Arthur Morgan ushers in the era of engineered flood control in the wake of the 1913 Dayton flood

by

J. David Rogers, Ph.D., P.E., P.G., M.ASCE

Arthur Earnest Morgan

- **Arthur Morgan** was born to Johan and Anna Morgan of Cincinnati on June 20, 1878, where his father attended surveying classes in Lebanon. While Arthur was still an infant the family moved to St Cloud, Minnesota, the head of practicable navigation on the Mississippi River.
- Meningitis nearly killed young Arthur and measles weakened his sight, but his character was shaped by a Baptist mother and alcoholic father, who fought constantly.
- Arthur worked hard to wean himself from the nightly brawls, learning how to curb his anger and frustration.
- He loved climbing trees, playing "tree chase," and boxing. As a lad he roamed the woods around St. Cloud and became a skilled botanist and geologist, forming a local "Geology Club" with some of his friends.
- He joined the Baptist Church and read all of the literary classics in St. Cloud's Public Library, in deference to his school studies.

Lumberjack in the Rockies

By his late teens he had a sense of being driven to do something more than usual, something above average, with his life, but he had no idea what that would be. His father encouraged him to become a surveyor, a craft with which he was already familiar.

Coercing a high school buddy, the pair set off an a "grand adventure," floating down the Mississippi River on a large tree trunk. In a letter he described stopping at a store to wait for a man who was said to have work. Young men lounged around the porch, he wrote, "*whittling their lives away, and are probably there yet. I happened to think, 'What if I should catch the same lethargy?' and we got up and left.*"

Morgan ventured westward from Anoka, MN by himself, working his way to Colorado picking fruit, delivering goods, and mining coal. He purchased 50 30-cent editions of Ruskin, Carlyle, Goethe, Emerson, and Kipling and tried selling them to miners, without any success.

His favorite job was at a lumber camp in the Rockies. But he soon learned the mill was sawing wood to be used to construct a gambling hall at a nearby mining camp. Being opposed to gambling – he quit and decided to return home.

- During his sojourn to Colorado Morgan completed his formal education, taking a scattering of classes at the University of Colorado during a 6-week summer term. His poor eyesight and meager resources could not sustain him so, alone and broke, he returned home.
- Morgan believed in the value of honest work, and scorned any scheme to profit one's self through chicanery or cleverness. He vowed to do something that would "*contribute to human well-being*."
- Back in Minnesota he entered the surveying business with his father, as Morgan & Morgan rather than Morgan & Son.
- In 1904-05 he achieved some measure of respect by preparing the Minnesota Water Control Code, whereby the state's statutes for drainage control were formally established. The governor offered Morgan the post of state engineer, but he declined because his wife Urania, an osteopath, died suddenly, just four months after the birth of their first child, Ernest. He decided to leave Minnesota.

Supervising Drainage Engineer for the USDA

Congressional panel formed to investigate the Everglades development scheme in 1909, hastened by Arthur Morgan (second from left, first row). He was 31.

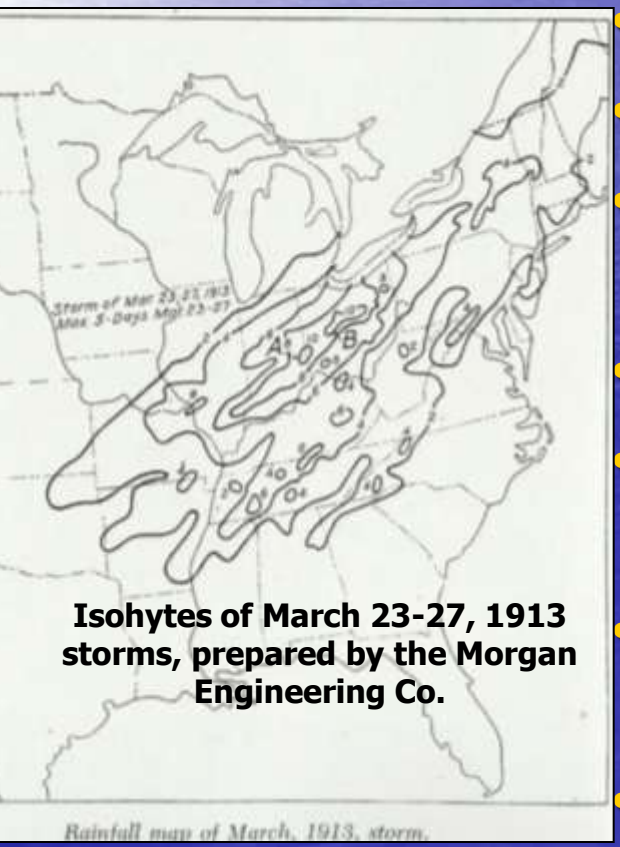
- Morgan was one of four engineers hired by the Department of Agriculture's Office of Drainage Investigation in 1907. He soon became the Supervising Drainage Engineer.
- The image at upper left shows him in 1908 with his "instrument men," the same year that he contracted malaria.
- While Morgan was working for the Department of Agriculture he received numerous inquiries about a proposal to sell drained swampland in the Florida Everglades.
- When the Everglades surveying report fell into Morgan's lap he refused to approve it for publication, leading to a congressional investigation and exposé of the fraudulent investment scheme.

The Morgan Engineering Company of Memphis

- In 1910 Morgan left government to set up the Morgan Engineering Company in Memphis, strategically located halfway up the Mississippi.
- The following year (1911), he married Lucy Griscom, a biology instructor on the Wellesley faculty, whose Quaker sense of mission would greatly influence Morgan's life decisions. At 33, Morgan had finally completed his apprenticeship.

- The firm specialized in consultations pertaining to water resources development, irrigation, and flood control for a wide range of clients, from railroads to government agencies.
- He was able to attract many solid and capable civil engineers, to work on an array of challenging problems. In each case, Morgan would reward these men by making them partners in his young firm, a most unusual practice at that time.
- This became the Memphis Morgan Engineering Company, which thrived for many years after Arthur Morgan departed.
- Among the pioneering schemes the Morgan Engineering Co. developed was the 175-mile long bypass floodway extending southwestward from Cape Girardeau, MO for a congressional flood committee; and subsequently adopted by the Little River Drainage District in 1928. They excavated more than 100 million cubic yards of earth.

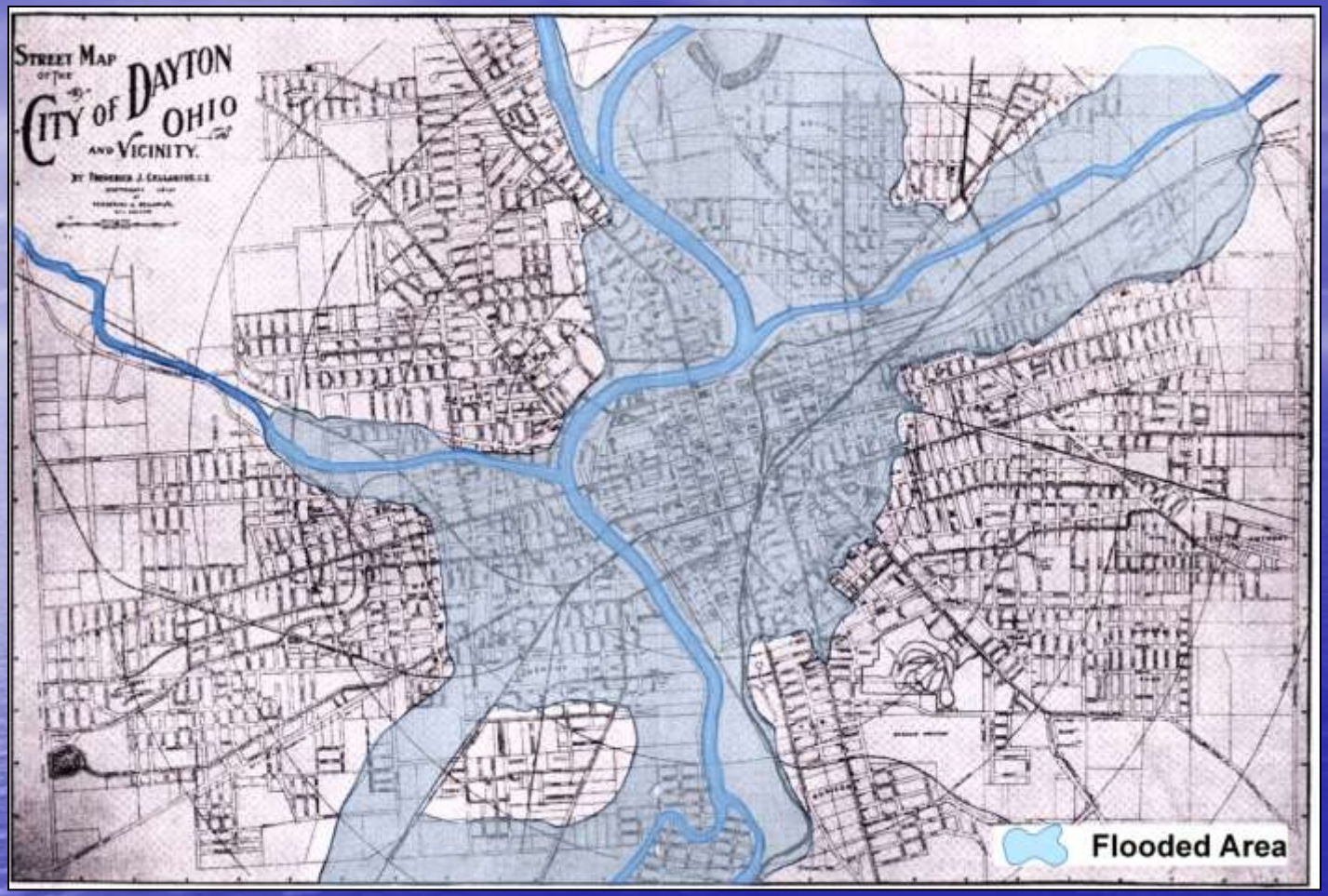
The 1913 Dayton Flood



Isohytes of March 23-27, 1913 storms, prepared by the Morgan Engineering Co.

- 4 rivers converge in Dayton within one mile of each other
- The Dayton area averaged one major flood every decade
- The Great Miami River watershed covers 3,937 square miles, 115 miles of channel; feeds into the Ohio River
- 23 March - Easter Sunday, rain begins falling
- 24 March - heavy rains. A 7 AM river reaches high stage for the year at 11.6 ft and continues to rise
- 25 March - 5:30 AM the Miami River reached unprecedented 100,000 cfs flow, streets begin flooding at 6 AM
- 26 March - flood waters reach their crest at 1:30 PM

- The city had designed their levee systems to withstand a peak flow of 90,000 cfs
- The flood waters reached a peak flow of 250,000 cfs, considered a 500-yr event at that time.

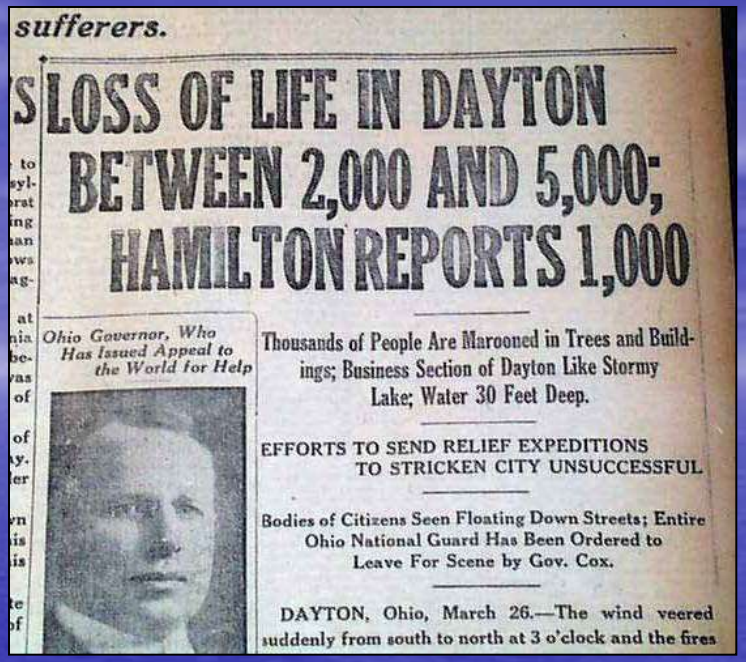


- 10 square miles of Dayton were inundated
- 20,000 homes were destroyed in Ohio, most along the Great Miami River Valley. Hamilton was the hardest hit, with Dayton second.
- 700 people died in the storm event, including 467 in Ohio. Most of the casualties were elderly and children/infants
- 1400 horses and 2000 other domestic animals also died in the flood

Many homes exhibit holes in their attics, where stranded survivors were rescued

- Martial law is declared and the U.S. Army is brought into prevent looting and supervise distribution of aid to the civilian populace

Public outcry and demands for action



sufferers.

LOSS OF LIFE IN DAYTON BETWEEN 2,000 AND 5,000; HAMILTON REPORTS 1,000

Ohio Governor, Who Has Issued Appeal to the World for Help

Thousands of People Are Marooned in Trees and Buildings; Business Section of Dayton Like Stormy Lake; Water 30 Feet Deep.

EFFORTS TO SEND RELIEF EXPEDITIONS TO STRICKEN CITY UNSUCCESSFUL

Bodies of Citizens Seen Floating Down Streets; Entire Ohio National Guard Has Been Ordered to Leave For Scene by Gov. Cox.

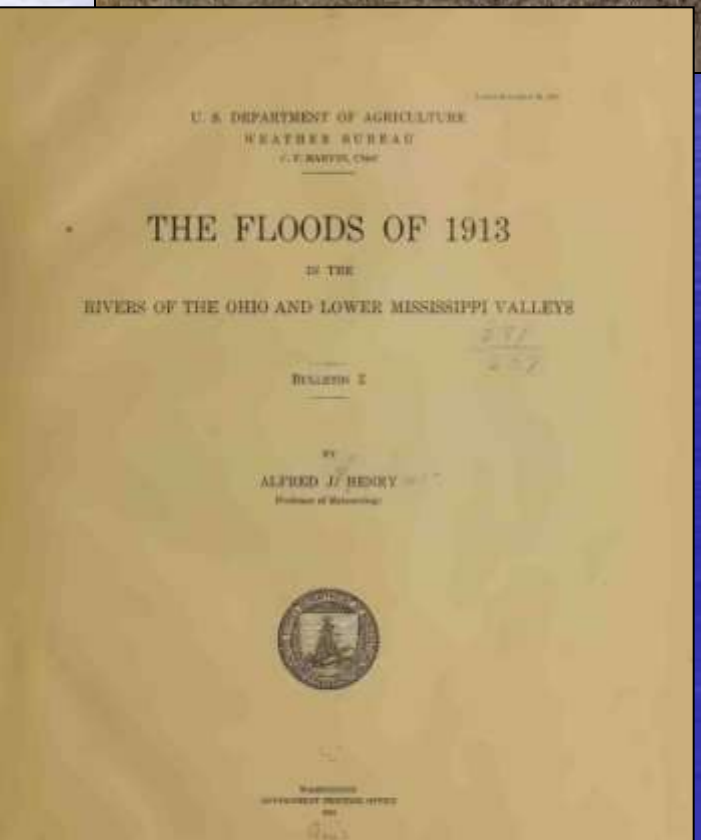
DAYTON, Ohio, March 26.—The wind veered suddenly from south to north at 3 o'clock and the fires

- Dayton's newly appointed City Manager was **Henry Matson Waite**, who was a civil engineering graduate of MIT in 1890. He had previously served as City Engineer for Cincinnati from 1911-13.
- The citizens of Dayton vowed that such a catastrophe of human suffering should never occur again.
- Dayton's City Engineer **Gaylord Cummin** had worked for the Morgan Engineering Company.
- Two months after the flood the city retained the Morgan Engineering Co. to develop a plan of "fail-safe flood control" for Dayton, but Morgan realized that could only be accomplished by examining the entire watershed.

- Morgan moved from Memphis to Dayton, establishing the **Morgan Engineering Co. of Dayton** to carry out the work. He thrust himself into the research, design, and construction of a resilient flood control system, involving the entire watershed of the Great Miami River.


Arthur Morgan, CE

- The **Miami Conservancy District** required legal pioneering to formulate the agency on a solid legal foundation that would withstand a flood of challenges from the affected communities. Morgan's experience with drainage legislation west of the Mississippi proved invaluable.



U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

THE FLOODS OF 1913

IN THE

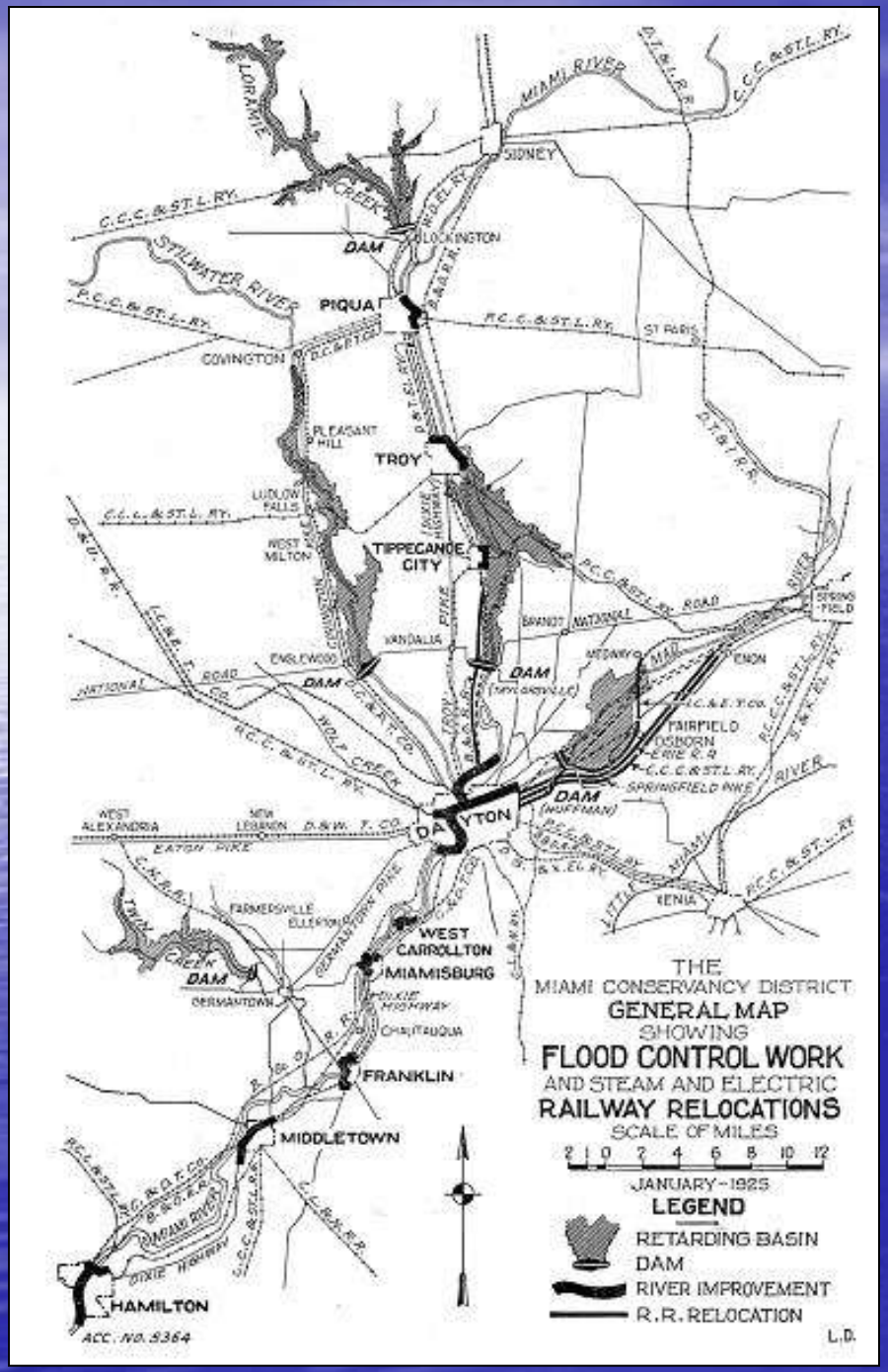
RIVERS OF THE OHIO AND LOWER MISSISSIPPI VALLEYS

BULLETIN Z

BY

ALFRED J. HENRY

Morgan began by hiring the best engineers he could find, including Ivan Hoek, Barton Jones, Charles H. Paul, Emory W. Lane, J. H. Kimball, and Gerard H. Matthes. He charged Hoek with reviewing all of the climatologic information, while dispatching an army of surveyors to carefully ascertain flood heights across the Great Miami River watershed….

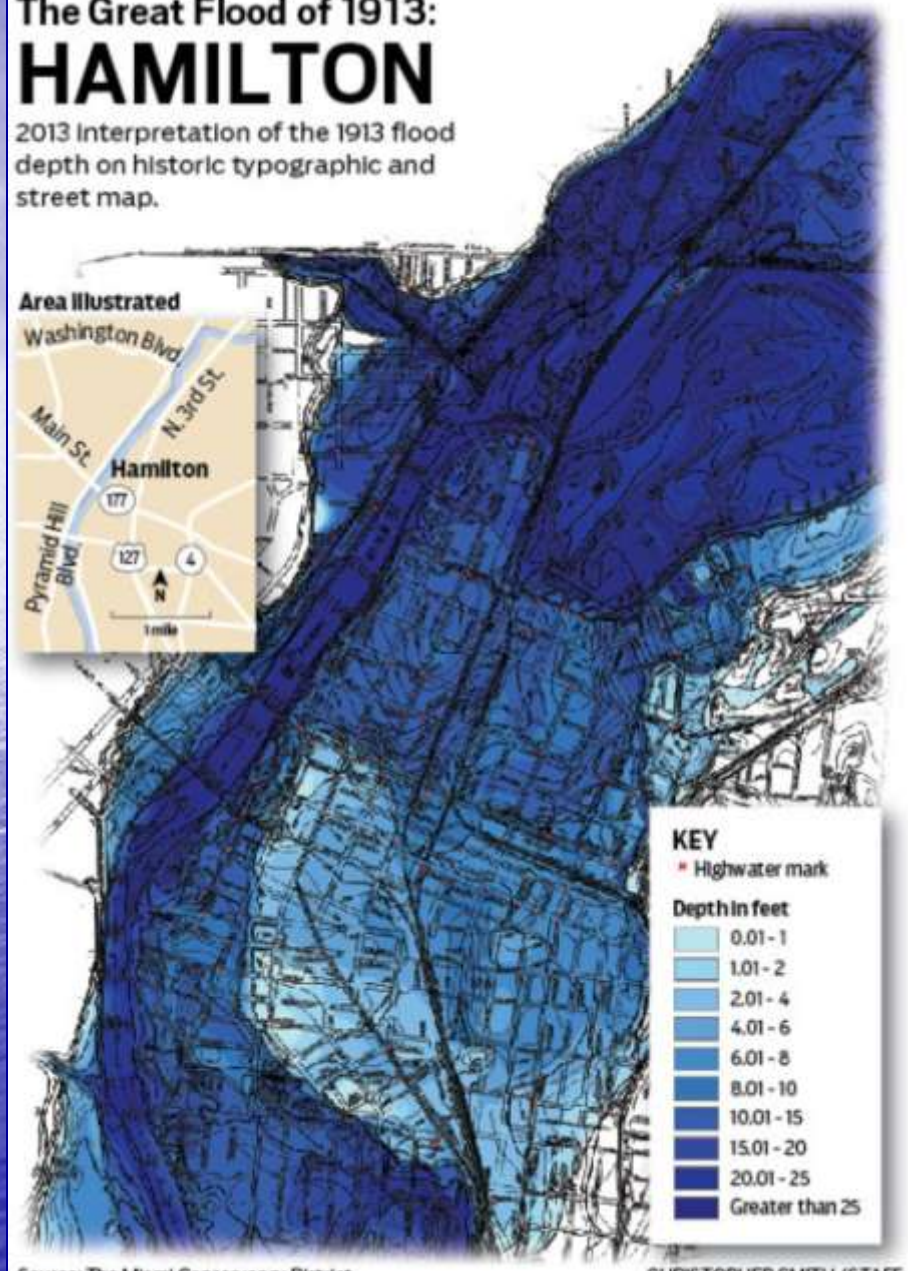


A revolutionary concept

- Morgan championed an ***integrated plan of flood control;*** which encompassed the 3,937 square mile watershed of the Great Miami River.
- The key elements included five mammoth retention basins, requiring some of the largest earth dams ever built in the United States up to that time

The Great Flood of 1913:
HAMILTON

2013 interpretation of the 1913 flood depth on historic typographic and street map.



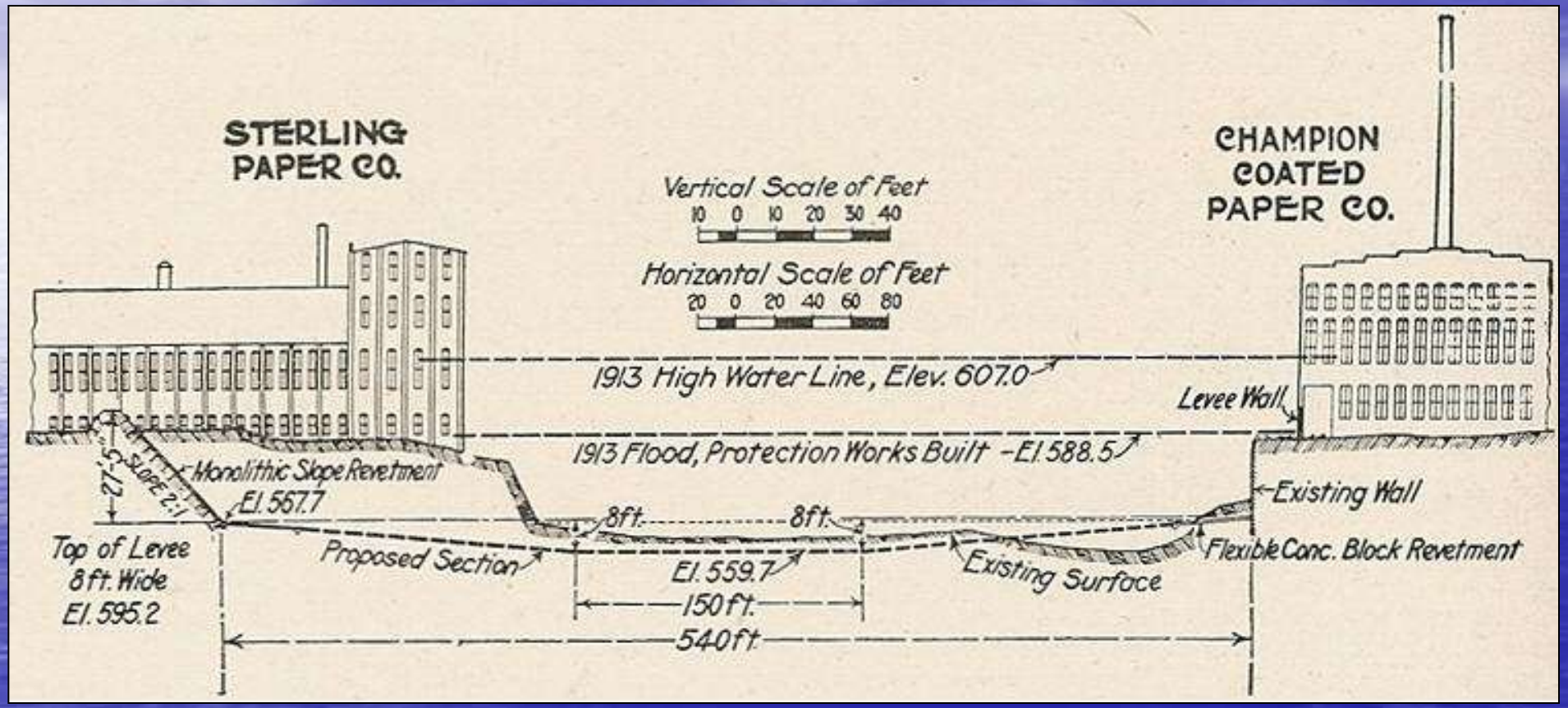
Source: The Miami Conservancy District

CHRISTOPHER SMITH/STAFF

An image of the CH&D Railroad bridge falling into the flood waters at Hamilton, Ohio. *Photo postcard courtesy of the Ohio Historical Society.*

Main to High Street Bridge in Hamilton, Ohio on March 25, 1913. This was one of four bridges to collapse, which would render much of the city cut off from outside help. *Photo courtesy of Wright State University.*

Entire factories were removed where such features encroached the *natural river channel*



Business and industries which encroached the 1000 year flow channel were razed and relocated. The channel of the Great Miami River was more or less restored to its natural cross section.

- **Excavation of Caisson #3 for the new Black Street Bridge across the Great Miami River in Hamilton, Ohio, as viewed on September 1, 1920. Massive amounts of pumping were required to keep the excavation dry.**

Armoring channel banks and levees to retard bank undercutting

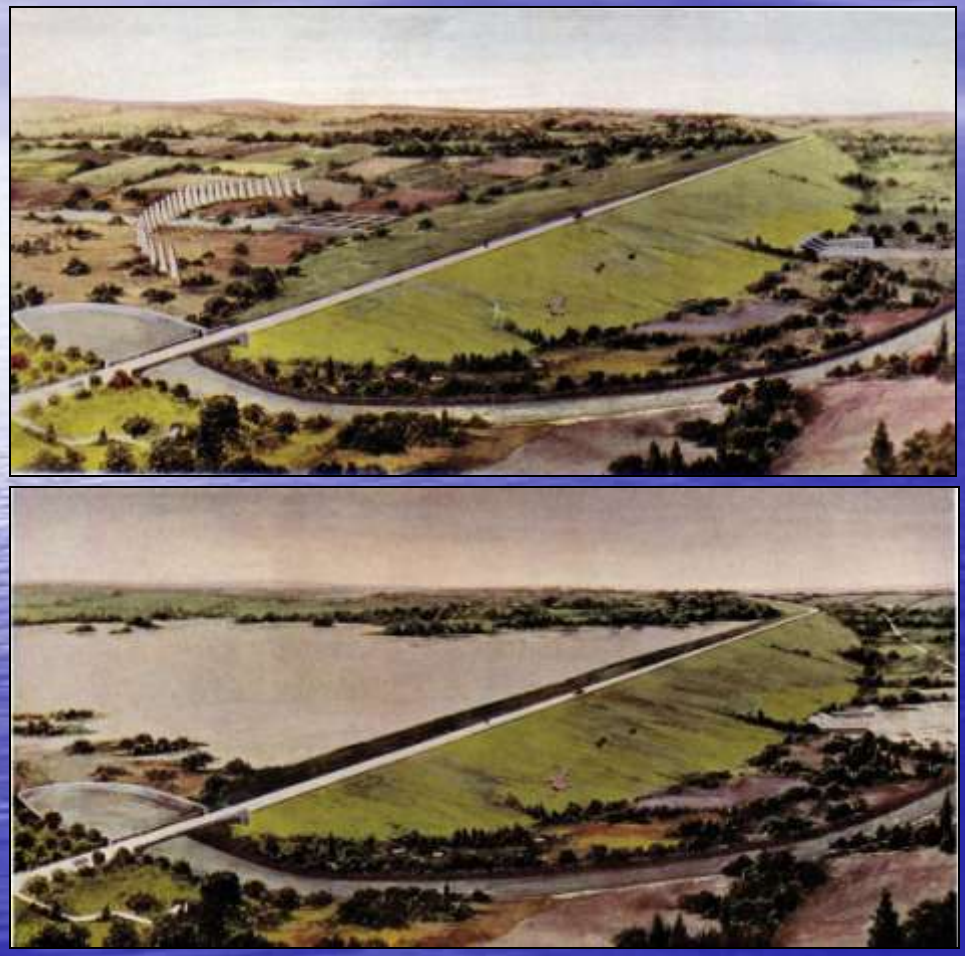
Various schemes were undertaken to pave undercut channel banks and newly graded levees, where scour was expected.

Concrete revetments were secured by steel cables passing through precast blocks

- The Miami Conservancy Project witnessed the transition from beasts of burden to mechanized transport for common earthmoving.
- The upper view shows work on the spillway for the Germantown Dam in early May 1920, using Fresno scrappers and hopper dumping wagons.
- Lower image - Shovels loading dump trucks on Great Miami River levees in Troy, Ohio

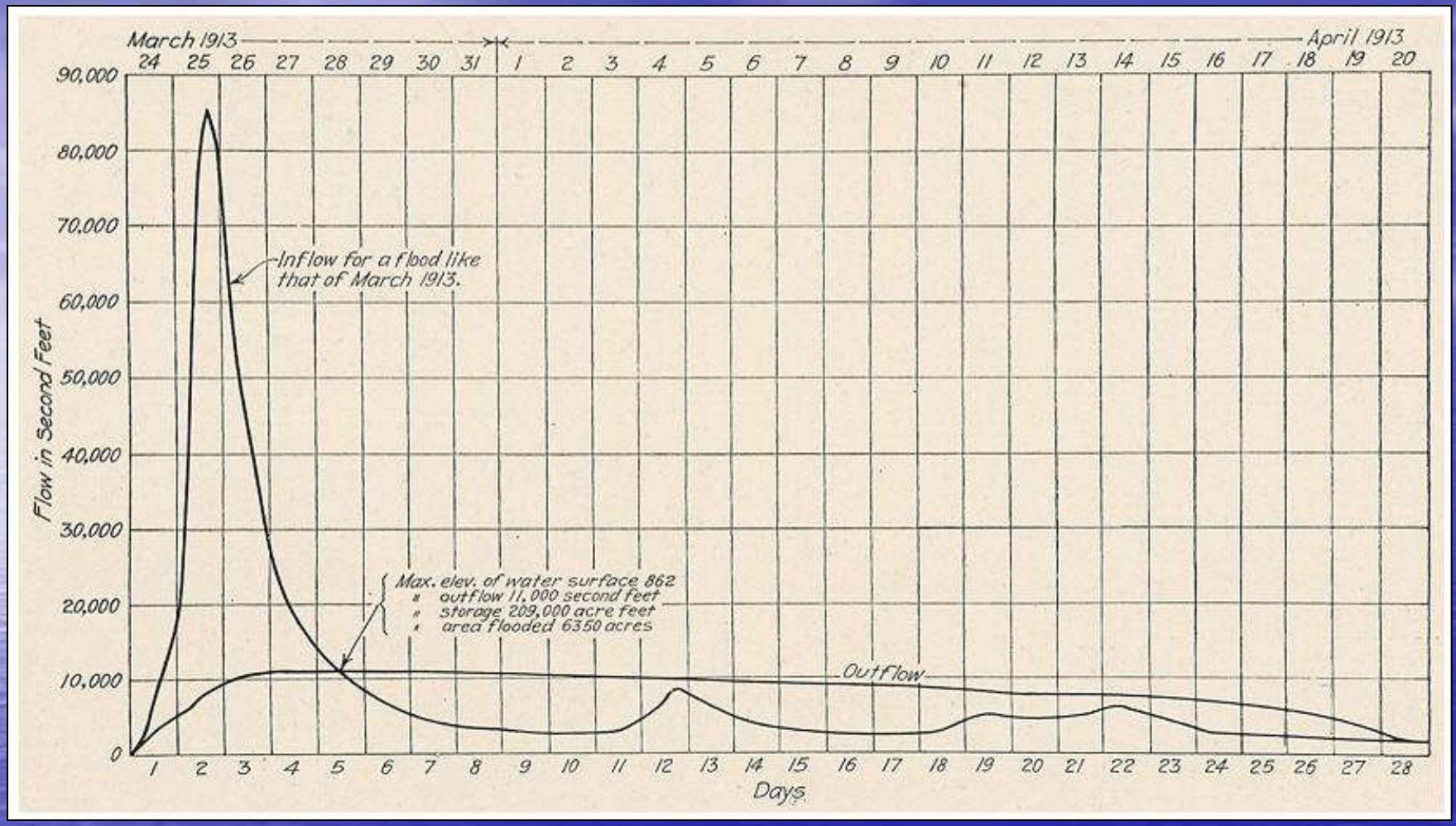
- **Improved channel of the Great Miami River flowing bank-to-bank on January 15, 1930, passing the Black Street Bridge at lower right.**

‘Dry Dams’ with no moving parts

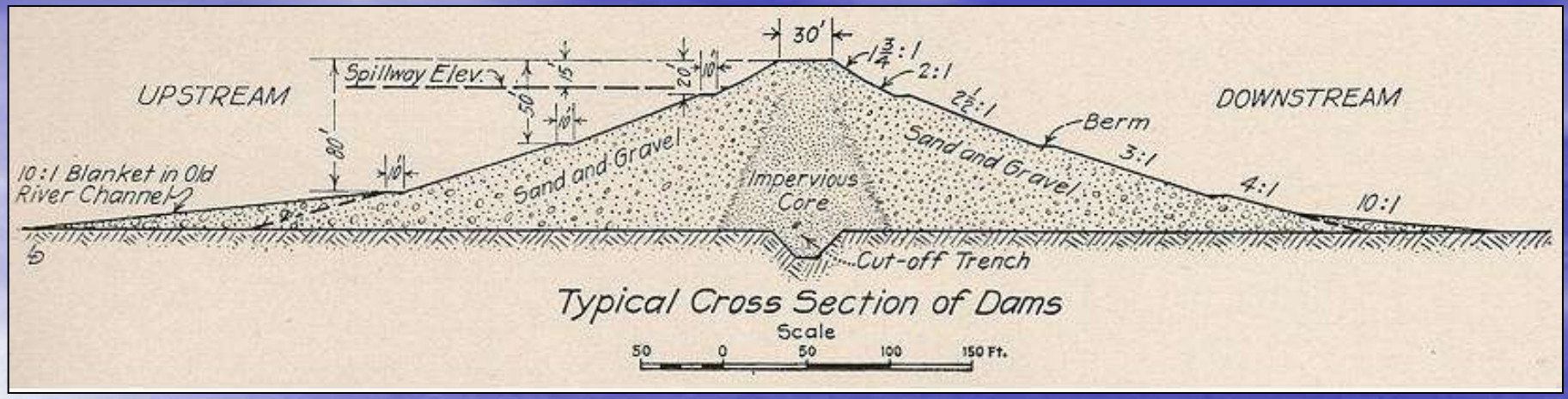


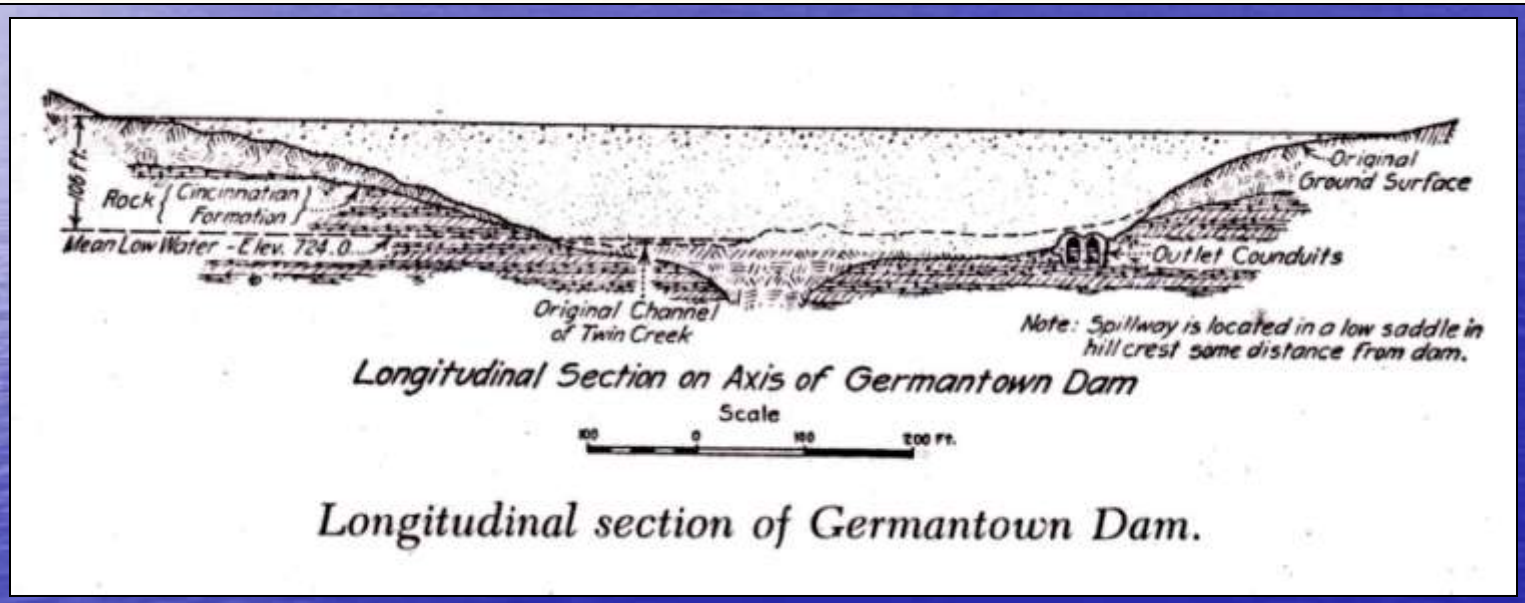
Color concept renderings prepared in 1914. The central service spillway was un-gated, while the auxiliary spillway sill was situated 15 feet below crest, allowing ample freeboard.

- Leaving a margin for error, Morgan decided to design for a flow 40 percent above that of 1913.
- Morgan devised an innovative plan using normally dry flood control basins rather than storage reservoirs, to provide flood storage and meter the peak flows. The massive “dry dams” would be the largest embankment dams in the country and were bereft of any moving parts, so that they would be “fail-safe.”
- Morgan presented his scheme to the public on October 3, 1916. The Dayton Daily News reported, "*before it was apparent to everyone that he had a grasp of the subject clearly beyond anything that was to be expected.*"
- "*During the five days that Mr. Morgan was on the stand, there was no request for information made… that was not met with instant response. The promptness and thoroughness of the answer was always more surprising and unexpected than the question itself.*“



- **Design inflow and outflow hydrographs for Stillwater River at Englewood Dam, illustrating the mollifying impact on the peak inflow, represented here by the March 1913 flood.**





- **Five of the largest earthfill embankment dams in the United States were constructed between 1916-22, using hydraulic fill methods.**

Puddled clay cores

Views showing excavation and filling of the core trench at Germantown Dam, during construction in early November 1920. Note pipes at lower left, which discharged slurry.

- Dragline excavating core trench for Englewood Dam in November 1920.
- Fill for the dam's shells was brought in on side-dumping rail cars, shown below.

Cut for railroad relocation through Huffman Hill in September 1920. The dam's left abutment is out-of-view to the right

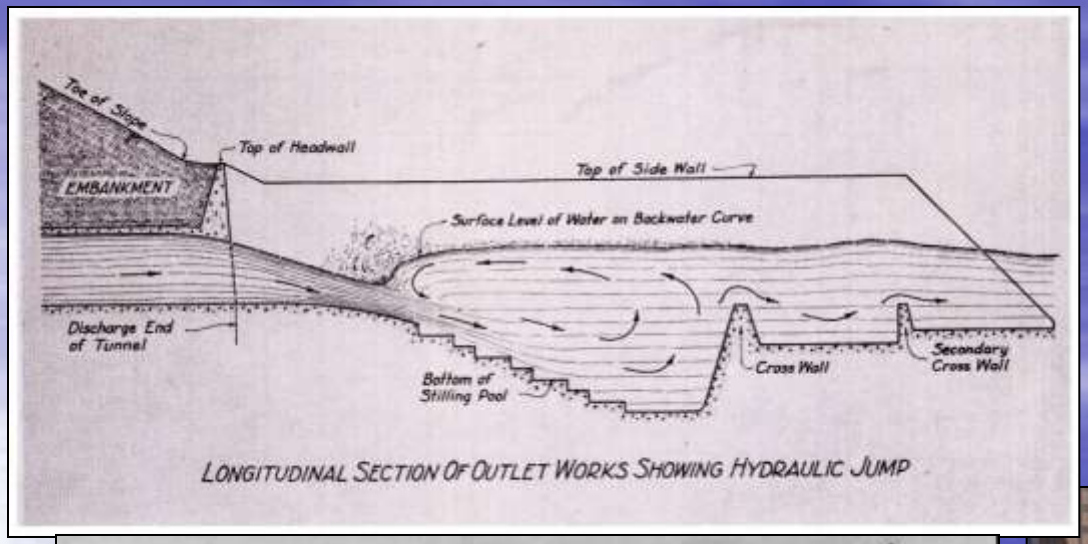
First extensive use of dump trucks, during levee construction in Troy, Ohio in 1919

The MCD was the first major public works project funded by a local improvement agency established by citizens of the affected area. It also ushered in a modern era of earthmoving and concrete work, though before the advent of soil mechanics.

Earthmoving equipment allowed for the 'control of nature'

- View from screening plant at Englewood Dam showing Bucyrus Class 24 electric dragline, Marion Model 36 draglines, and a traction roller working on Cross Dam No 2, as seen on September 15, 1920.

Innovations in energy dissipation



LONGITUDINAL SECTION OF OUTLET WORKS SHOWING HYDRAULIC JUMP

- Morgan's firm employed hydraulic models to evaluate innovative schemes for energy dissipation in the un-gated outlet works of the retention basins, and at flow transitions along the channel margins.

Englewood Dam Outlet

- The pass-through discharge outlet through Englewood Dam in 1929 (above) and during a flood event in January 1930 (lower)
- The critical elements of the five dams/detention basins were intended to function without human intervention

Taylorsville Dam

Upper - Taylorsville Dam was completed in 1920 along the Great Miami River, between Dayton and Troy, Ohio

Lower - This image taken in May 1922 shows the four open conduits beneath the service spillway of Taylorsville Dam

No Multi-purpose reservoirs

Taking care of the workers

- Morgan's trademarks were **engineering innovation** and inculcating a **strong sense of community** between all levels of a project – providing housing, job safety, schools, libraries, and all manner of self improvement, such as after-hours vocational training.

LEGAL PRECEDENTS AND CHALLENGES

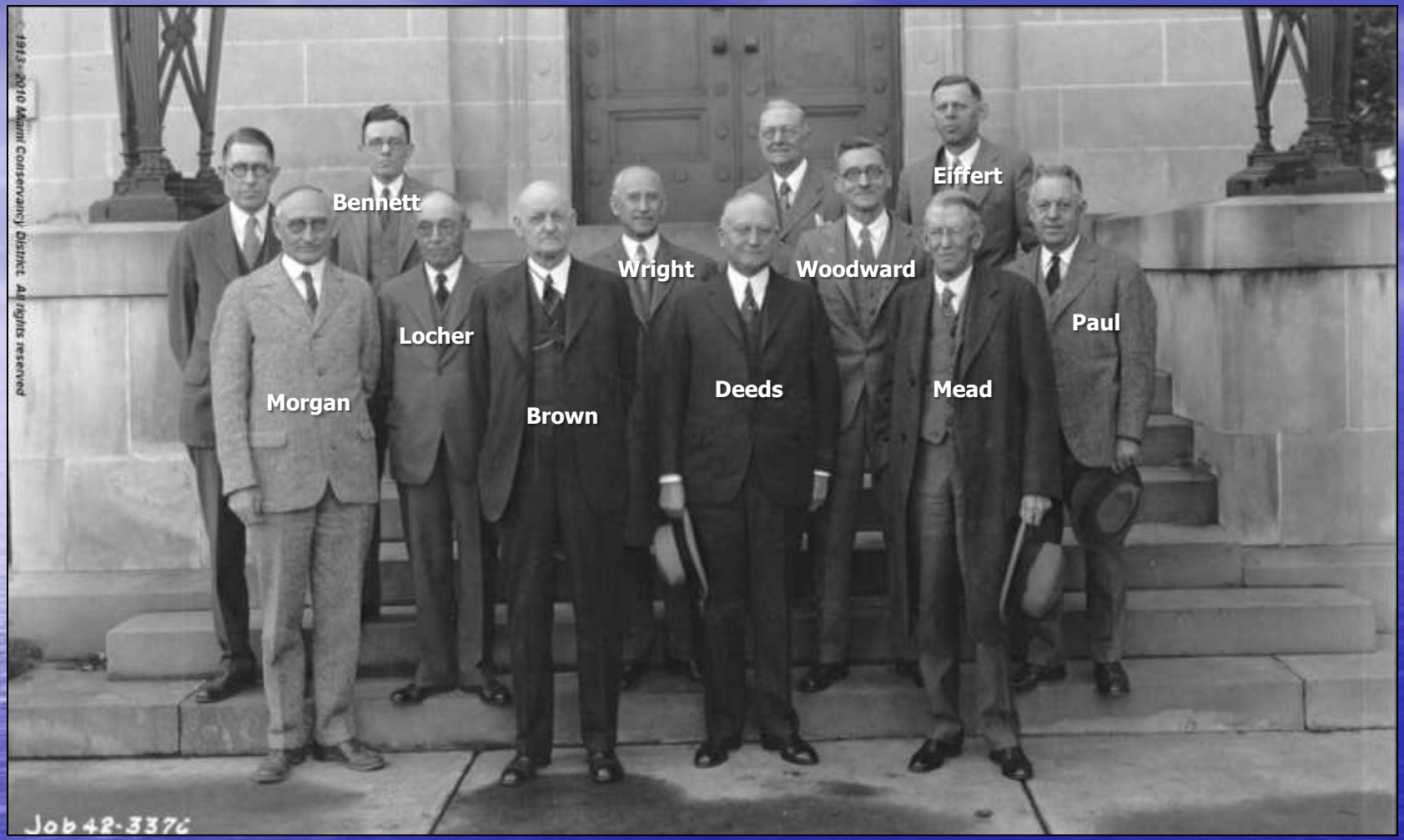
Concreting the flow bypass through Lockington Dam

- The Miami Conservancy District required legal pioneering to formulate the agency on a solid legal foundation that would withstand a flood of challenges from the affected communities.
- Morgan's experience with drainage legislation west of the Mississippi proved invaluable. In 1914, Morgan drafted the **Ohio Conservancy Act** which was quickly passed and signed into law.

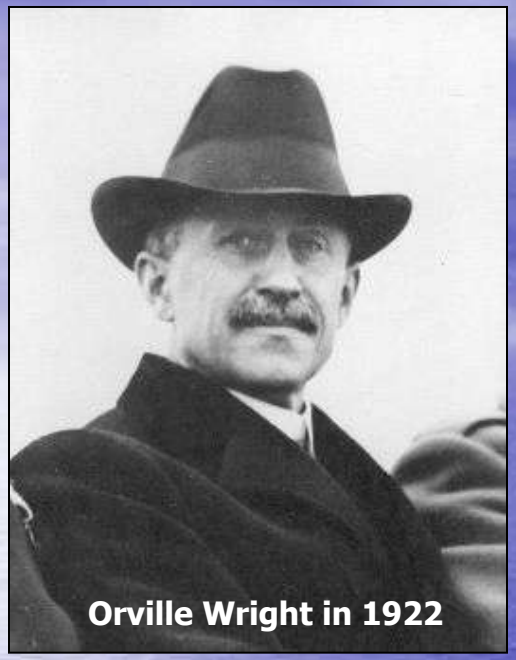
Adjudicating legal challenges

Miami Conservancy Court Judges visiting Lockington Dam on September 28, 1921

- The Conservancy Act allowed local governments to establish "conservancy districts" for flood control.
- After much debate regarding the act's constitutionality, the Miami Conservancy District (MCD) was established on June 1915 and appointed Morgan as its first president.
- Work immediately began on his Dayton flood control system.
- The Miami Conservancy District legislation was so novel it faced 61 legal challenges – all the way to the Supreme Court.



- The Miami Conservancy District is overseen by a chief engineer, a board of directors, and a board of consultants. The three groups periodically convene in Dayton and review the district's activities. This shows one of the five year inspection tours, on October 17, 1929.



Orville Wright in 1922

Arthur Morgan in 1922

- While visiting Washington D.C. in 1909, Morgan witnessed one of the first public flights made in the United States.
- After moving to Dayton in 1913 he met **Orville Wright** and they would continue to interact for roughly 35 years.
- In 1916 the two selected the site for a new airfield close to Huffman Dam and the Wrights' flying field, Huffman Prairie.
- This site became **Wright Army Airfield** (shown at lower left), now **Wright-Patterson Air Force Base**, the main R & D center for the Air Force, and Dayton's largest employer.

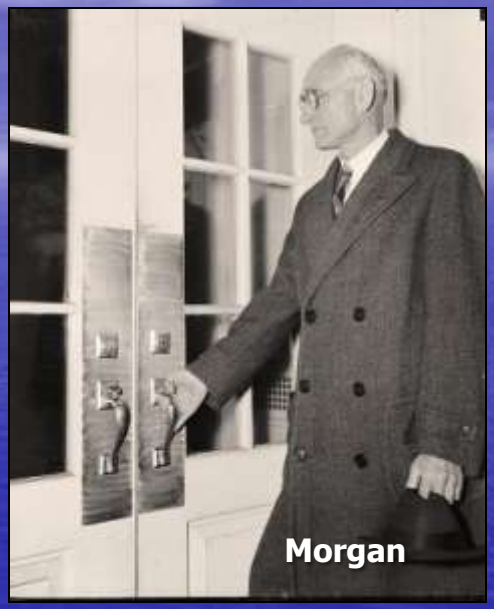
- **In 1921 Morgan accepted the presidency of tiny Antioch College** in Yellow Springs, Ohio, founded by Horace Mann in 1853, and in danger of closing. He revitalized the college, single-handedly shaping the school's character and values.
- Morgan was a practical, but autocratic visionary, who relished new ideas. He quickly implemented a cooperative education program and unique community government system, where students held one another accountable.
- He felt that the combination of practical work with a liberal arts curriculum was the perfect educational blend, because *"the world needed more engineers able to talk about things besides engineering and baseball."*
- Morgan said education's greatest defect was that it didn't emphasize personal and social responsibility. Being self-educated in both engineering and liberal studies, with experience in government and private sector engineering, he was a born problem solver. Burton Clark described Morgan thus: *"He moved from engineering to social engineering in pursuit of utopia, and his utopianism was a critical element in the revision of Antioch College."*

- Tennessee Valley Authority was established in May 1933. President Roosevelt appointed three TVA Directors , including Arthur E. Morgan as its Chairman, because of his expertise in dams and flood control. The other members were Harcourt A. Morgan , an expert in agriculture, and Harvard-trained attorney David Lilienthal, an expert on publicly-owned utilities.

Morgan was relieved of his chairmanship of the TVA in May 1938


Lilienthal


Roosevelt


Morgan

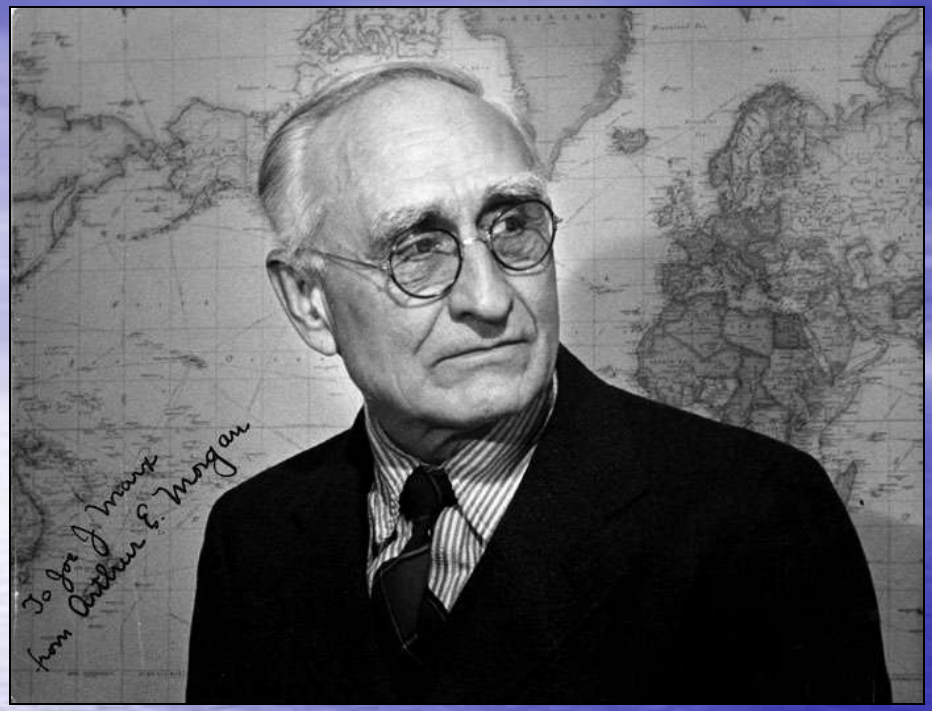
- David Lilienthal and Morgan became increasingly at odds with one another over their differing philosophy regarding what the TVA was intended to do. Lilienthal viewed Morgan as overly paternalistic and possessed of a misplaced trust of the private power industry, who had engaged the TVA in expensive litigation.
- In May 1938 Roosevelt summoned Morgan to the White House for a face-to-face examination, and decided to fire him for "contumacy," the willful refusal to obey a superior's order.

Back to Antioch College


Arthur and Lucy Morgan in November 1938

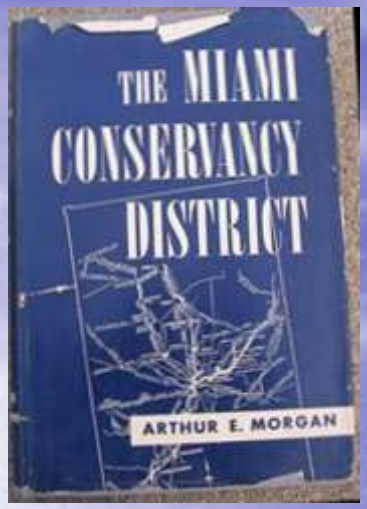
- At left: Rare smiles from Arthur and Lucy Morgan, back in Yellow Springs, Ohio after being relieved of his position as Chairman of the TVA in 1938.
- Morgan was 60 at this time and most thought his career was over, but not Morgan himself, he seemed invigorated by the experience.

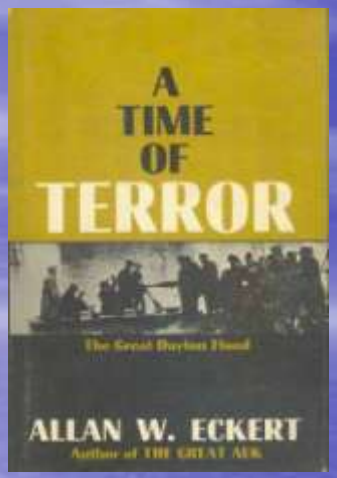
- He returned to Antioch College, where he served as a trustee and perennial lecturer for the next 37 years.
- In retirement he founded **Community Service, Inc.,** to promote recognition and development of the "small community." This vision survives today as the "*Arthur Morgan Institute for Community Solutions* "in Yellow Springs, Ohio, administered by his granddaughter Faith Morgan.

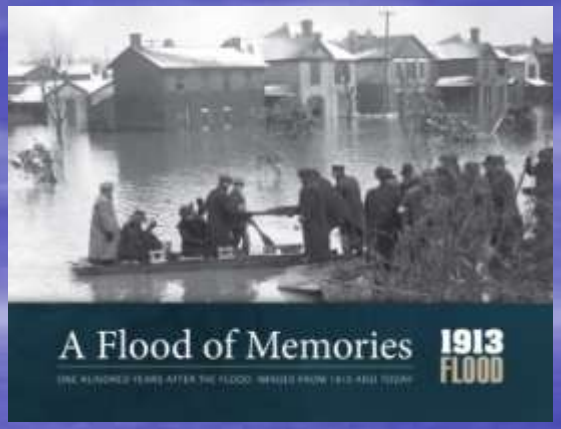


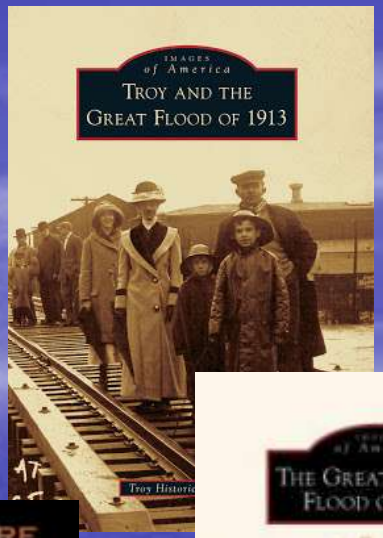
Morgan leading a civil rights march in 1963

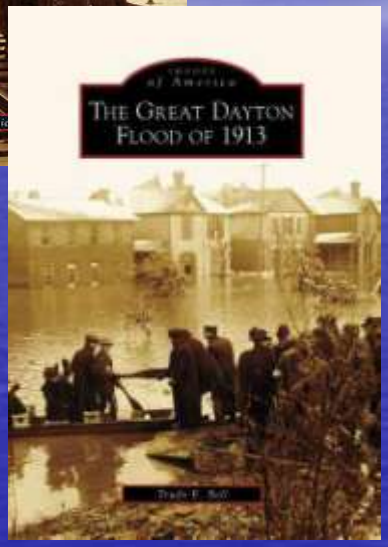
- During his 37 year retirement Morgan served as a consultant for several foreign governments and published books on topics ranging from the ideas of Sir Thomas More to the dam-building by the U.S. Army Corps of Engineers.
- His last work, "The Making of TVA," was released in 1974, a year before his death at age 97.

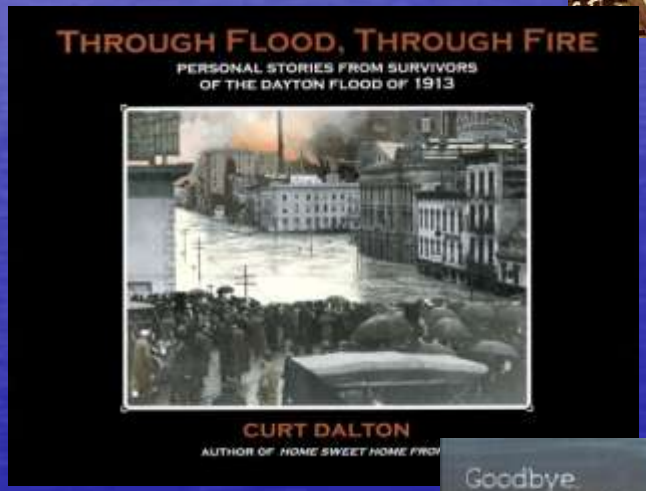


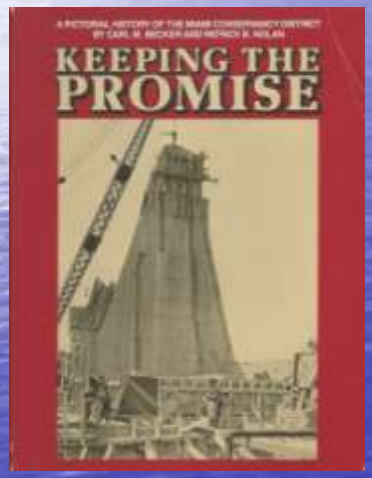


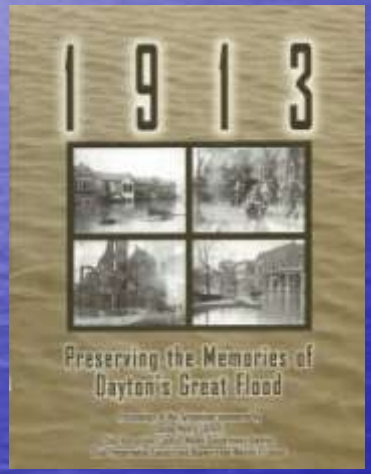


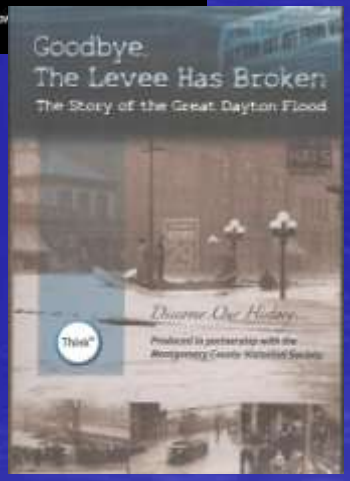


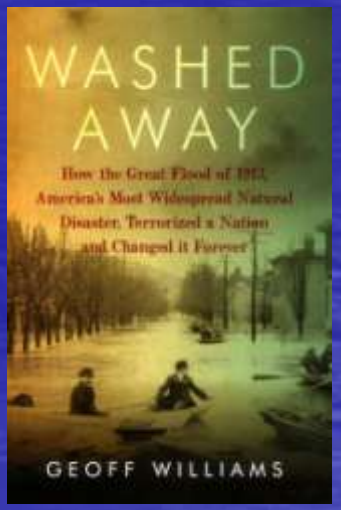












- **A number of books have been written about Arthur Morgan, but it wasn't until this year that very much has been written about the 1913 Dayton Flood.**

Special thanks to:

Kurt A. Rinehart, P.E., Chief Engineer of the
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Antioch University Archives
ASCE-EWRI History & Heritage Committee
Trent Dames Civil Engineering Heritage Fund
of the Huntington Library

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In .PDF format for easy downloading