by Stan Polivick

Cape Girardeau's South Sprigg Street Bridge Adventure

South Sprigg Street Bridge, Cape Girardeau, Missouri

In southeast Cape Girardeau in 2007, an event of unexpected impact and duration occurred. This became our story of an adventure from hellish geology to an award-winning bridge.

The story begins with the sudden manifestation of 19 large sinkholes in the southeast area of Cape Girardeau, located a half mile from the Mississippi River in the vicinity of the South Sprigg Street Bridge. This group of large holes opened up over a period of only a few weeks; many holes opened in only a few hours. Several of the holes close to the South Sprigg Street Bridge caused the paved creek bank to fall in, and also caused the road pavement on the north end approach to cave in. This road provides important access to nearby industrial sites such as the Buzzi Unicem quarry and cement production facility; the SEMO Stone quarry with their associated concrete, asphalt and gravel supply; a local dairy farm; the City's wastewater treatment facility and solid waste transfer station. It also serves as an alternate route into Cape Girardeau for residents and commuting college students. The road closure had a significant, negative impact for many users.

The City began fixing the holes by filling the large, deep cone-shaped vortexes with boulders and various sizes of rock. Concrete was pumped into some holes to try and seal off the cavity. With the holes filled, the City repaired the road pavement and opened the road to motorists and industrial site users. It was an exciting and demanding effort, and things seemed back in order by late 2007 or, so we thought. The holes near the north side of the creek and bridge approach formed again in spring of 2008. The City again filled the holes and fixed the road. Surely, it was fixed this time! But, not for long. The holes near the north end of the bridge came back in 2011. The City filled them with concrete and rock and fixed the road again. The process was repeated in 2012. In 2013, the holes came back even larger than before, and new ones appeared. The City closed the road. City staff began a detailed review searching for a sustainable solution to this monumental problem.

Some basic geo-technical work had been done by the U.S. Army Corps of Engineers in 2009. This was studied carefully for any insight that could be helpful. There were discussions with engineers familiar with karst topography. Karst is the term for the limestone formations where holes form. The karst is a series of crevices in the limestone bedrock that form over very long periods of time. These crevices form where water sits on the limestone and slowly dissolves it. The soil on top settles, causing a low spot allowing water to stand. This causes the limestone to dissolve more and the problem accelerates. The crevices become large enough for the water to gradually wash the soil away, creating a void. Eventually the

soil over the void settles, causing the hole. Often, the hole becomes a dramatic and quick manifestation, as witnessed in 2007.

While the discussions of what to do were ongoing, there were other discussions about how to pay for the solution. During that time, the Mississippi River became an active player in the situation. The flood actually proved to be a benefit. This seemed cosmically fair since the holes were observed to be more active soon after a flood event, and therefore were somewhat attributed to the river's actions.

In the summer of 2013, the river rose to a fairly high stage, such that a federal disaster declaration was issued. The declaration opened an avenue to emergency relief funding through the Federal Highway Administration. These funds could be used for restoration of the bridge and roadway. The City applied for the funds and received approval in May 2014. The City promptly selected Horner & Shifrin as the design engineering firm for the project. They teamed with Stantec, a geo-technical specialist, and began work in October 2014.

A troubling requirement in the disaster declaration regulations was that the project had to have a construction contract signed by September 2015. Due to the complexity of the problem, the design work was expected to take longer than usual. Recognizing this challenge, the City requested and received approval for a one-year time extension, so the project needed to be under construction by September 2016.

The design work involved a tremendous amount of geo-technical investigation to chart what the bed rock looked like at the site. This was accomplished by setting up a grid of core holes, test pits and soundings. Through two sets of field investigations, a total of 134 soundings, 84 core holes and two test pits were done. This data was reviewed to answer questions like "Do we save the old bridge?" "Do we choose a different alignment?" "Do we choose a new location?" and "What do we do with them big ole sinkholes?" The City decided to put a new, longer bridge in the same alignment and location as the current bridge. This longer bridge would span over the areas with the sink holes. The project involved digging and exposing the bedrock at the footing sites to be certain the bridge foundations would be on solid rock. The new bridge would be three spans totaling 385 feet in length. The old bridge was 150 feet long. The final design work was completed. Bids were opened July 2016. The construction contract with Robertson Construction was signed in September 2016, meeting the requirements for the disaster declaration.

Construction began by demolishing the old bridge and excavating the areas for the new bridge footings. We found very large crevices and holes; several were larger and deeper than expected. The holes proved quite challenging to address. With fierce determination, the design and construction team worked closely together and managed to build a solution for each of the challenges. This involved large cap structures for the crevices and holes. These caps were a combination of boulders, concrete and reinforcing steel. It also required building the footings a bit larger and stronger than originally planned.

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In April 2017, construction work was moving along on schedule and making good progress when the story took another turn. The Mississippi River flooded again. This time the forecast was for a near-record stage of 48.5 feet. For reference, local flood stage is 32 feet. If the forecast stage was reached, it would be only five inches lower than the all-time high for Cape Girardeau. Thankfully, the river did not reach the forecast "near record" stage. It did get up over 45 feet, shutting down bridge work for a couple of weeks. We were thankful the flood occurred after the last bridge footing was finished. Once the flood waters receded, the work resumed with capping off a very large hole near the north end of the new bridge. This one was more than 60 feet wide. We drove 35-foot-long steel sheet piles across the hole to seal it off and then capped the area with boulders and concrete.

Now, the actual above-ground bridge work could begin. The last two sets of bridge girders were set; the framing for the bridge deck was completed quickly; and the concrete for the bridge deck was cast on Aug. 11, 2017. Casting the bridge deck used more than 450 yards of concrete and took more than nine hours. With the bridge deck in place, the roadway approaches at each end could be completed, and the curbing and guard rails could be set. The last item of work was to hang a 12-inch water line on one side of the bridge and an 8-inch gas line on the other. With the utility lines finished, the work area was cleaned up and the bridge was completed and opened to traffic on Oct. 13, 2017.

Our story took 10 years from start to finish. We encountered and overcame quite a number of challenges including several rounds of holes forming and the subsequent road repairs; hellish-looking geology; eight river floods during the 10 years, with one major flood during construction; an aggressive schedule requirement; and finding the funds for the project. The total project cost was more than $6 million, with $4.9 million of that for construction. In February 2018, the project was honored to receive an American Council of Engineering Company's (ACEC) Engineering Excellence award. This was awarded to the design engineering firm, Horner & Shifrin, for their excellent work on the design of a very complex and challenging project. Thanks to the great team of Robertson Construction's crew, the Horner & Shifrin construction manager and design team, and the city project manager, this was a very successful project. The teamwork, with their collective skills and abilities, was the key to the success of the project.

The City is pleased to have completed an important and challenging project to restore a critical roadway into service for our community. It is also encouraging to have our project recognized by a prestigious group like ACEC for excellence in engineering.

Stan Polivick *has been serving Cape Girardeau and its public works department for 10 years. Before coming to Cape, he held city engineer positions in Louisiana and Mississippi after graduating from Mississippi State University in 1980. He was recently featured in FEMA's Partners in Resilience video series: https://www.fema.gov/media-library/assets/videos/161620.*