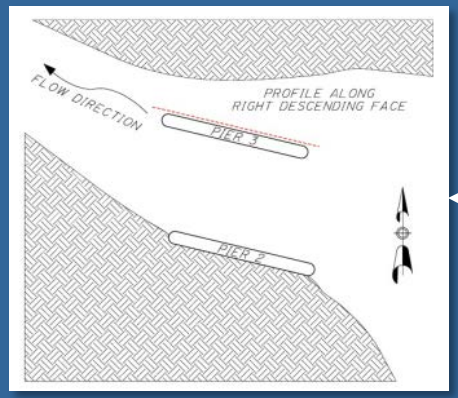
Approach 3 2-D Imaging with 1-D Profiling

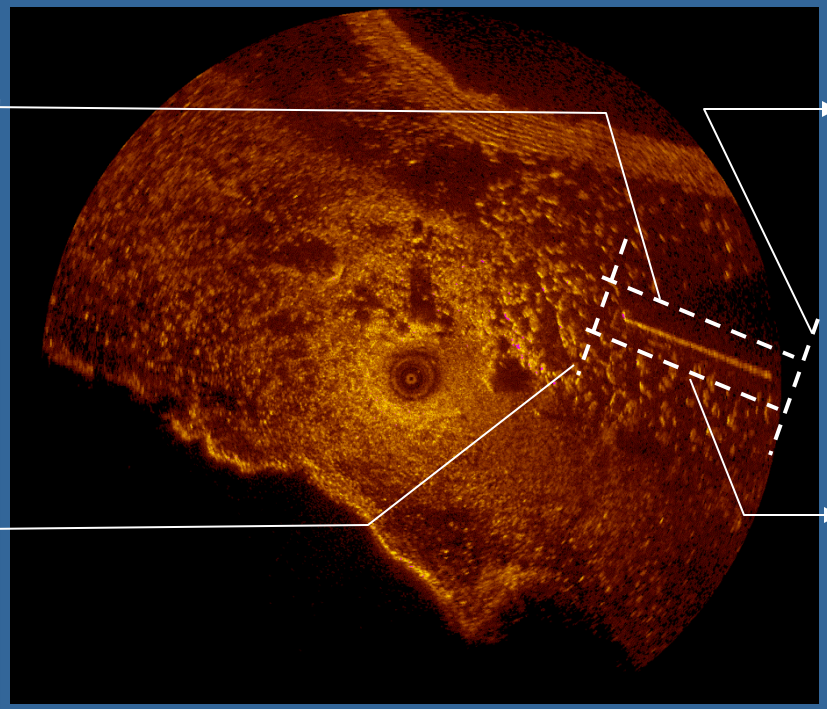


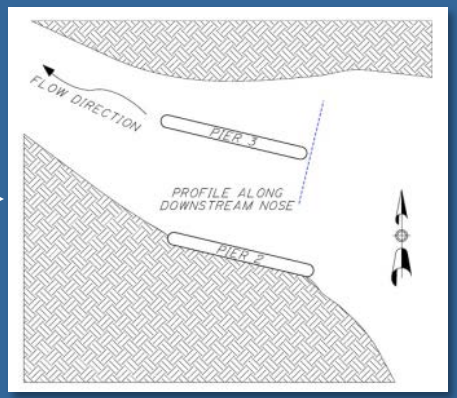
2-D Imaging with 1-D Profiling (cont'd)

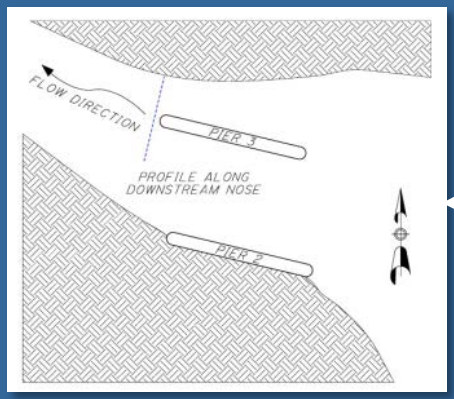


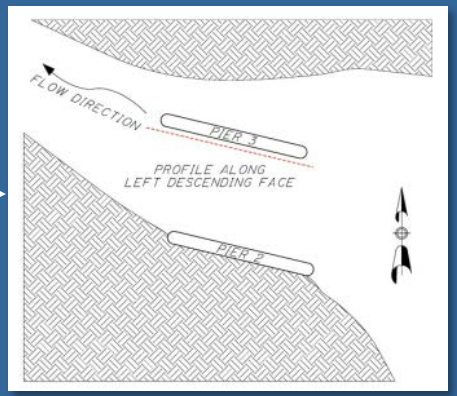
2-D Imaging with 1-D Profiling (cont'd)



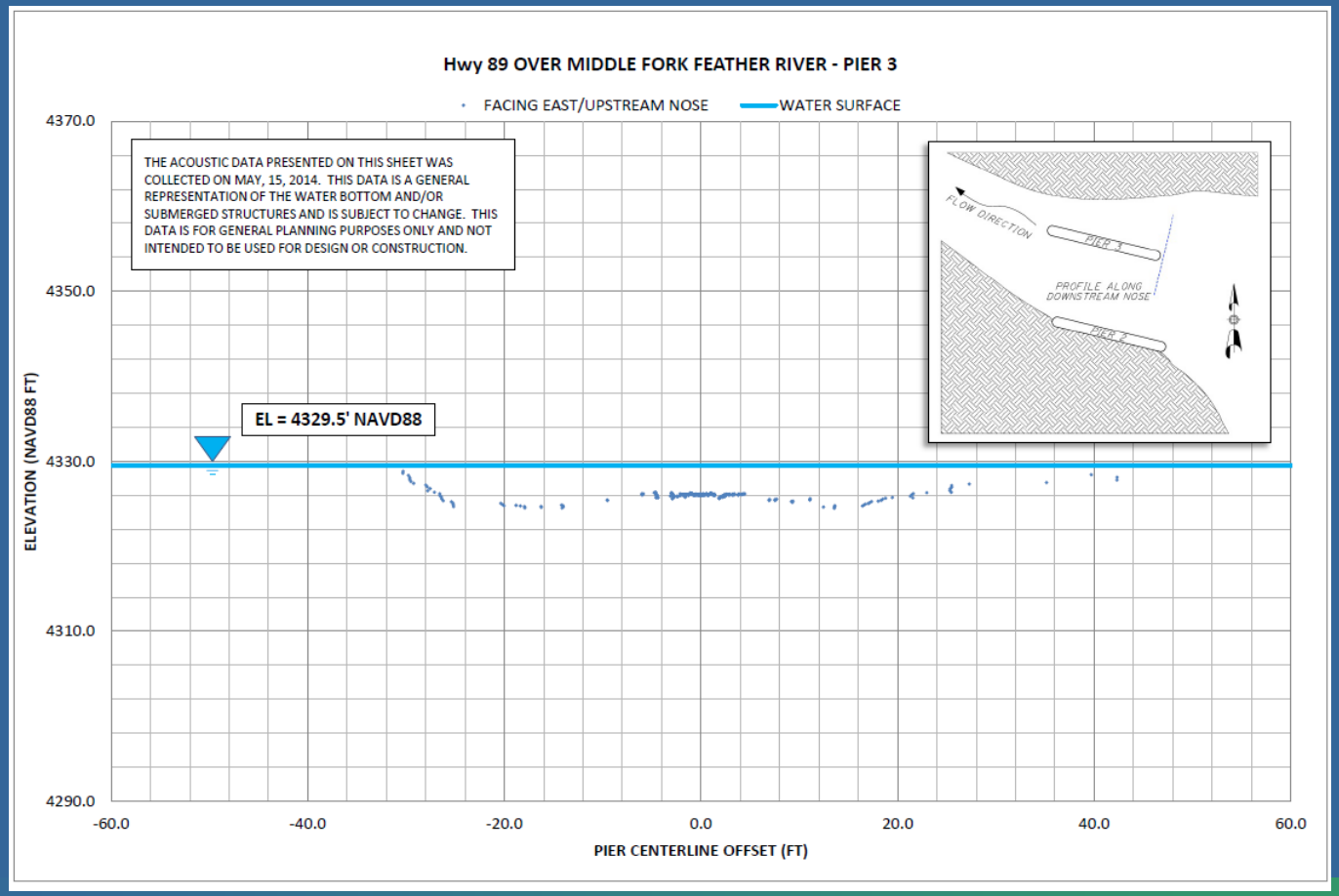




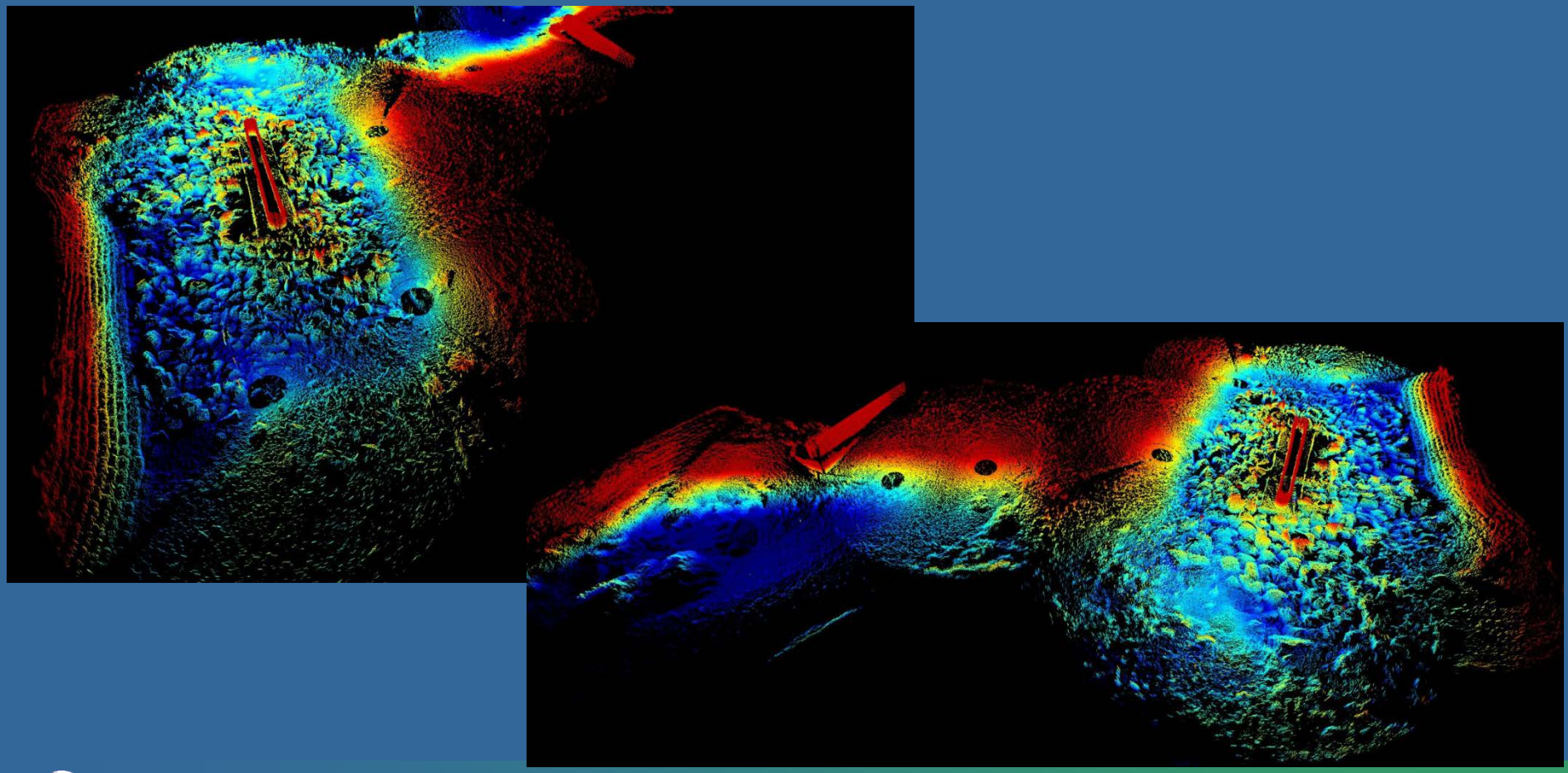


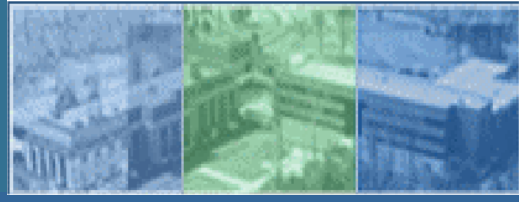


2-D Imaging with 1-D Profiling (cont'd)

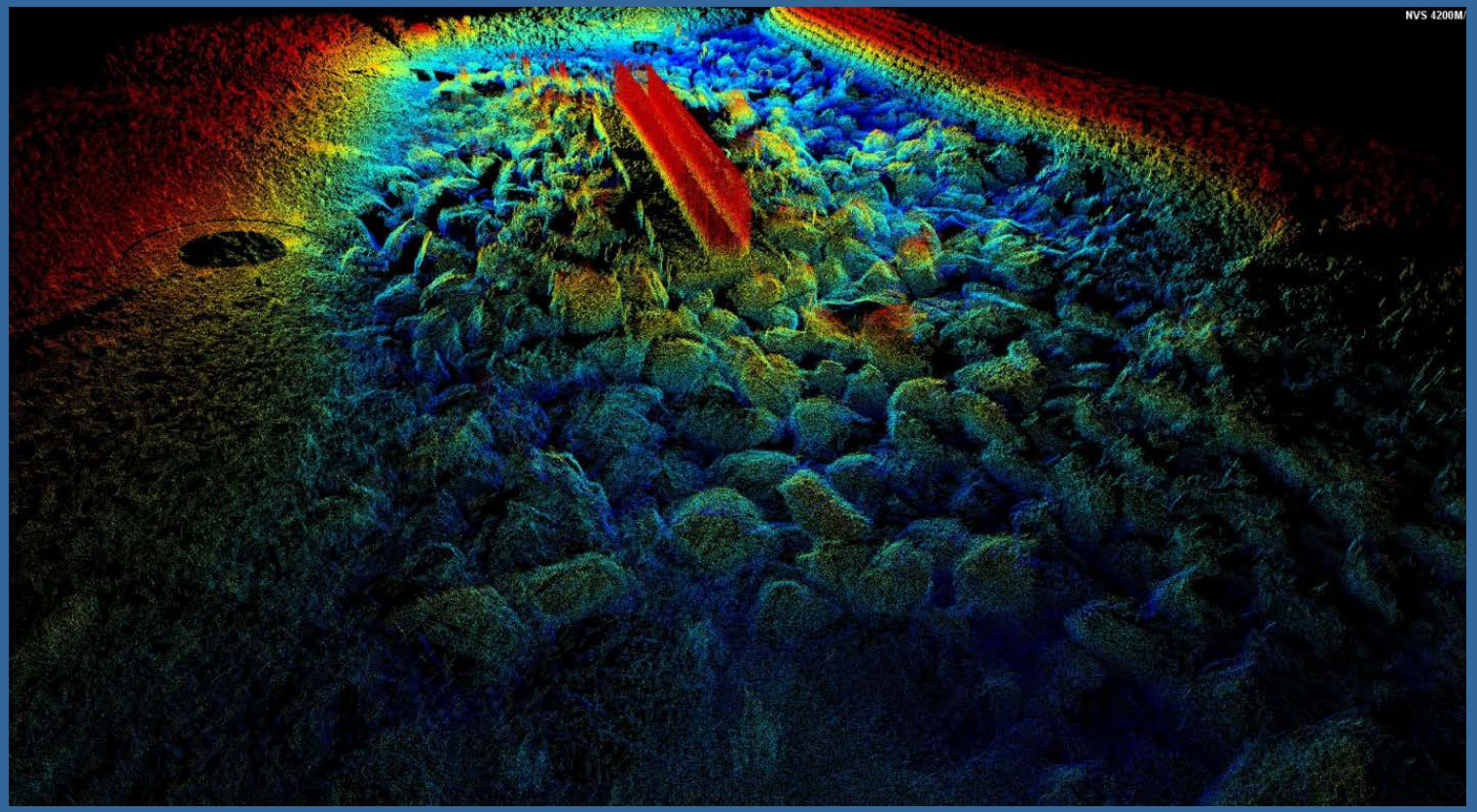


3-D Point Cloud Data for CFD

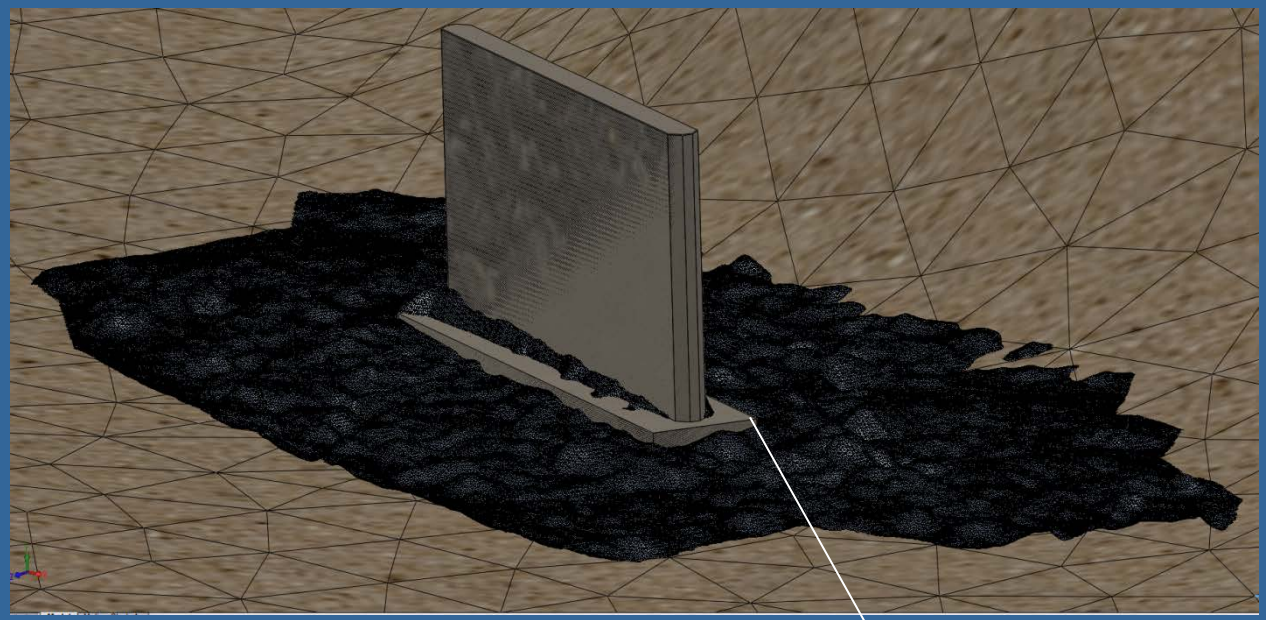




3-D Point Cloud Data for CFD

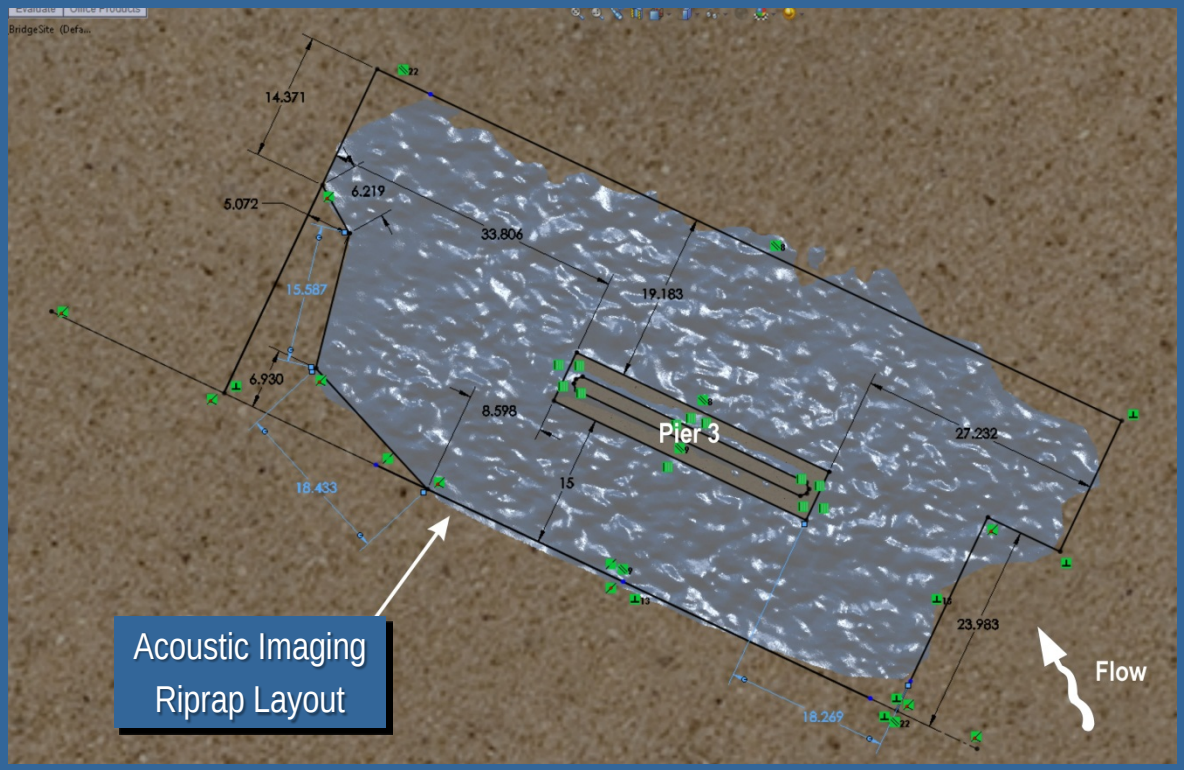


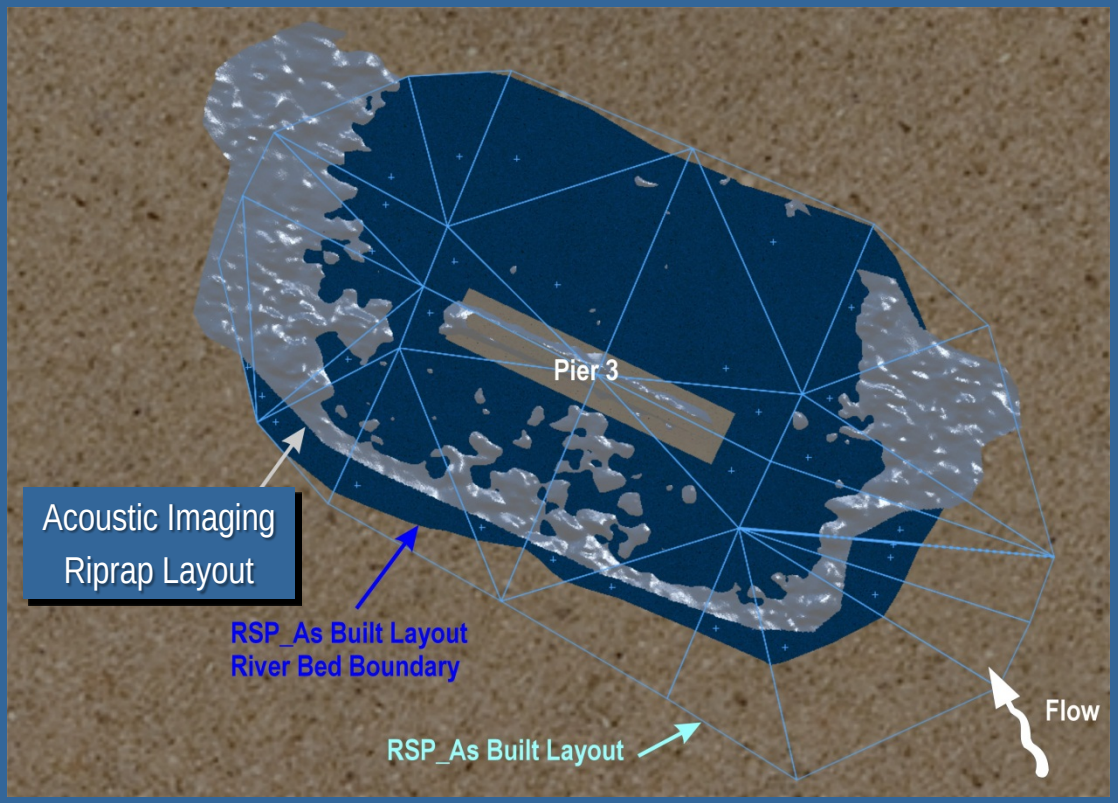
Combining with Structural Model



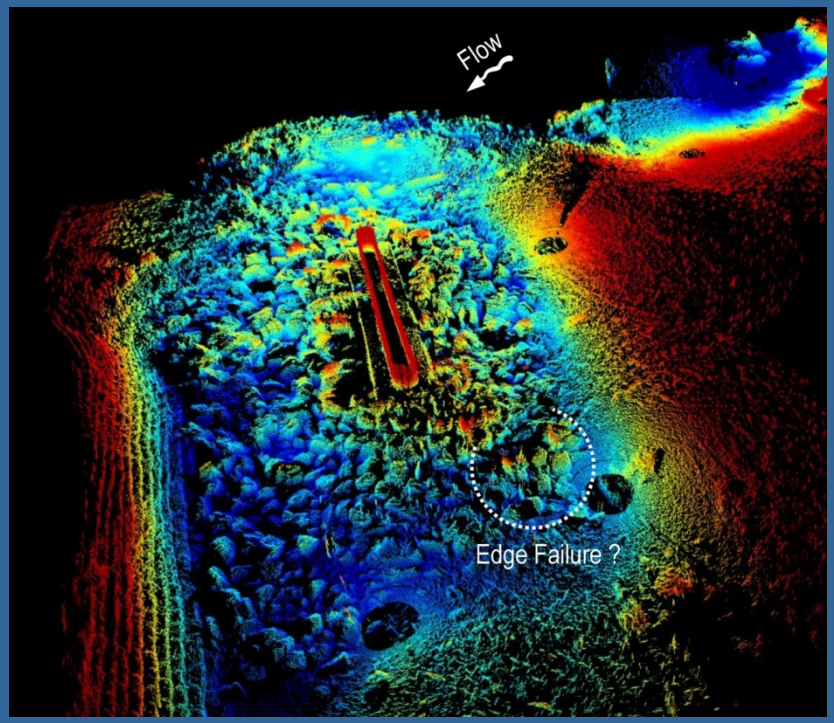
Matching coordinates between structural feature and bathymetric feature

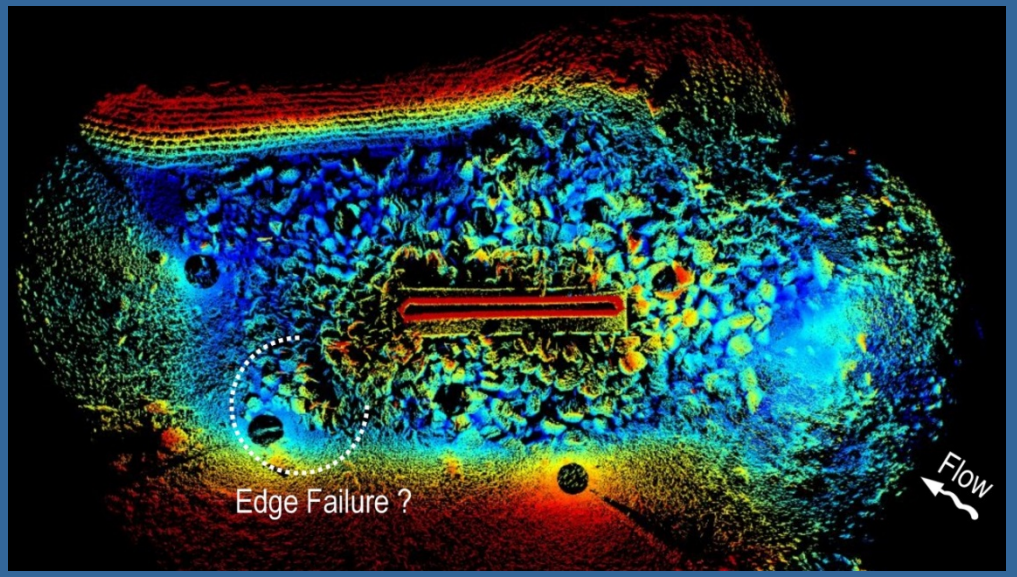
Current Condition




Pier 3
Acoustic Imaging
Riprap Layout
RSP_As Built Layout
River Bed Boundary
RSP_As Built Layout
Flow

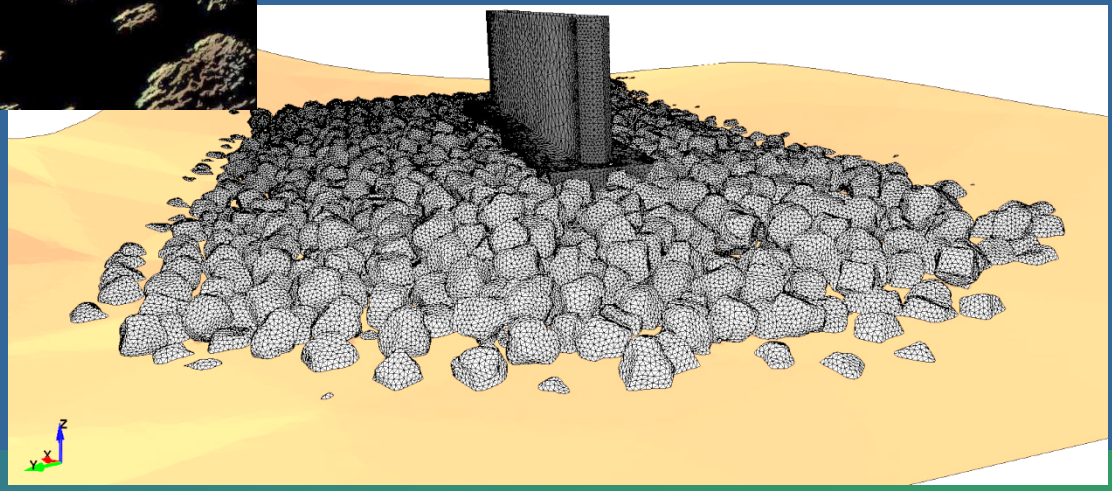
Potential Riprap Edge Failure



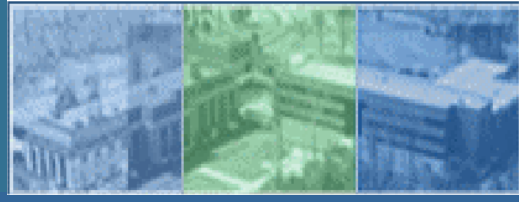


Next Step—Computational Modeling

Acoustic image



CFD model



Acknowledgement

- Literature review
  - Ayres Associates
  - Oscar Suaznabar
- Experimental study
  - Oscar Suaznabar
- Caltrans coordinator
  - Kevin Flora
- Numerical modeling
  - Cezary Bojanowski
  - Steven Lottes