



Countermeasure Design, Implementation, and Monitoring

Nicole Bartelt | Assistant Waterway Engineer

October 5, 2017

Brief History of MnDOT Scour program

- MnDOT issued formal screening guidelines in 1990
- Completed screening of all bridges in 1992
- Continued to work on all unknown foundations and scour critical bridges to present day
 - No unknown foundations left on the system (either replaced, rated critical, or rated low risk)
 - All bridges have been evaluated for scour, have a scour code, and have POAs as needed
 - Currently 350 scour critical bridges in MN, 37 are MnDOT owned

Typical MN Countermeasures

- Riprap
- Guidebanks / Spurdikes
- Bendway weirs
- Articulated Concrete Block (ACB), less common

Riprap

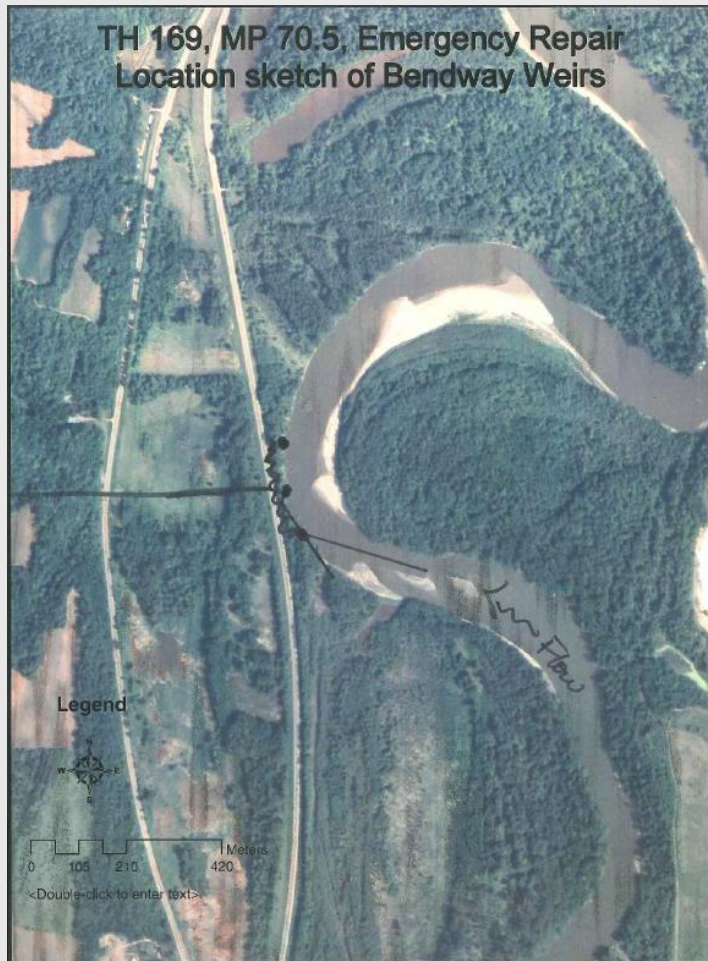
- Most common form of countermeasure
- All spillthrough abutments have riprap
- Variety of rock material and quality throughout the state



Guidebank / Spurdike



Bendway Weir



Date: 4/11/2012 1:57 PM
Lat: 0 Lon: 0

Bendway Weir location



Bendway Weir





Why new countermeasures?

- Variable riprap sources
 - Quality – angularity and durability
 - Quantity
 - Trucking (price)
- Filter material

Matrix Riprap

- AKA: Partially grouted riprap
- Renamed to avoid contractor confusion
- Frequent uses:
 - Very high velocity areas
 - Limited or poor riprap
 - Vandalism areas



Implementation Research project

- May 2012 – Hired Paul Clopper of Ayres Associates for a demonstration project
- Installed grout on an abutment slope with rounded riprap, only installed on one abutment

<http://www.dot.state.mn.us/bridge/hydraulics/resources.html>



Lessons learned

- Best to use a screw-type pump (got “pulses” of grout with a dual-piston)
- 2-3” hose diameter (2” minimum)
- Need contractor education on this method
 - Website with youtube video on installation and grout
- Always need to be onsite during install

Use in construction projects



Not so good



10/9/2017

mndot.gov/bridge/hydraulics

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Not so good



Lab study - Design impacts

- Most work with PGR was done for pier protection
- We want to use it primarily for abutment protection
- Hired SAFL-MN in April 2015
 - Within limits of the flume, could not fail the matrix riprap
 - Used both rounded and angular riprap

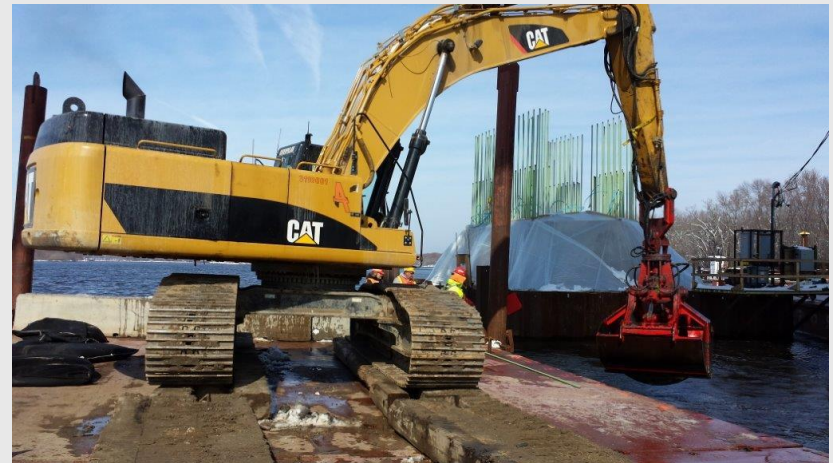
<http://www.cts.umn.edu/Research/Projectdetail.html?id=2012004>

Limitations

- Cannot place underwater – environmental restrictions (not allowed by the MPCA and DNR)
- Aesthetics – although coloring the grout makes a big difference
- Contractor knowledge
- Not sure of long-term survival - monitoring

Geobags

- Placing filter material in deep or fast moving water is difficult
 - Big 4'x4' geotextile bags partially filled with aggregate
- Used on 2 jobs on the Mississippi River



Geobag installation

Video Links

Below are links to videos of a geobag installation.

- Geobag filling: <https://youtu.be/SiDBDUntQPU>
- Geobag Stitching: <https://youtu.be/XQYsCedvYK8>
- Geobag Placement: <https://youtu.be/4sTrDazhSIM>

Inspection of Countermeasures

- Upgrade scour code to “P” – protected
- Inspect during and after flooding to ensure they performed as inspected
- Visual and 3D sonar inspection after flooding
- Primarily sonar and probing during flooding

Monitoring

- Fixed monitoring
- During flooding
- Post flood / routine inspection

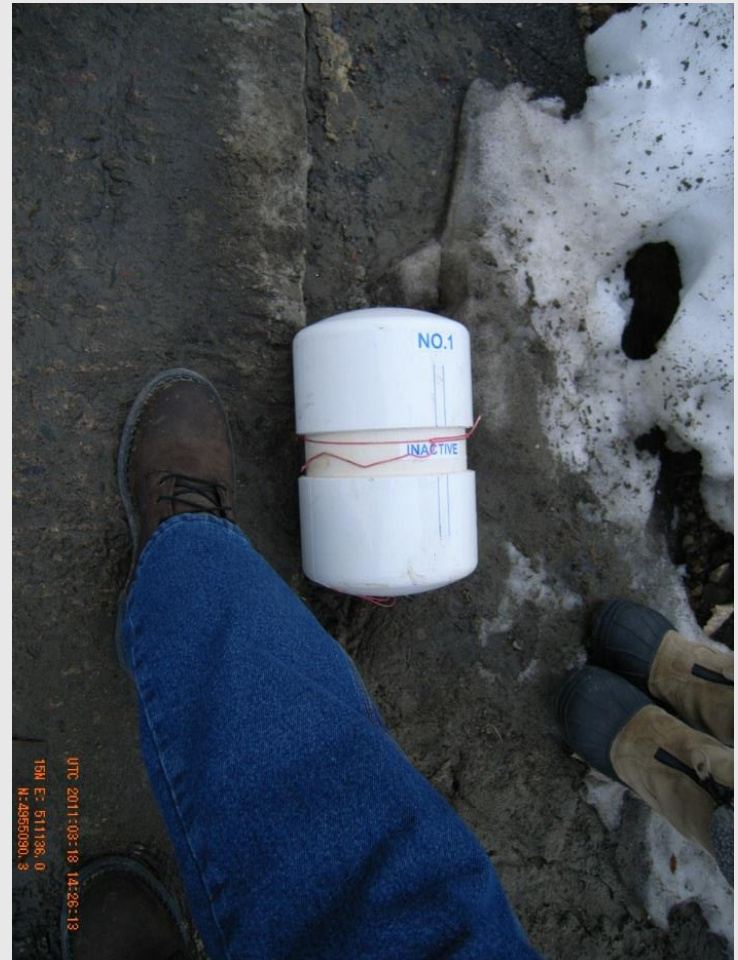
Fixed Monitoring

- Fixed sonar
- Float-outs
 - Monitor geobags and riprap placement
- Tilt sensors



Fixed monitoring issues

- Power
 - Solar power in MN at bridge sites
- Unsure if installed correctly
- System bugs/problems in getting the alarms (and false alarms)



Monitoring during floods

- Side-scan sonar (Humminbird 898c)
 - Pole mounted
 - Boogey-board
- ADCP
 - Mounted on riverboat
- Partner with USGS to measure tough spots

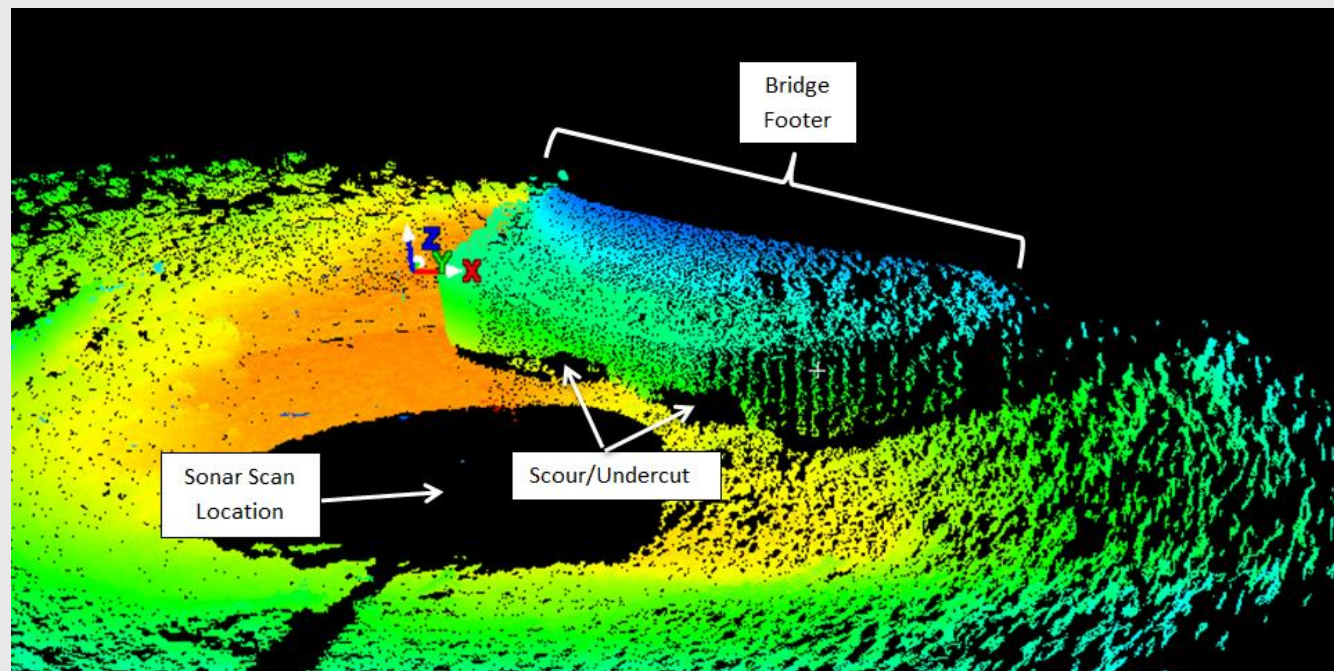




Post flood / routine monitoring

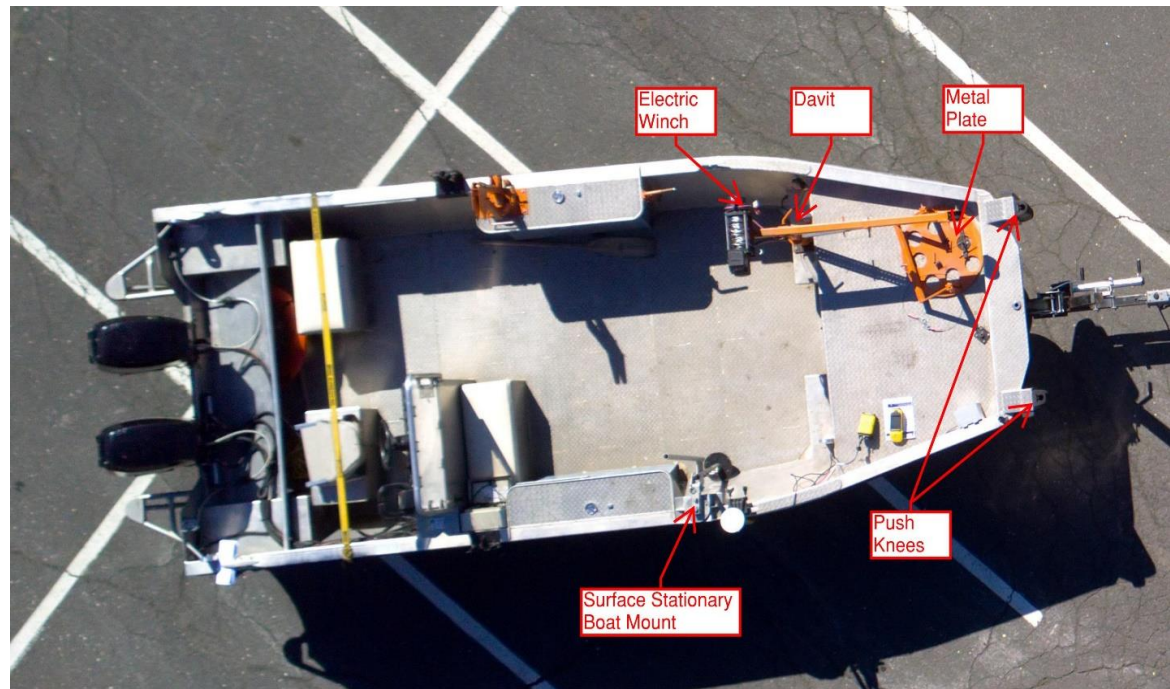
- 3D mechanical scanner
 - Blueview 1350
- Side scan
- Visual inspection
- Partner with underwater divers to get a complete picture

BV5000 3D System



Boat Configuration

- There are three basic deployment methods: boat mounted surface, metal plate, and tripod.



Boat Mounted Surface Stationary Deployment Method



Metal Plate Stationary Deployment Method



Plate was manufactured by our Mankato District bridge maintenance staff. It weighs about 75 lbs with the pan and tilt unit mounted on it.

Plate deployed using cherrypicker

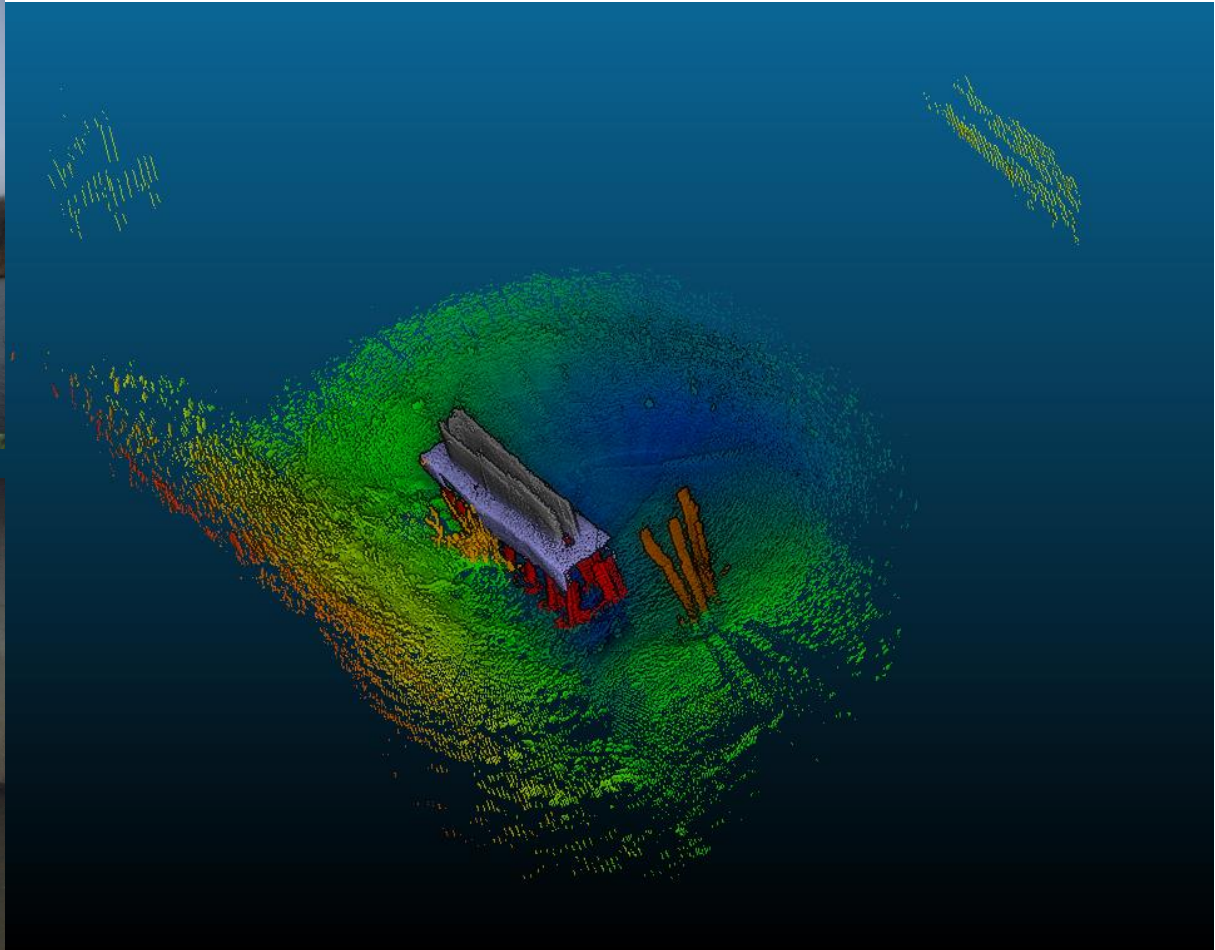


Tripod Stationary Deployment Method

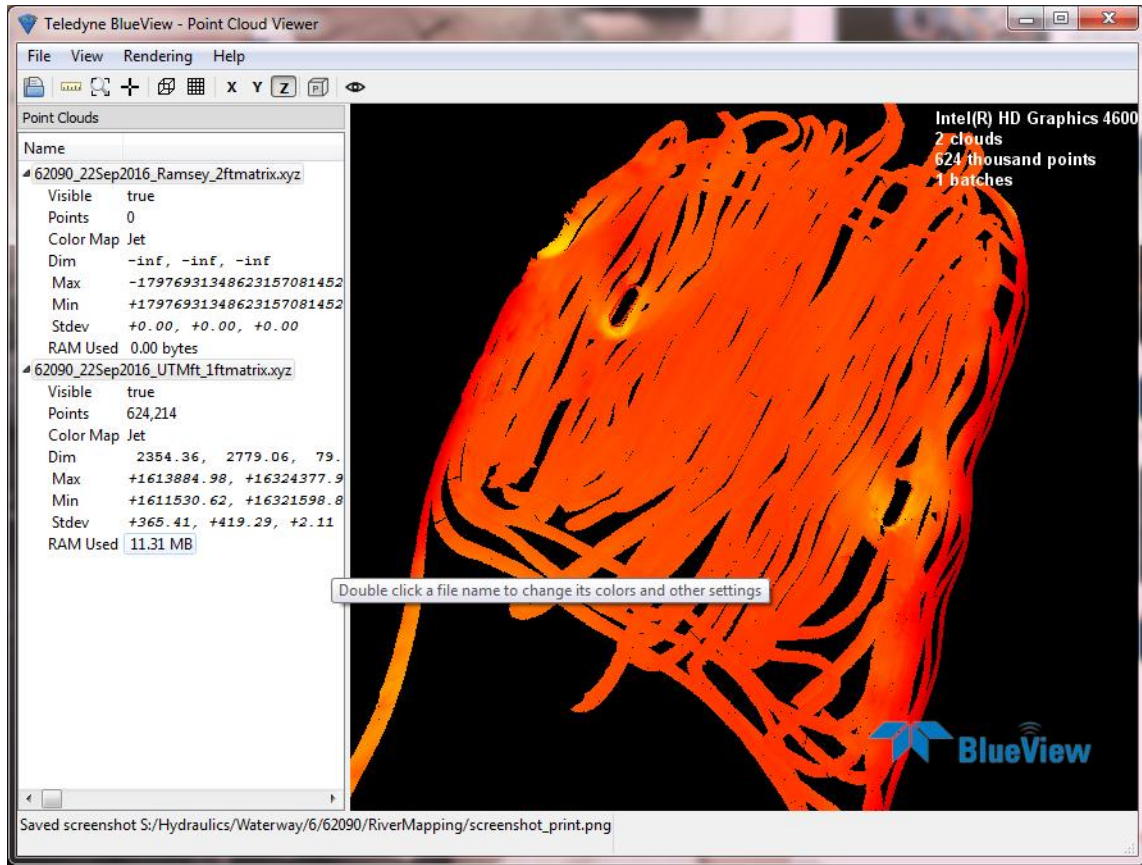


3D scan Post Flood – Contraction Scour

<https://www.youtube.com/watch?v=KKP3qKvPIQA>

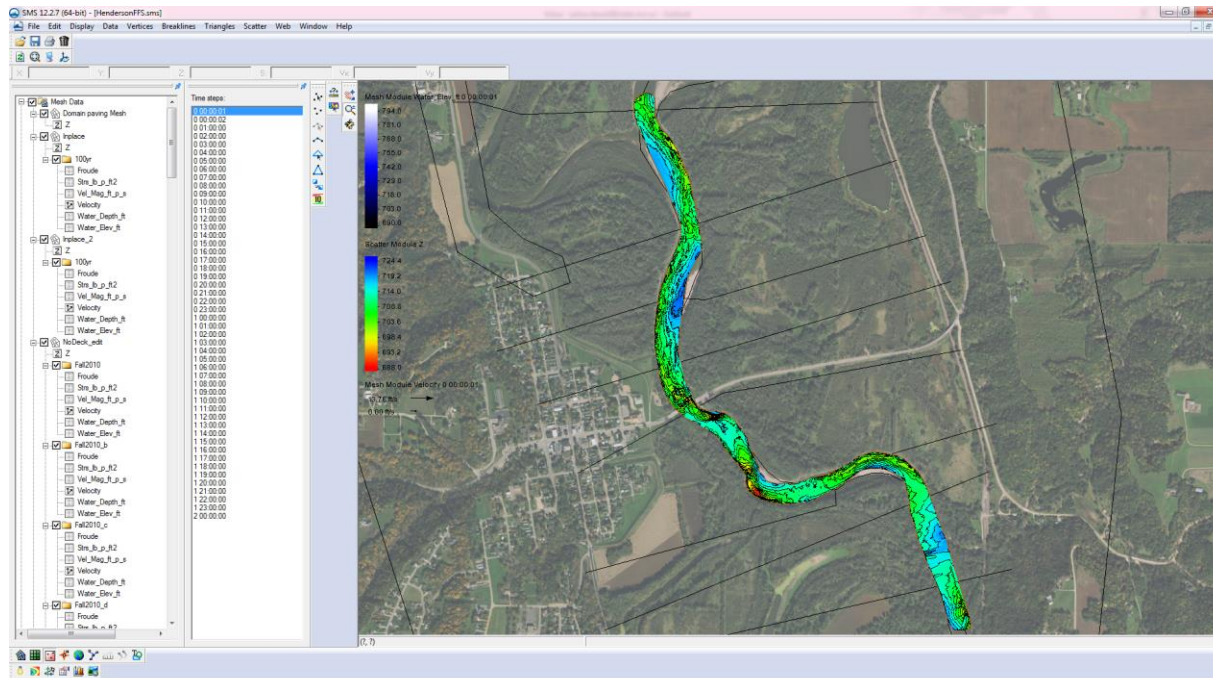


Mobile Scanning

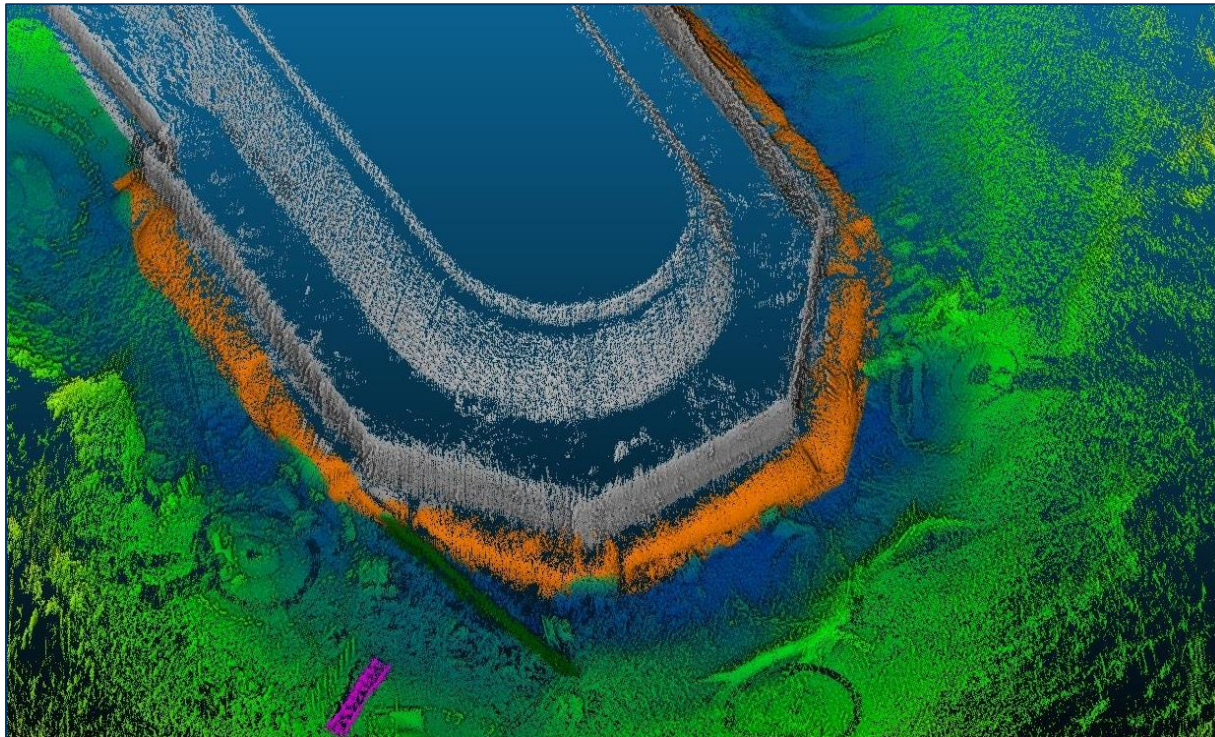


- Data is Geo-Referenced
- Pitch and Roll are accounted for
- Soundings of structures using stationary methods can be “dropped” into this data set

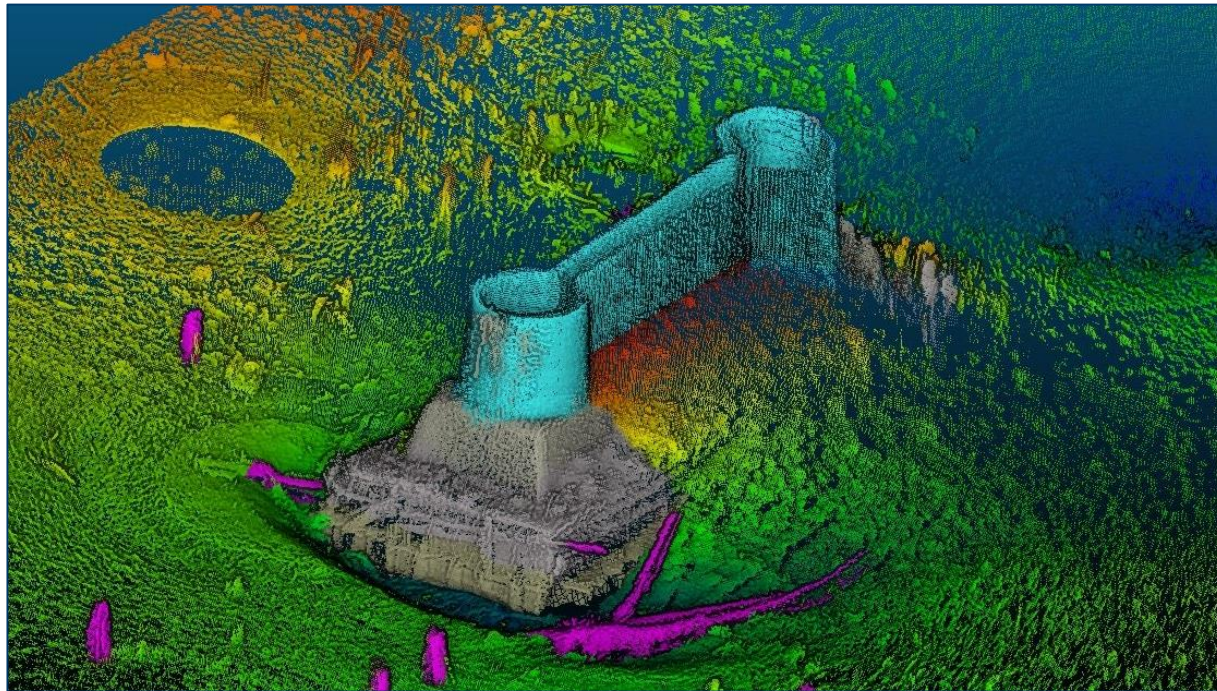
Data can be used for 2D modeling



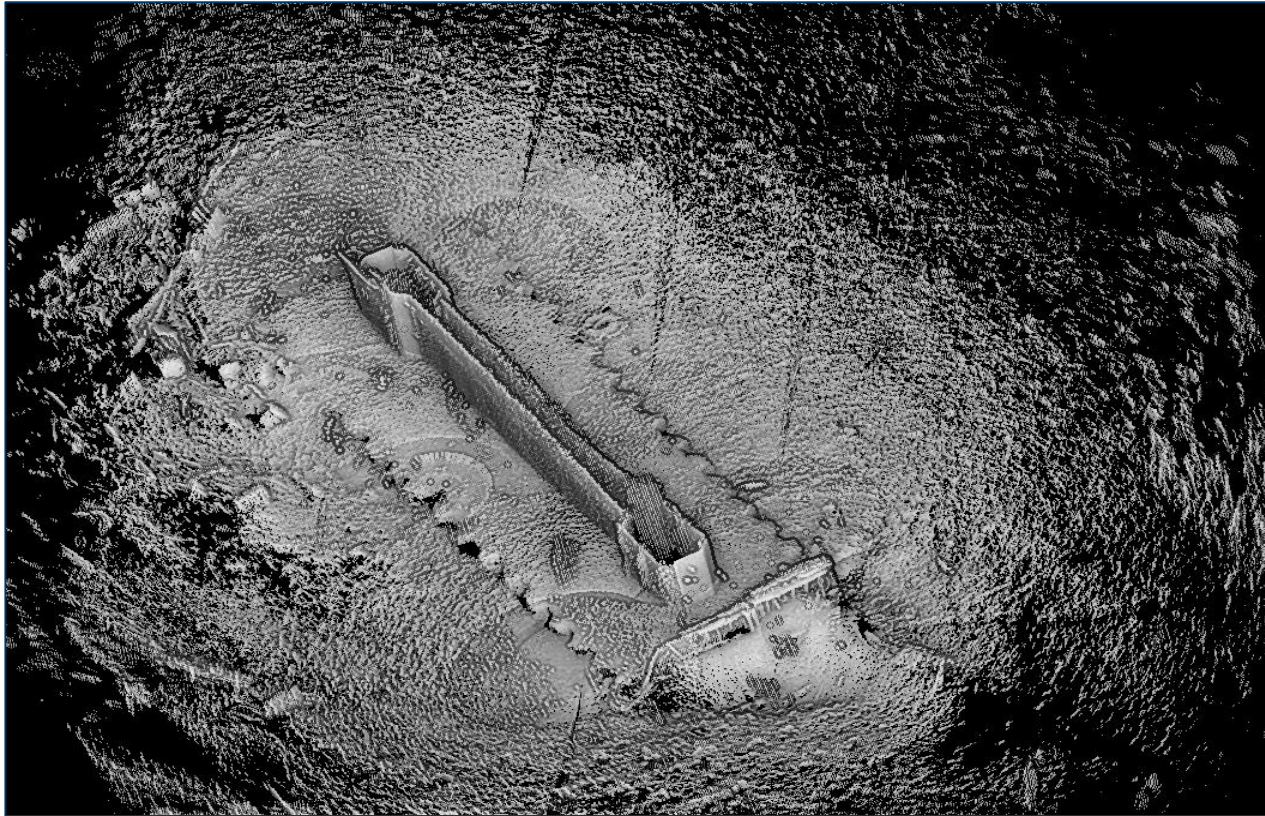
Case Studies Br 2440- Third Ave Br.



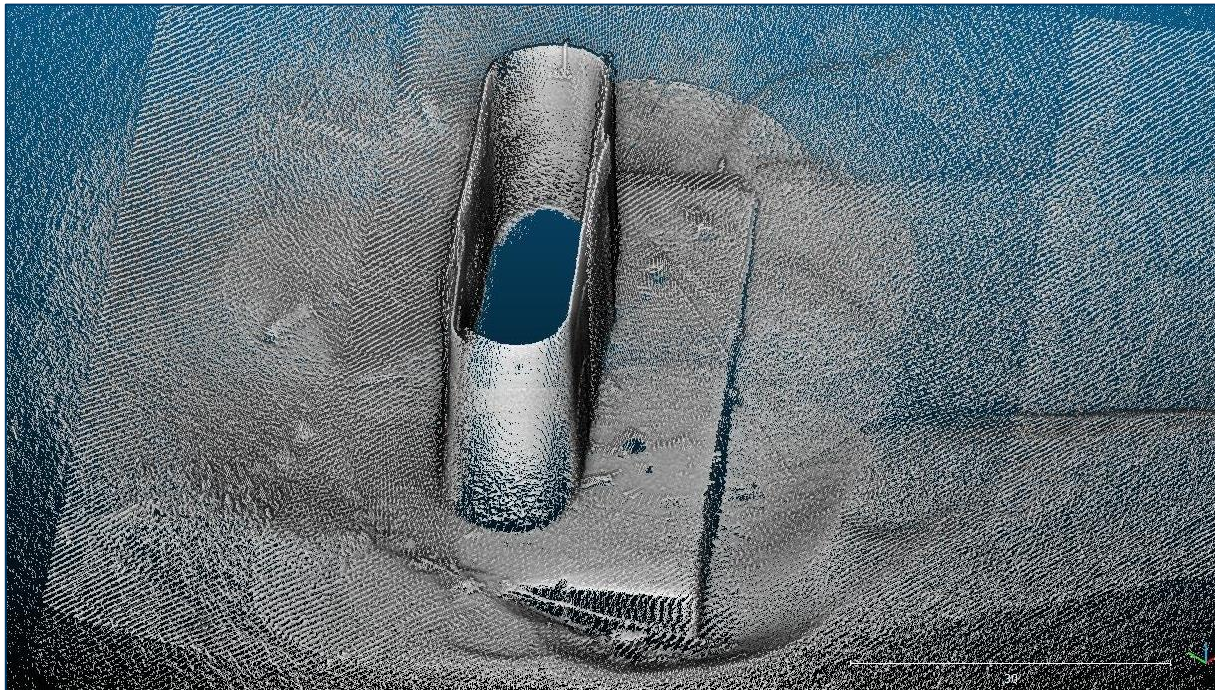
Br 4654- Stillwater Lift Bridge



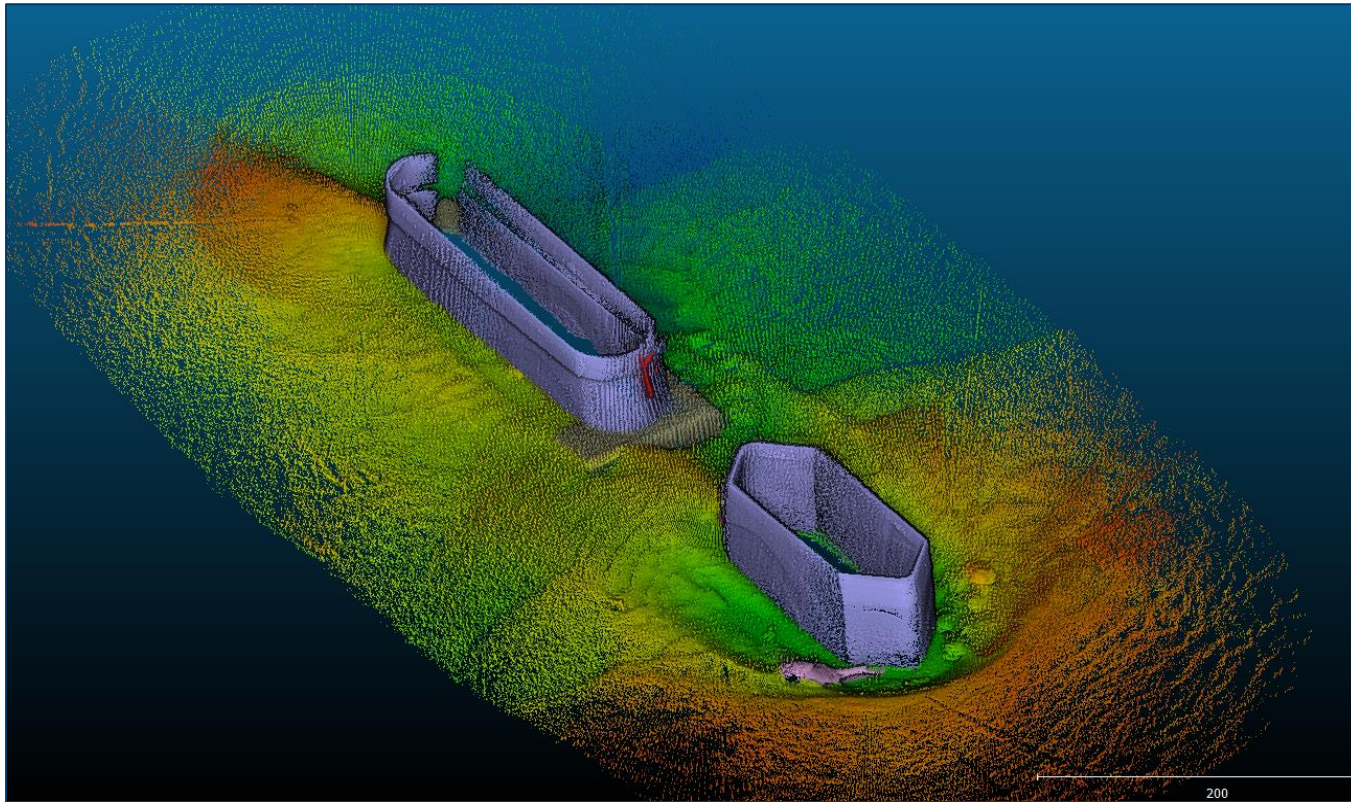
Br 19004- Hastings Br.



Br 9040- Red Wing



Br 85851- Winona Br.



Thank you again!

Nicole Bartelt

nicole.bartelt@state.mn.us

651-366-4474