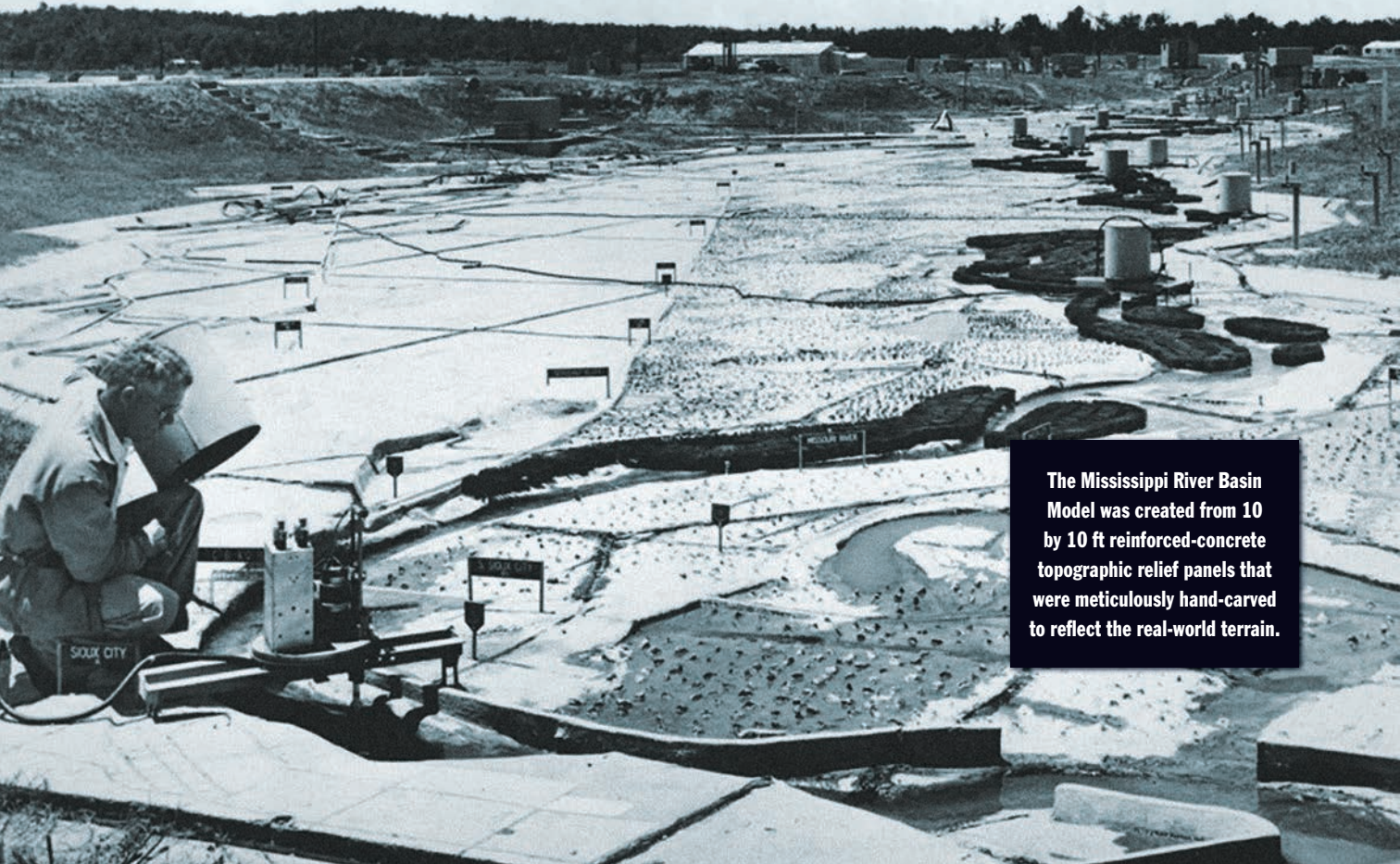


# · HISTORY LESSON ·



The Mississippi River Basin Model was created from 10 by 10 ft reinforced-concrete topographic relief panels that were meticulously hand-carved to reflect the real-world terrain.

## Restoration Required: The Mississippi River Basin Model

IN THE OCTOBER 2017 issue, contributing editor T.R. Witcher presented the history of the U.S. Army Corps of Engineers' Waterways Experiment Station (WES), in Vicksburg, Mississippi. The article, "Modeling to Prevent Disaster: The Waterways Experiment Station," touched briefly on the construction and operation of the WES's Mississippi River Basin Model (MRBM), which was constructed near Jackson, Mississippi, some 40 mi east of Vicksburg. In this special edition of History Lesson, Sarah Smith McEwen, P.E., CFM, M.ASCE, a founding member and president of Friends of the Mississippi River Basin Model, a nonprofit organization dedicated to the restoration and reinvention of the model, discusses the purpose of the MRBM, how it was constructed and used, and its future possibilities.

**T**HE LARGEST AND MOST all-encompassing physical model in the world sat idle in Jackson, Mississippi, overgrown and abandoned for decades, until a community group of civil engineer volunteers, including ASCE members, decided to see if something could be done to restore it. One of the most successful experiments in physical hydraulic engineering ever constructed, the Mississippi River Basin Model (MRBM), which was selected as an ASCE Historic Civil Engineering Landmark in 2018, is on the road to its second life.

The history of the model is one of early efforts toward community resiliency. It began with the Great Mississippi Flood of 1927, the worst natural disaster the country had known until that time. In response to the disaster, Congress passed the Flood Control Act of 1928, which authorized the U.S. Army Corps of Engineers to design and construct projects to control floods on the Mississippi River and its tributaries (as well as on the Sacramento River in California). Unfortunately, a decade later, the 1937 flood along the Ohio River inflicted new damage to the Mississippi River system. Federal and state resources were strained to aid recovery because the disaster occurred during the Great Depression. With two such significant floods now on record, the Corps decided that a more comprehensive approach to flood control should be evaluated. A to-scale physical model of the Mississippi River system would be a critical tool for demonstrating potential flood-control measures to officials, laypeople, and engineers. A model could also be used to convince lawmakers of the need for centralized control over all reservoir operations during flood emergencies. While approvals for the full-scale model were pursued, the groundwork was being laid to facilitate the construction of the model.

While still struggling with the threats and consequences of systemic flooding on the river and its tributaries, the na-

tion soon found itself thrust into World War II. Labor was in limited supply, but innovative planning led to a decision that would push the construction of the MRBM forward. Gen. Eugene Reybold, then the chief of engineers for the Corps, decided that prisoner of war (POW) labor could be used as a supplemental workforce. Starting in 1941, he negotiated with Provost Marshal General Allen W. Gullion, who recommended that recently captured members of the German Africa Corps provide the labor to start model construction. Reybold chose a location for the model near Camp Clinton, a future POW campsite, just outside of Jackson; it had an ideal topography that would minimize excavation. The land for the camp was purchased in late 1942, and shortly thereafter the land for the MRBM site, within walking distance, was purchased.

Camp Clinton consisted of 790 acres and could accommodate up to 3,000 POWs. The prisoner compound was enclosed by a 10 ft high woven-wire fence topped with barbed wire. Guard towers equipped with searchlights and telephones were situated every 200 ft. Although no machine guns were housed in the towers, every guard was armed. Ten feet inside the outer fence was a second woven-wire fence, 20 ft high and topped with barbed wire.

Work began on August 30, 1943. The POWs, whose average age was 22, were integral in moving earth, installing an underground cistern and water systems, and laying the groundwork for the reinforced-concrete panels that would be used to model the exact terrain of the basin. After 1,200 prisoners cleared the site, 275 U.S. civilians completed the work.

The POWs were paid \$0.80 a day, saving the federal government the equivalent of millions in today's dollars over the life of the project. In addition to clearing nearly 1 sq mi of ground, the prisoners

constructed roads and bridges and dug drainage ditches and storm sewers, resulting in a sewer system of approximately 85,000 linear ft of pipe ranging from 6 to 60 in. in diameter. Using mainly shovels, pickaxes, and wheelbarrows, the prisoners moved more than 1 million cu yd of earth.

The prisoners worked from 1943 to 1946, when they were released from the camp and returned to Germany. (Many POWs and their families returned to Clinton to revisit the site at a reunion in 1996.)

After the earthwork was complete, the task at hand was to recreate the terrain of the Mississippi River basin. Construction of the model itself began in 1947. A concrete laboratory needed to be located between the former POW camp and the model site to make the reinforced-concrete panels that would create the model of the terrain. So a lab in Mount Vernon, New York, was moved to the Clinton site and became the concrete division of the Waterways Experiment Station (WES). The WES team consisted of a hydraulic division and a construction division that would lead the effort to build the model. Members of the WES staff and their families moved into the section of Camp Clinton formerly occupied by the German officers.

The concrete forms for creating the 10 by 10 ft reinforced-concrete topographic relief panels were hand-molded to reflect the terrain. The overbanks—anything that is associated with the river that is not within the channel—would be modeled on those contours and integrated with bathymetric data. The panels were cured in the lab, shipped to the model site, and lifted by crane and placed in their precise locations. Some panels were later placed on piles designed to act as floating slabs to counteract the effect of the unique soft-soil conditions of Central Mississippi. This system enabled those panels to remain level.

The technology at the time allowed the

**The model encompasses the Mississippi River and its tributaries from Hannibal, Missouri, to Baton Rouge, Louisiana, and from the Atchafalaya River to the Gulf of Mexico. It includes stretches from the Missouri River to Sioux City, Iowa; the Ohio River to Louisville, Kentucky; the Cumberland River to a point above Nashville, Tennessee; the Tennessee River to Pickwick Dam, Tennessee; the Arkansas River to a point above Tulsa, Oklahoma; and the Ouachita River to Monroe, Louisiana.**



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Mississippi River, its tributaries, and the floodplains and stream channels to be accurately molded to a horizontal scale of 1:2,000 and a vertical scale of 1:100. The cost of the model would translate into roughly \$83 million today.

The panels were matched at their corners by unique identifying numbers. Once placed, they were sealed with rubber to prevent water from eroding the soil beneath them. With age the seals have disintegrated and as a result, some of the panels have shifted.

The initial plan was for the model to encompass the entire 41 percent of the continental United States and parts of Canada that the Mississippi River basin drains. The site was graded and sodded to reflect this. During construction it became apparent to engineers that the upper reaches did not need to be included, so the model as constructed consists of the Mississippi River and its tributaries from Hannibal, Missouri, to Baton Rouge, Louisiana, and from the Atchafalaya River to the Gulf of Mexico. It includes stretches from the Missouri River to Sioux City, Iowa; the Ohio River to Louisville, Kentucky; the Cumberland River to a point above Nashville, Tennessee; the Tennessee River to Pickwick Dam, Tennessee; the Arkansas River to a point above Tulsa, Oklahoma; and the Ouachita River to Monroe, Louisiana.

Individual sections of the model went online as early as 1949, but the completed MRBM operated primarily from 1966 to 1971. The upper reaches were modeled independently for design-level storms while the remainder of the model was completed and calibrated. Initially it was estimated that some 600 people would be needed to operate the model manually, but with instrument automation that number was reduced to fewer than 10. The instruments included inflow, stage, and outflow devices as well as a timing unit. The inflow instruments looked like manual typewriters and could be operated by switches or a perforated paper program roll, much

like a player piano. The stage transmitters, located at points on the model that correspond to real-world gauges, recorded the water elevations and sent that data to a recorder. The recorder printed the information on a chart read by model technicians.

To replicate the roughness of overbank vegetation, folded screen wire was cut to the scale of trees and placed in the model. This reflected natural obstructions that might impede the flow of water. Located centrally along each major stream was a control building that housed the flow programmers, stage recorders, and automatic calendars used to record the dates of the recordings. The control houses were the hub for the electronic data collection and communication systems.

All 74 originally scheduled model tests were completed by 1971, though others were conducted occasionally afterward. A few of the key simulations were as follows:

- verification of two flood events, in 1947 and 1950, on the Missouri River and its tributaries from Sioux City to Hermann Reach (1952)
- verification of the Mississippi River alignment from Thebes and Golconda, both in Illinois, to Baton Rouge and to the Gulf of Mexico via the Atchafalaya River, a distributary (1970)
- tests to assist in developing computer programs (1969)
- test on the Morganza spillway for water quality impacts to New Orleans and Baton Rouge (1973)

In 1961 the local chamber of commerce decided to develop the MRBM site as a tourist attraction. Site improvements included concrete sidewalks and observation platforms. By 1964 the facilities included a self-guided tour and recorded lecture on the model's history and operation. It was estimated that during the 1960s an average of 5,000 people each year visited the model, where they could stride like giants from Memphis, Tennessee, to Baton Rouge in 15 minutes or jump over the mainline of the Mississippi River.

In the late 1980s and early 1990s, the model was used to simulate the effect that raising the levees along the Birds Point-New Madrid Floodway in Missouri would have on the river and its tributaries. In 2011 that floodway was operated for the first time since 1937, likely saving lives and millions of dollars in flood damage along the Mississippi River south of New Madrid.

The Corps deeded the model to the Department of Interior in the 1970s but maintained a lease on the property, which it transferred to the City of Jackson in 1993. The larger park surrounding the model was renamed and developed as Buddy Butts Park, and the MRBM was listed by the state as a Mississippi Landmark.

In late 2016, a group of volunteers supported by the Mississippi Section of ASCE founded Friends of the Mississippi River Basin Model to restore

**Prisoners of war from World War II, who were being held at nearby Camp Clinton, were integral in moving earth, installing an underground cistern and water systems, and laying the groundwork for the panels.**





the model, renew Buddy Butts Park, and enhance educational opportunities for children in Mississippi. As a nonprofit, Friends seeks to preserve, restore, and renew the model; improve environmental and recreational opportunities; and enhance science, technology, engineering, and mathematics (STEM) education in the Jackson area. The group intends to clear the forest immediately surrounding the MRBM and add a multiuse trail that will have interpretive, educational stations to teach visitors about the history of the site and the Mississippi River and its tributaries.

Friends has also developed a master plan that includes renovating the historic water tower, visitor observation tower, and selected buildings on the site as well as adding such park amenities as benches, picnic tables, restrooms, and eventually an education and science center. The center will house interactive displays on the science, math, and engineering behind the model itself and the discoveries that have stemmed from the MRBM as well as the history of the site and the river system. Eventually, the group would like to reconstruct a prisoner-of-war barracks where visitors can learn more about Camp Clinton. Its members would also like to develop an interactive mobile app through which visitors could superimpose their likenesses onto a map showing their location in the real world.

Since the founding of Friends, the organization has hosted numerous cleanup days. The ASCE Younger Member Group for the Mississippi Section hosted ASCE student chapters from the University of Mississippi, Jackson State University, and Mississippi State University in an event aimed at removing trees and excess vegetation from the site. ASCE leaders who serve on the Friends board have become active in the community through this project, hosting walking tours, visiting schools, and working with local community colleges to promote civil engineering. International groups have visited the site and taken tours, and the MRBM was selected to host several AmeriCorps teams to assist with cleanups and visit with local community members to learn more about the area.

**Over the decades, the site has suffered from disuse, but a new effort is under way to restore the model and use the site for educational and recreational purposes.**

Two of the most popular events hosted at the model recently have been a walking tour and a screening of the ASCE film *Dream Big: Engineering Our World*. The walking tour, in 2017, was hosted by the Mississippi Humanities Council and featured Wayne O'Neal, the former chief engineer of the model, as its guide. In May 2018, a projector was used to show *Dream Big* to local community members, including children, and ASCE student members helped conduct several STEM activities inspired by the movie.

While much has been done, there is plenty left to accomplish in order to clear and secure the site and begin restoration in earnest. The group is seeking grants for clearing and grubbing the site, including removing and replacing an existing fence, securing the buildings and water tower, installing gratings over open cisterns, and completing the site engineering and design. Any funds remaining will be used to begin work on the walking paths, education features, and marketing and outreach activities.

The model's legacy is a testament to the ingenuity of engineers. It made a significant contribution to the development of the field of physical modeling and established support for the hydraulic computer models used today. Anyone wishing to support the Friends of the Mississippi River Basin Model's efforts to bring this historic site back to life can visit [friendsofmrhm.org](http://friendsofmrhm.org) for more information. **CE**



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