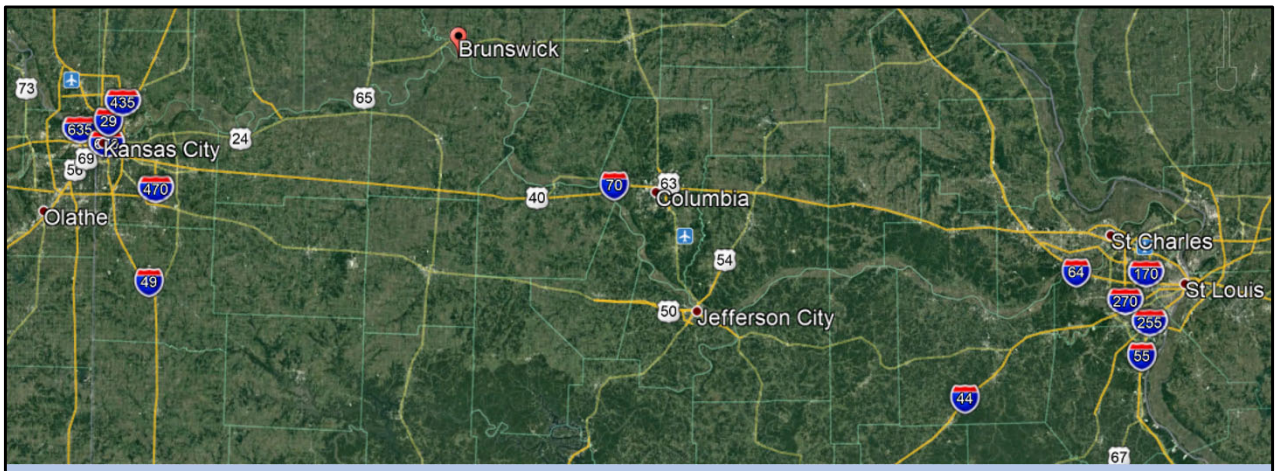
Emergency Response: RxR Bridge Collapse Brunswick, MO

- Owner: Norfolk Southern RxR
- Prime: Hanson Professional Services
- Sub: Prairie Engineers, P.C.

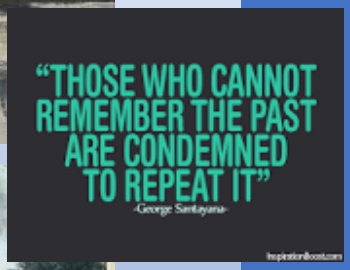
October 1, 2019 highwaters on the Grand River have formed a large log jam upstream of the RxR bridge, it's 267' long consisting of eight spans. The hydraulic forces applied on the bridge are resulting in structural deformation to the structure.



Brunswick, MO

Brunswick is near the confluence of the MO river and the Grand River in central Missouri, north of I-70 between KC and St Louis.

Brunswick is 118 river miles down stream from Kansas City. The Norfolk Southern bridge over the Grand River is 1 mile from the Brunswick boat ramp and 3 miles up stream from the MO River main navigation channel.



History

Original bridge at this location built 1868;

rebuilt 1889 with four TT spans;

rebuilt 1916 with DPG

This bridge location has some history to tell us… First bridge was built in 1868, and then rebuilt in 1889 using a typical TT or Through Truss spans design as you see in the upper left image.

Rebuilt again in 1916 using a DPG or deck plate girder span system.

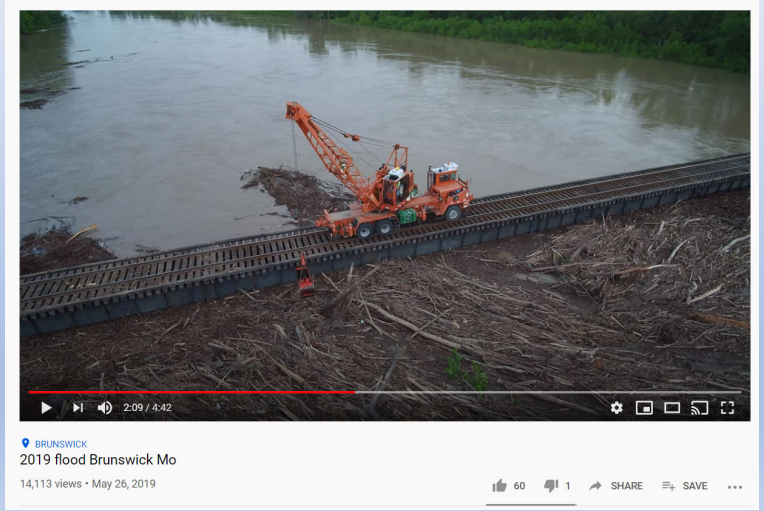
The lower image shows the DPG structure nearly overtopped with high water

Looking down stream from Hwy -24

The RxR bridge normally has 5-7 feet of clearance above the river

In May 2019 - spring rain events carried large amounts of timber down stream on the grand river, creating a log jam at the RxR bridge

Missouri State Patrol did an aerial survey of flooding along the Grand River near Brunswick on Wednesday, May 29. The National Weather Service said “near-record” flooding along the river was forecast to approach 1993 historic levels…



Here is an image of the log jam in May being broken up with cranes
Q: Where does all this timber come from?
The Grand River extends northerly for 226 miles into central Iowa. It has a watershed of 7,900 square miles, The Grand River Basin has more than 1,000 third order or higher streams.
No dams or flood control structures have been built on the river. That allows for the timber to collect and move down stream during high water flow events.

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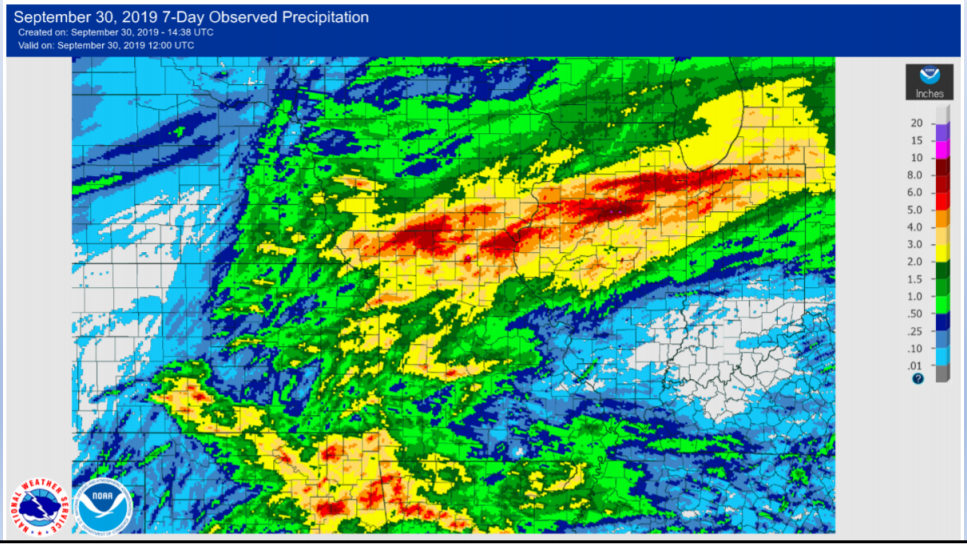
Seven-day Observed Precipitation



Here is a look at what was taking place in the Missouri River basin from September 23-30, the 7 days preceding this event. The heaviest rainfalls were over the Grand River drainage basin.

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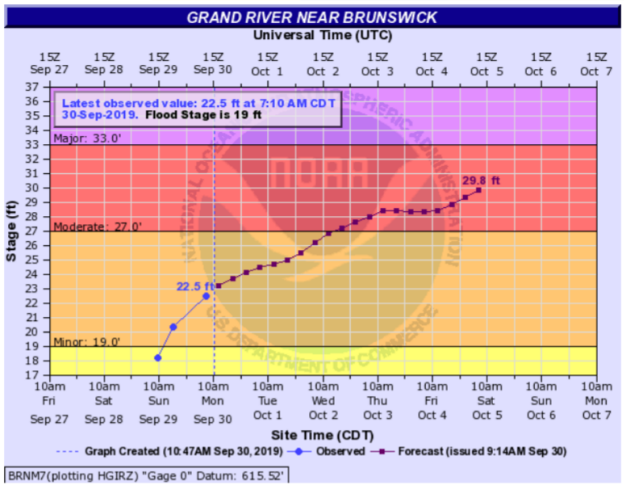
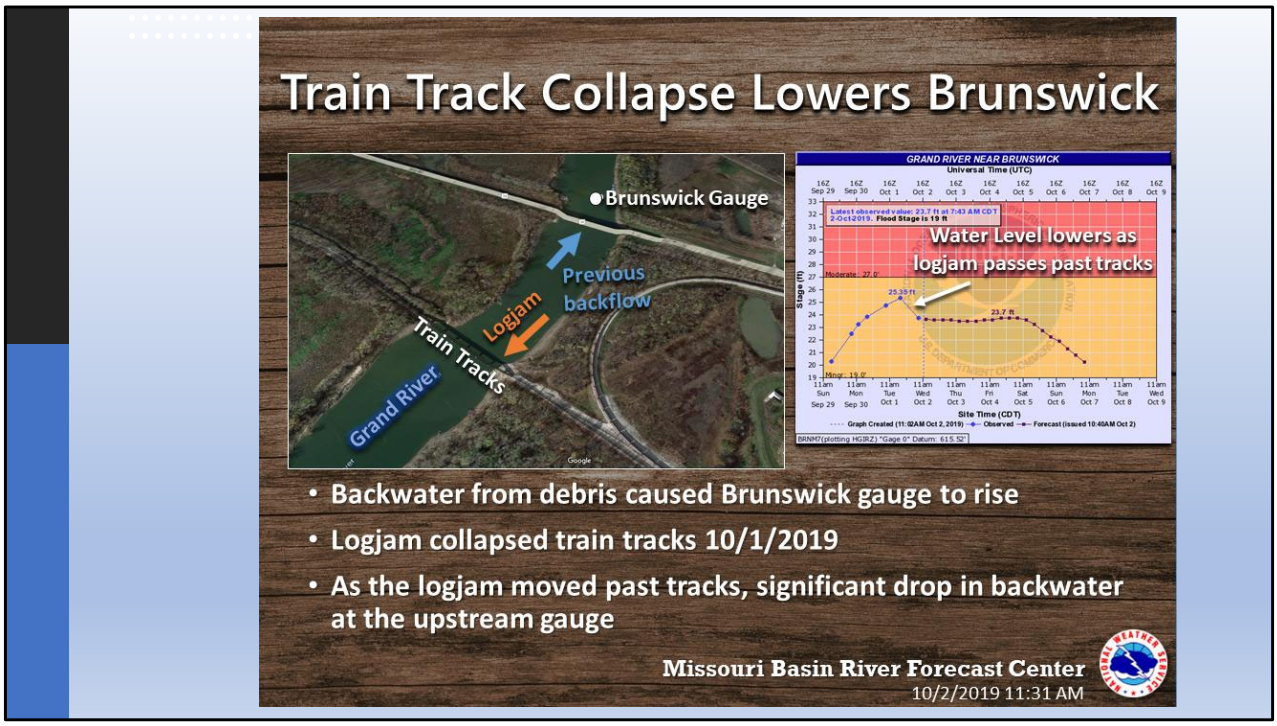


- The Grand River near Brunswick is at 22.5 feet in minor flood stage and is forecast to rise to at least at 29.8 feet in moderate flood stage by Saturday evening.
- Moderate flood stage begins at 27 feet.
- For stage-related impacts and other site specific details go to: https://water.weather.gov/ahps2/hydrograph.php?wfo=eax&gage=brnm7

at 07:00 AM on Sept. 30th the river had risen 4.5 ‘ in the prior 24 hours, and was forecasted to continue rising all week as the water worked its way down the Grand River basin to the Mo River



The log jam at the bridge was holding back over two feet of water, the upstream gauge on the 24 Hwy bridge recorded the rapid water level drop

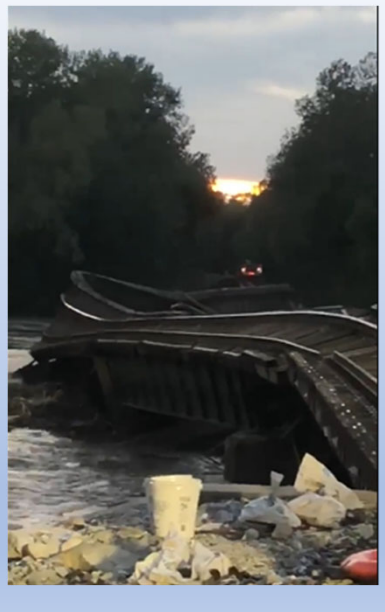


Image clips from the video as the bridge fails and the log jam rushing through the opening

October 1, 2019

"Just before dark, the railroad bridge west of Brunswick, the Norfolk Southern rail line, their main line, the bridge has washed out,"

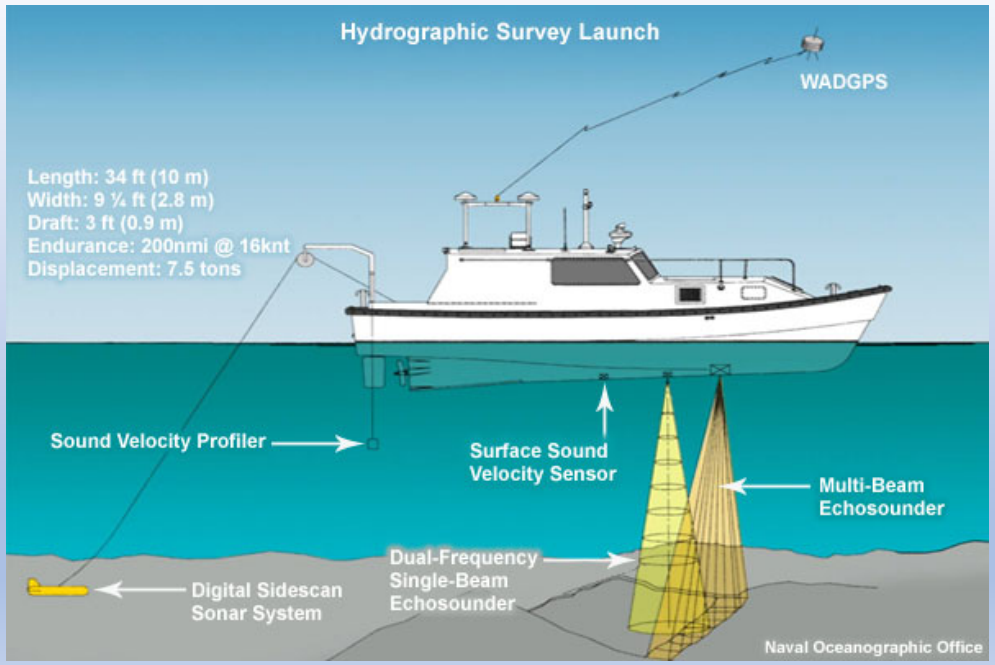
Brunswick emergency management director Brent Dickerson told KWIX radio….. Dickerson said barricades have been set up to protect people.

"….for safety reasons is the main thing, **because we don't know where the bridge went.** We do know it went down, most of the middle sections did go down to the south. We don't know if it's there sticking up or whatever."

Q: who do you call when you can't find a bridge in the water?

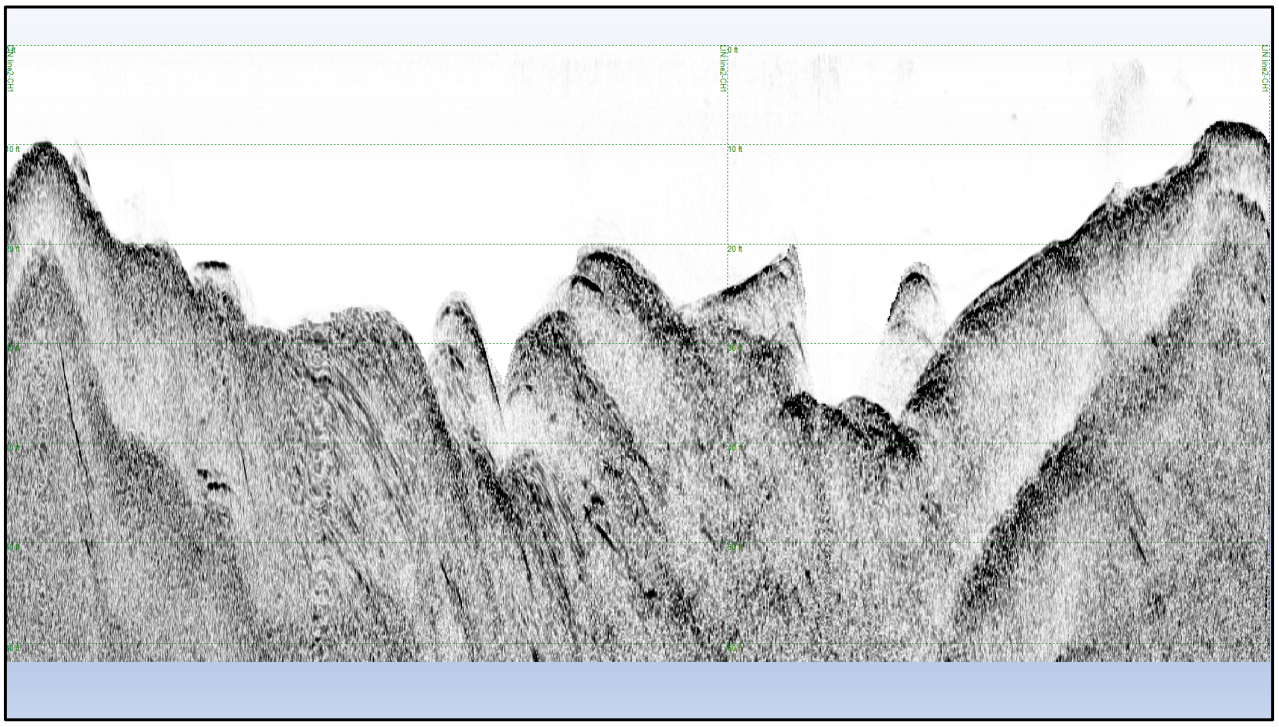
A: the hydrographic surveyors

Excerpt from the live radio feed with Brunswick emergency manager on KWIX radio. So exactly who do you call when you can't find your bridge in the water?

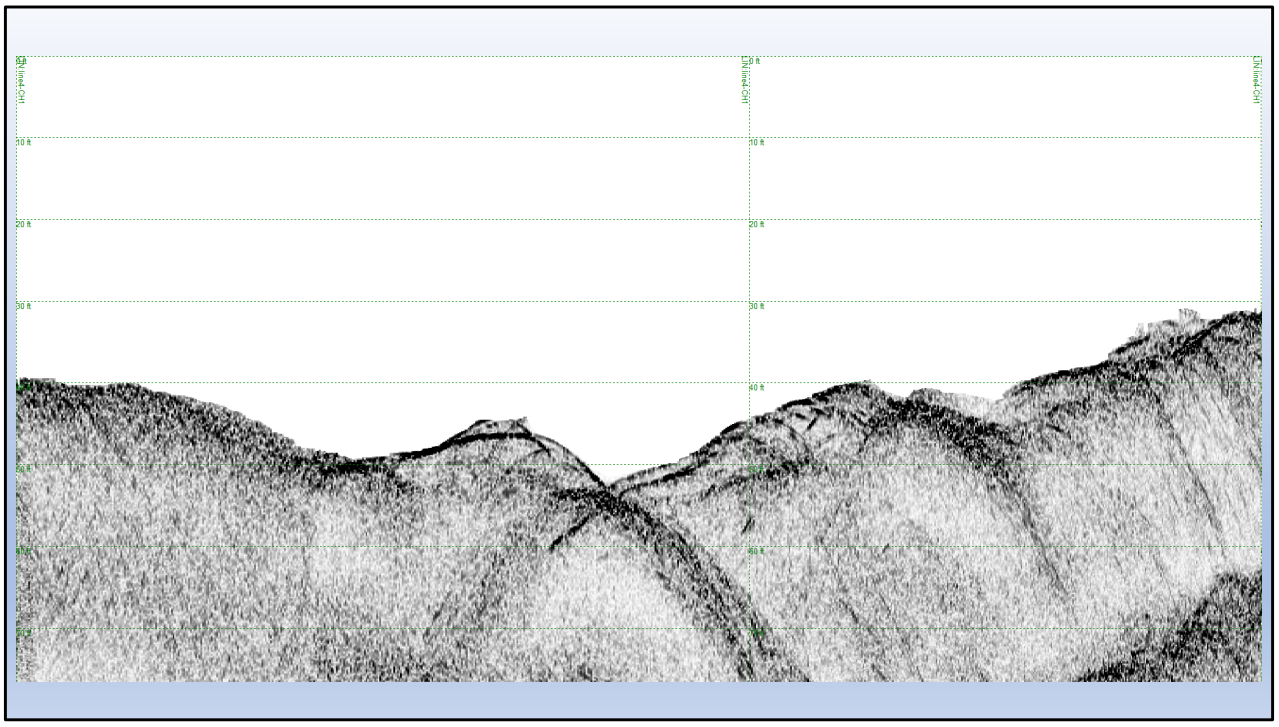


For those in the audience not familiar with hydro graphic surveying, here is quick primer on the fundamentals of the system-
The vessel is equipped with GPS positioning and multiple GPS antennas (like what you see on heavy construction dozers & graders) that monitor the attitude or inclination of the vessel
The vessel also has an MRU - a motion reference unit , that uses accelerometers, gyros and records the pitch, roll and heave information

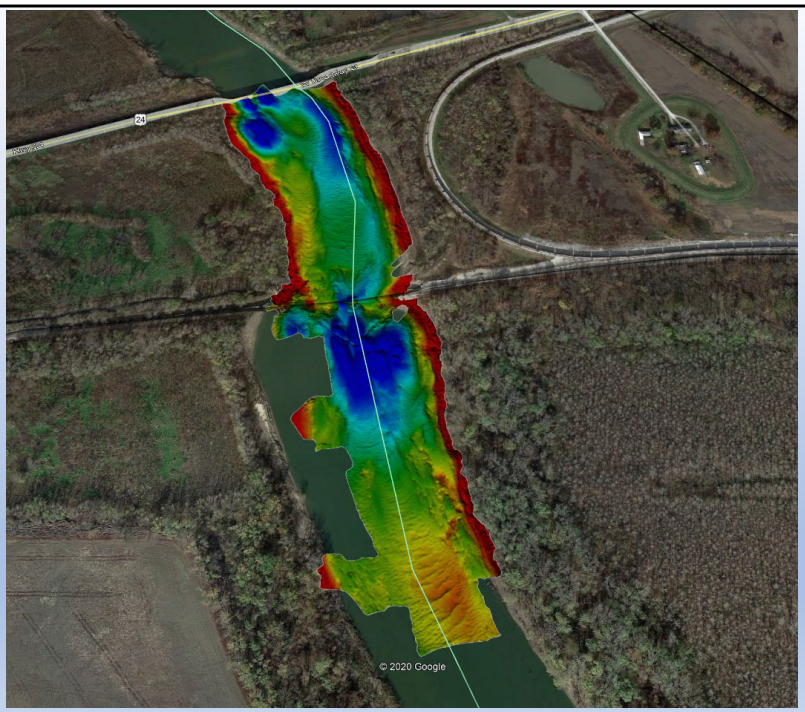
You may recall from your early physical science class that sound moves ~4 times faster in water than it does in air.
The rate sound travels in water is also impacted by water temperature and water density. In simple terms the denser the water the faster the sound will travel. The vessel is equipped with sound velocity profiler to measure these conditions during the surveys.



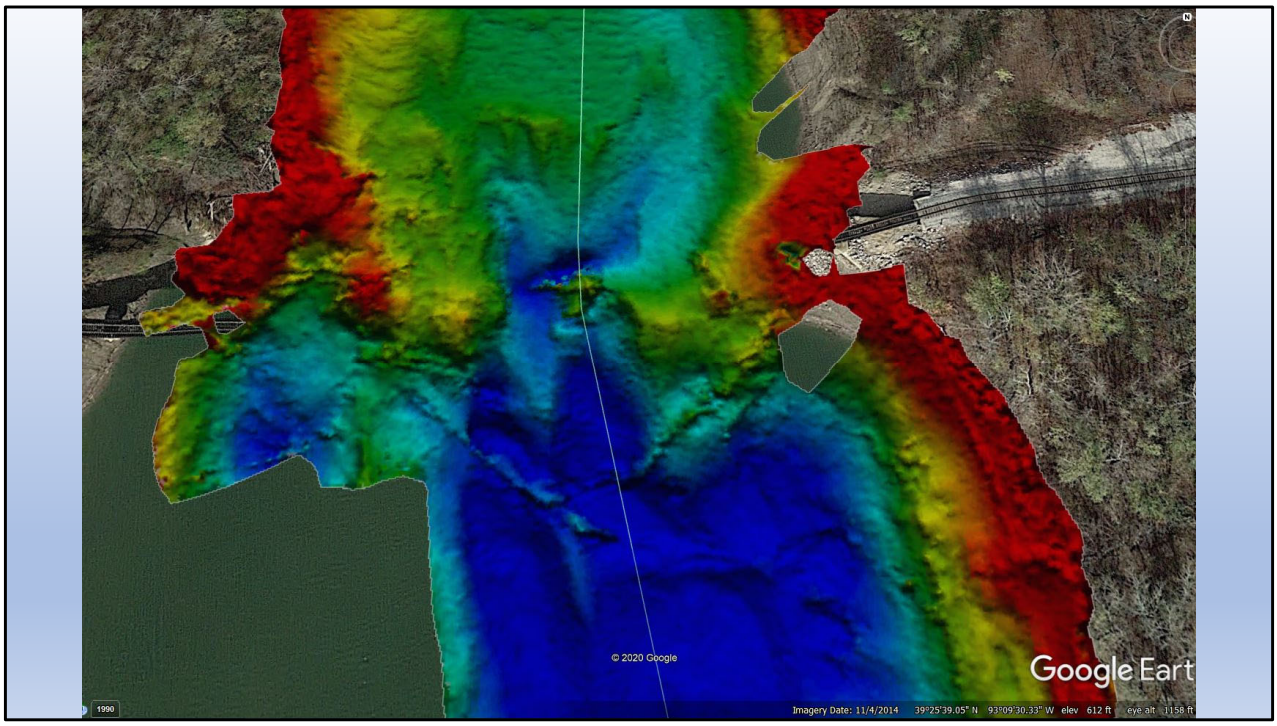
The dual frequency single beam records directly below the boat. This graphic is of a cross section collected from bank to bank along the alignment of the RxR bridge



This single beam dual frequency line captured the bottom of a new scour hole over 40’ deep down stream of the bridge



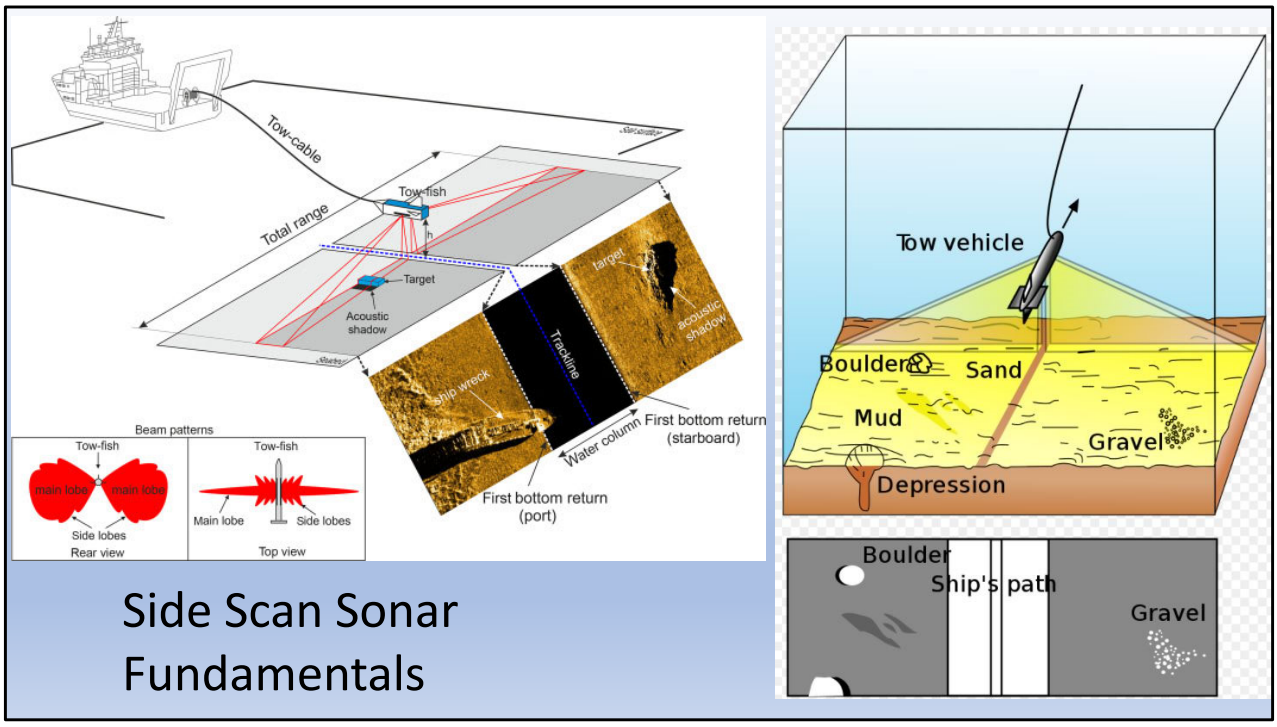
The multi beam sonar data covers a swath, or a wider area extending L & R of the vessel. Multi beam gives us a look at the full bottom surface. The dark blue areas are where the water scoured out the river bottom transporting away the soft sediment materials. You can see the that the sediment was deposited further down stream in an expected wave (crest and through) pattern.



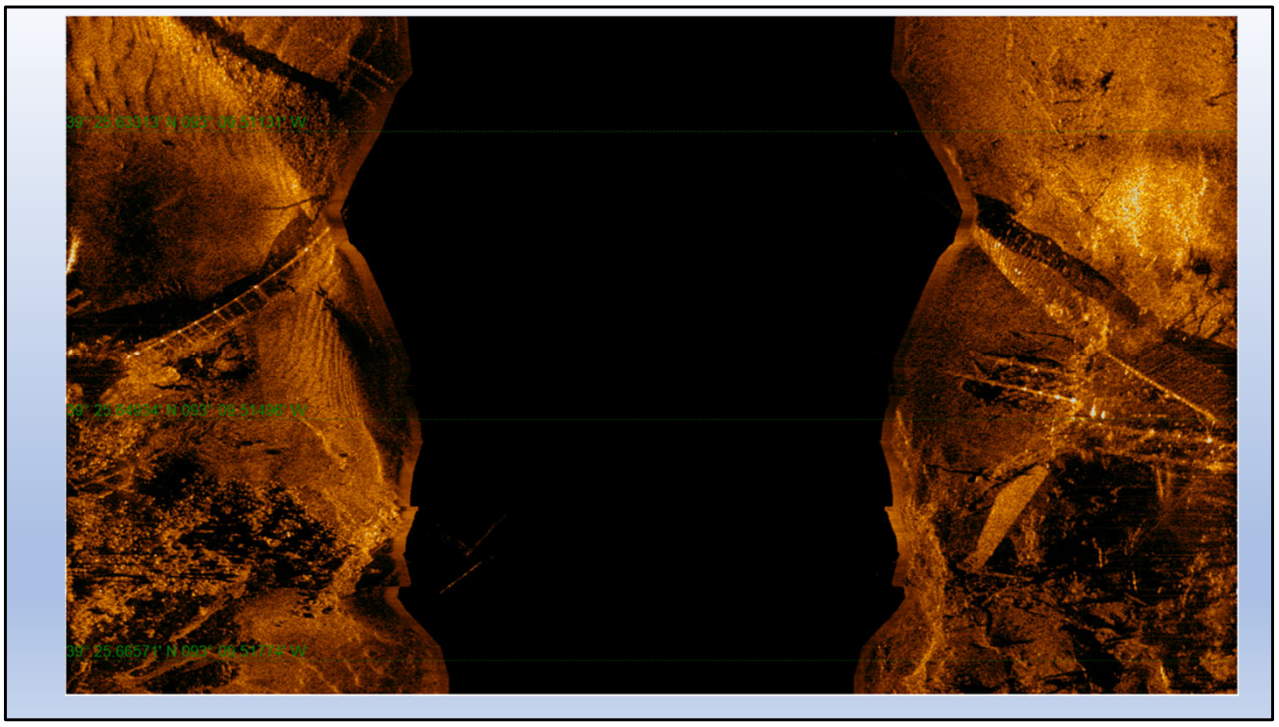
Here is a closer look at new scour hole formed when the bridge rail were cut and the water rapidly released. Note the linear features being recorded, and of note the parallel lines.

We collected this depth & clearance information from the bridge down stream to the confluence of the Grand River with the MO River and reported there was sufficient depths for the barges to navigate up river.

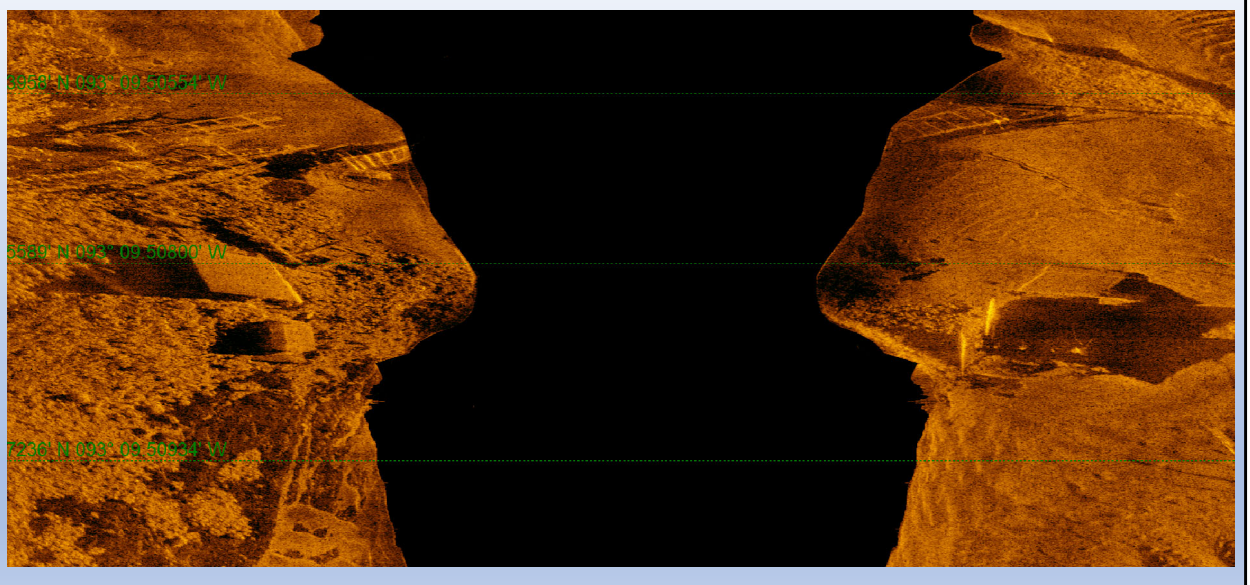
But where exactly were those missing bridge spans? Now that we knew the bottom depths and major obstructions we could deploy side scan sonar to look for the bridge spans and the piers.



We literally tow the side scan unit behind the boat on a cable. The cable is raised and lowered to keep the side scan unit close to the bottom while surveying.
Side scan collects L & R of the vessel, with a narrow dead zone directly below the unit. Objects above the river bottom are imaged and they cast or create shadows in the sonar image.



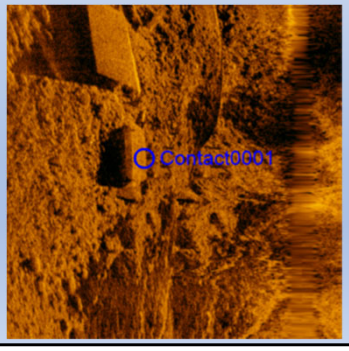
This a snip of the raw side scan image that shows the Rails, ties and steel beams that were supporting the spans, and a bridge pier



Another raw snip showing the bridge piers casting rectangular shadows

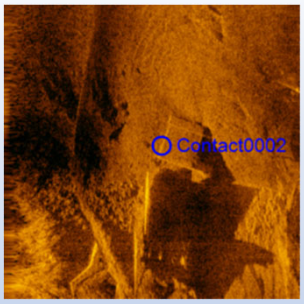
Contact0000
- Click Position
  39.4276498180 -93.1582954757 (WGS84)
  (X) 1454467.67 (Y) 1309419.68 (Projected Coordinates)
- Map Projection: MO83-CF

Dimensions and attributes
- Target Width: 11.68 US ft
- Target Height: 19.54 US ft
- Target Length: 24.51 US ft
- Target Shadow: 25.21 US ft

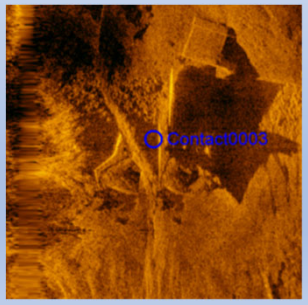


Contact0001
- Click Position
  39.4277247654 -93.1583180776 (WGS84)
  (X) 1454461.48 (Y) 1309447.03 (Projected Coordinates)
- Map Projection: MO83-CF

Dimensions and attributes
- Target Width: 5.66 US ft
- Target Height: 5.18 US ft
- Target Length: 16.55 US ft
- Target Shadow: 8.04 US ft



Contact0002	Dimensions and attributes
• Click Position 39.4276156777 -93.1586522993 (WGS84) (X) 1454366.78 (Y) 1309407.98 (Projected Coordinates)	• Target Width: 11.56 US ft • Target Height: 3.70 US ft • Target Length: 11.89 US ft • Target Shadow: 10.83 US ft



Underwater imagery revealed what appeared to be piling from the original crossing dating back to the late 1800's.

https://www.massman.net/project/display/354

Contact0003	Dimensions and attributes
• Click Position 39.4277119861 -93.1586244855 (WGS84) (X) 1454374.90 (Y) 1309443.00 (Projected Coordinates) • Map Projection: MO83-CF	• Target Width: 14.67 US ft • Target Height: 9.36 US ft • Target Length: 37.18 US ft • Target Shadow: 22.26 US ft

Contact 0003 - the structural steel girder

- https://youtu.be/YjHS1Lk8KQk

EMERGENCY ENGINEERING FOR BRIDGE S-189.19

- HTTPS://WWW.HANSON-INC.COM/PORTFOLIO/EMERGENCY-ENGINEERING-FOR-BRIDGE-S18919/PORTFOLIO-DETAILS?ID=195

Now let's watch this video from Hanssen's web site and learn more about the bridge itself and the construction

AWARDS

2020 Dr. William W. Hay Award of Excellence (AREMA)

The National Railroad Construction and Maintenance Association
Small Project of the Year.

Questions?

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