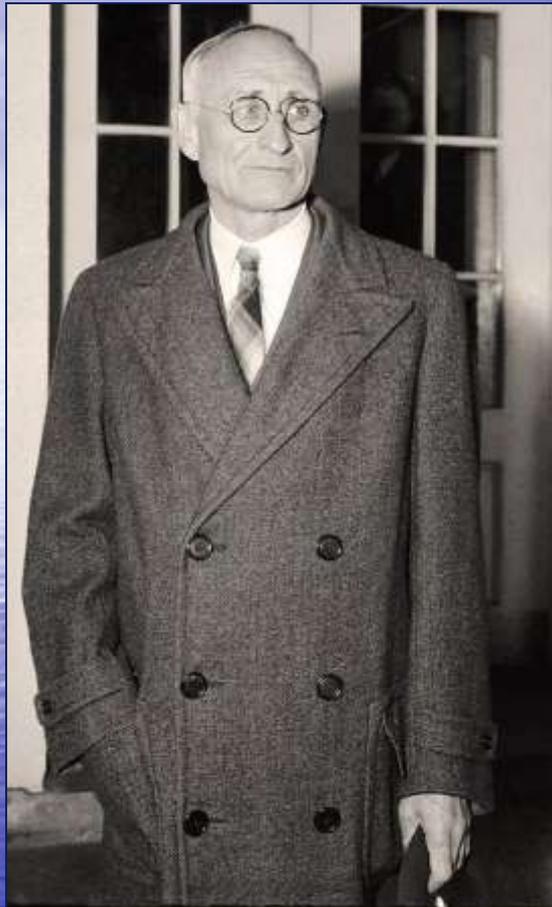


# Dr. Arthur Morgan, C.E.



**Memphis Consultant,  
Architect of modern  
flood control, and first  
Chairman of the TVA**

by  
**J. David Rogers, Ph.D., P.E., M.ASCE**

for the symposium

**History of the Tennessee Valley Authority**

**ASCE Annual Meeting**

**Memphis, Tennessee**

**October 21, 2011**



# 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 on 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

- Based on a competitive national examination, he was one of four engineers hired by the Department of Agriculture's Office of Drainage Investigation in 1907, where he soon became the Supervising Drainage Engineer.
- The image at upper left shows him in 1908 with his "instrument men and rodmen & Floyd & Co.," that same year Arthur experienced a major occupational hazard: malaria.
- While Morgan was working for the Department of Agriculture he received numerous inquiries about an investment 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 major congressional investigation and exposé of the fraudulent investment scheme.



Morgan



Morgan

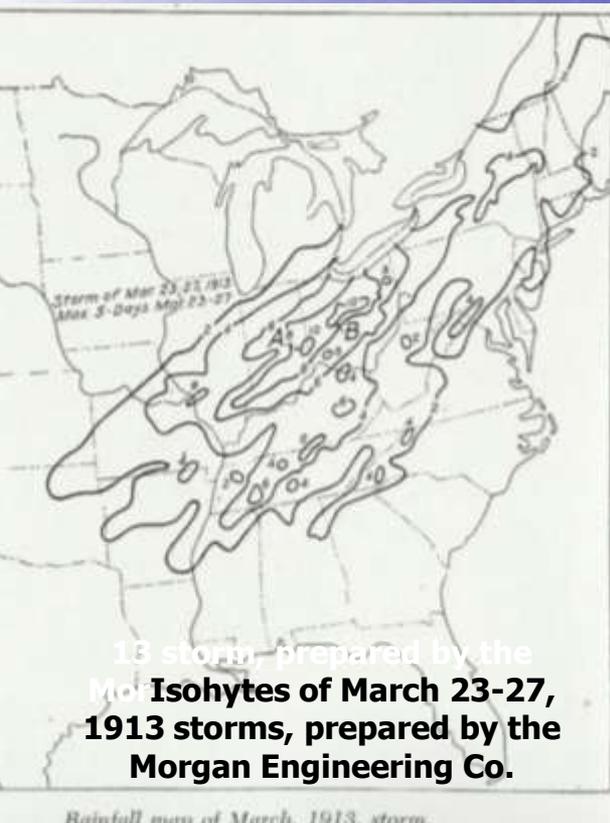
Congressional panel formed to investigate the Everglades development scheme in 1909, hastened by Arthur Morgan (second from left, first row). He was 31.



# 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 young biology instructor on the Wellesley faculty, whose Quaker sense of mission would greatly influence Morgan's life decisions. At 33, Morgan had, at long last, 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; subsequently adopted by the **Little River Drainage District** in 1928.

# The 1913 Dayton Flood



- 4 rivers converge in Dayton within one mile of each other
- The Dayton area averaged one major flood every decade
- 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 Miami River reaches unprecedented 100,000 cfs flow, streets begin flooding at 6 AM
- 26 March - flood waters reach their crest at 1:30 PM





- The flood waters reached a peak flow of 250,000 cfs, considered a 500-yr event.
- Before the, the city had designed their levee systems to withstand a peak flow of 90,000 cfs
- 10 square miles of Dayton were inundated
- 20,000 homes were destroyed in Ohio, most along the Miami River valley
- 700 people died in storm event; 467 in Ohio and about 300 from Dayton (mostly women and children)
- 1400 horses and 2000 other domestic animals died in flood.



- The citizens of Dayton vowed that such a catastrophe of human suffering should never occur again. Two months later, they hired Morgan Engineering Co. to develop a plan of “fail-safe flood control” for Dayton.
- 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 Miami River.
- 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.



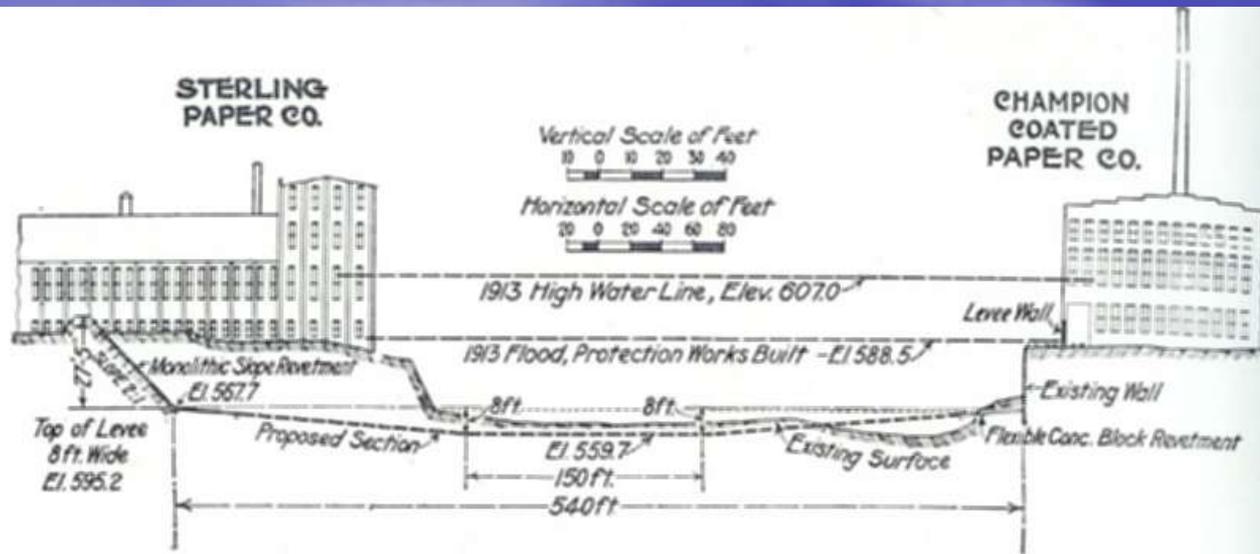
Arthur Morgan, CE

# 'Dry Dams' with no moving parts



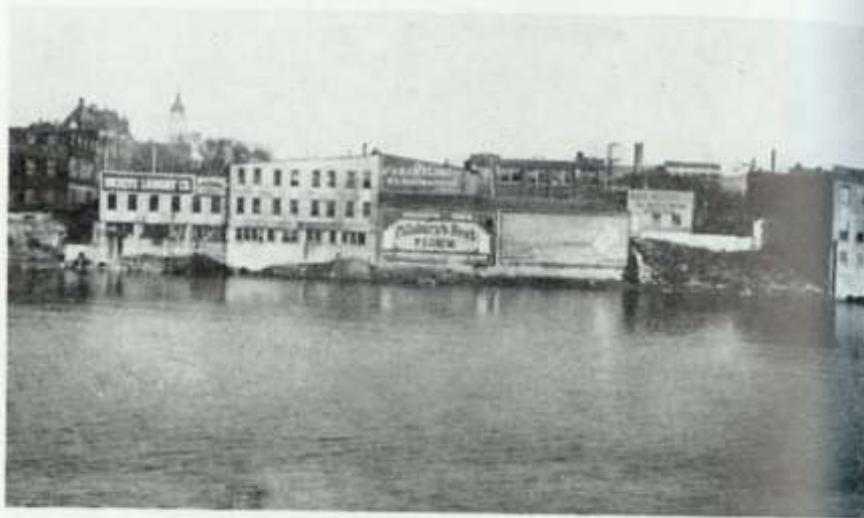
Color concept renderings prepared by Morgan in 1914. The central service spillway was un-gated, while the auxiliary spillway sill was situated 15 feet below crest.

- 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.*"
- The Miami Conservancy District legislation was so novel it faced 61 legal challenges – all the way to the Supreme Court.



Cross section of river channel at Hamilton. Showing a restricted condi-

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

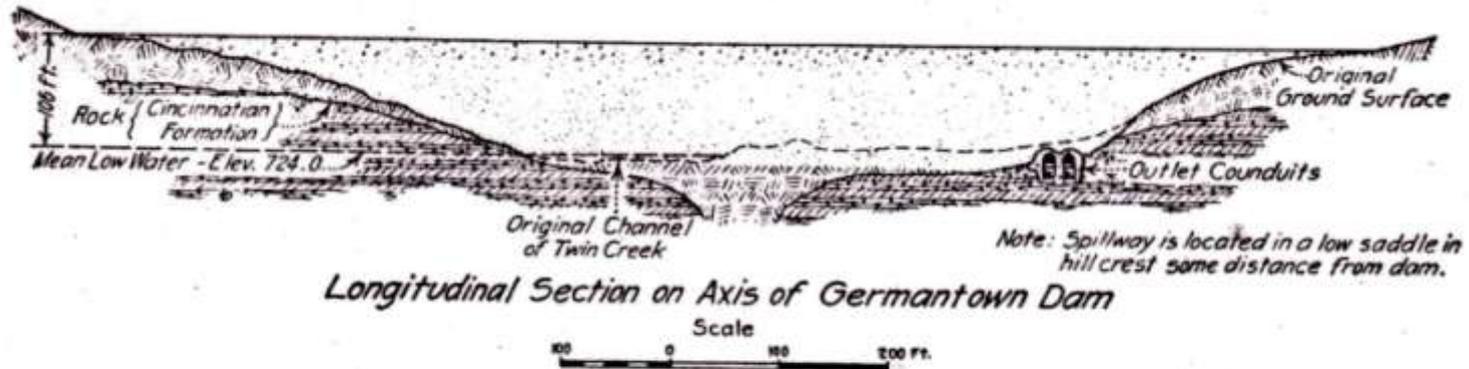


River channel at Hamilton before improvement.



Same river margin after improvement. Buildings along river edge removed.

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

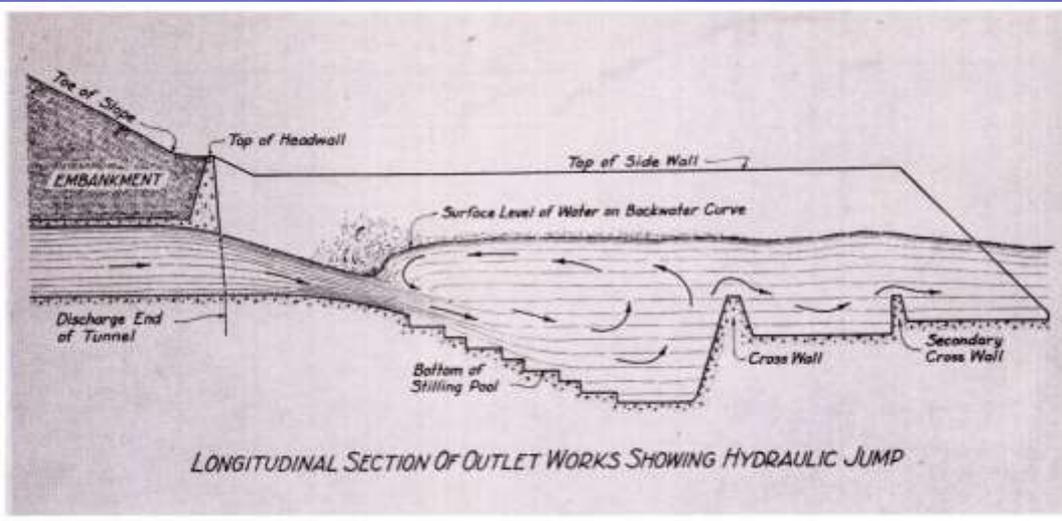


*Longitudinal section of Germantown Dam.*



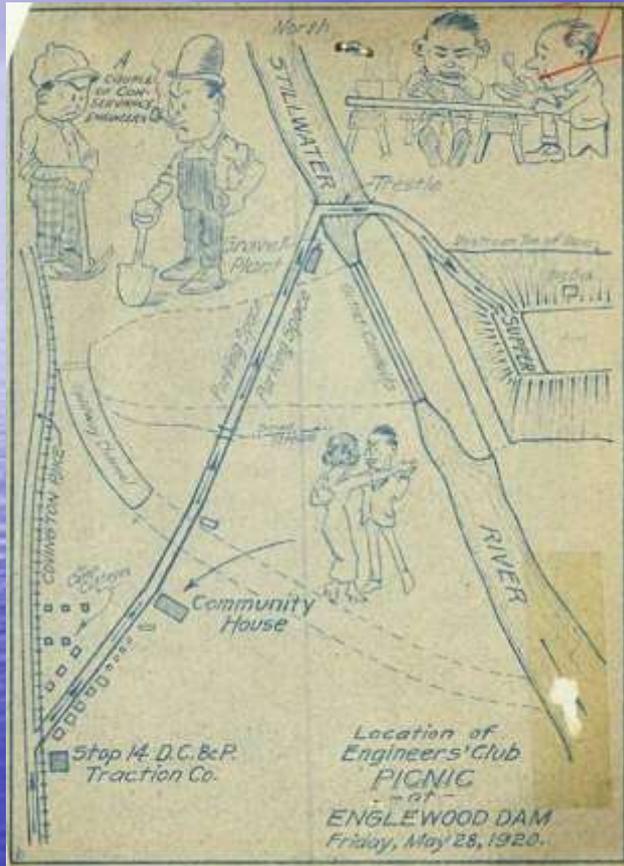
- Five of the largest earthfill embankment dams in the United States were constructed between 1916-22, using hydraulic fill methods, shown here

# Innovations in energy dissipation



- Morgan's firm used 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.

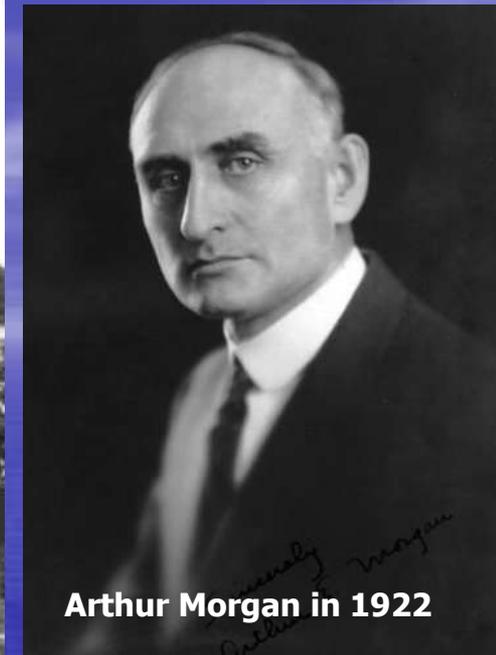
# Taking care of the workers



- 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 training.



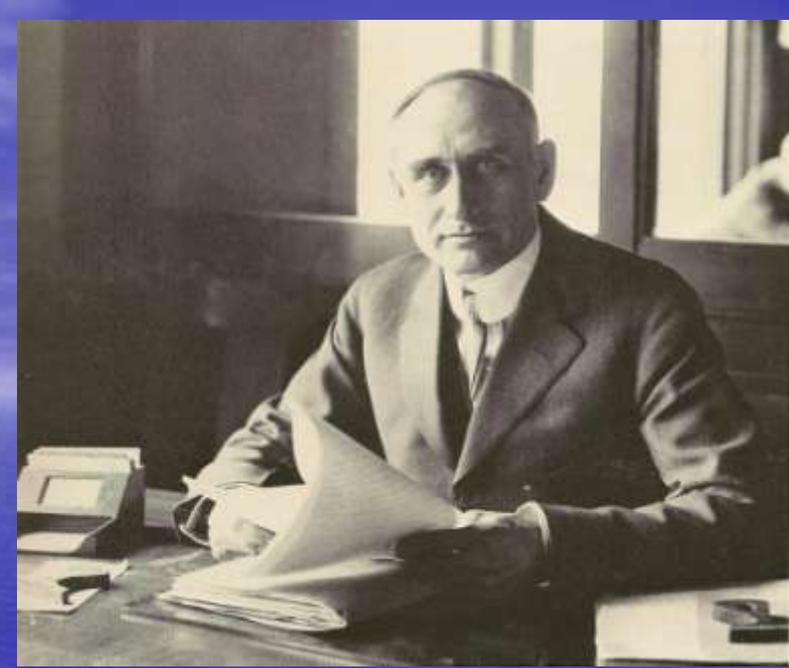
Orville Wright in 1922



Arthur Morgan in 1922

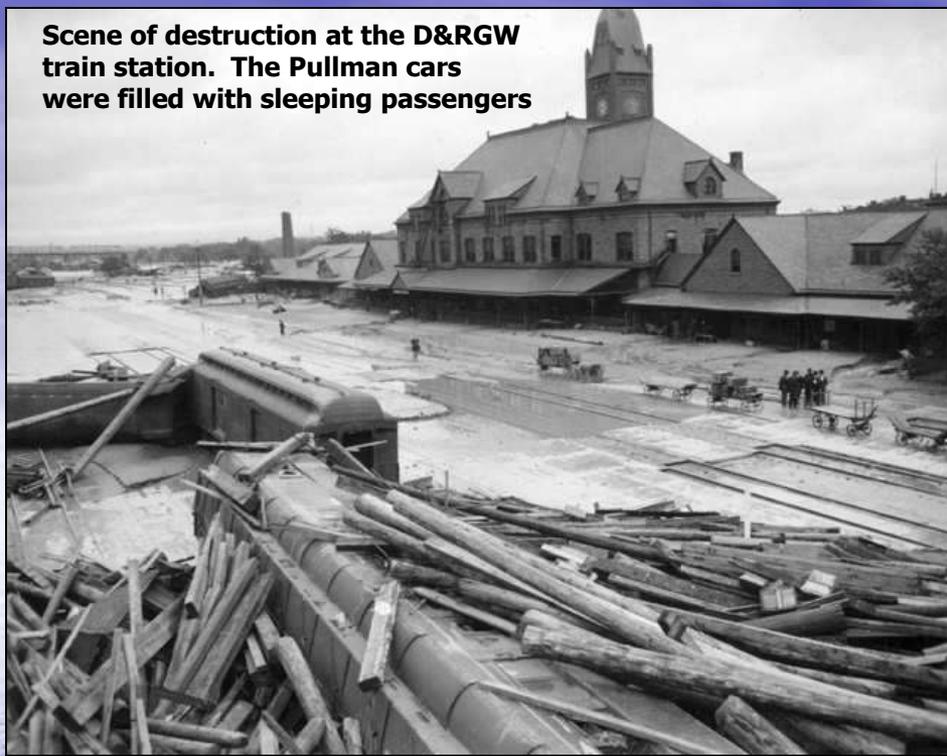


- While visiting Washington D.C. in 1909, Morgan witnessed one of the first public flights made in the United States.
- After moving to Dayton in 1913 he met **Orville Wright** and they would continue to interact for roughly 35 years.
- In 1916 the two selected the site for a new airfield close to Huffman 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."***

Scene of destruction at the D&RGW train station. The Pullman cars were filled with sleeping passengers



# The Pueblo Flood of June 3, 1921

The first hint of an impending flood came at 6:30 PM on June 3, 1921, when an unknown person called and reported that the Arkansas River was flooding upstream because of a sudden cloudburst ten miles west of Pueblo. The flood worsened when Fountain Creek also began to flood from down pours 30 miles north. The flood peaked a little after midnight, while a train was parked in the station, filled with sleeping passengers.

- **1500 people lost their lives in the flood** and there was \$20 million dollars in damage. The flood level was over 15 feet in some places. All of the bridges over Fountain Creek were destroyed; however, the bridges over the Arkansas River remained. The telephone company had 9-1/2 feet of water and approximately 225,000 dollars in damage.
- Soon after the floodwaters subsided, Pueblo leaders realized the city needed more protection from the Arkansas River. Pueblo hired **Arthur Morgan** to perform similar studies to those he had overseen for Dayton, Ohio. In April 1922, the Colorado Legislature passed an act authorizing formation of the **Pueblo Conservancy District** to construct flood controls on the Arkansas and Dry Creek, and the district issued \$4.5 million in bonds to pay for the construction (1922-29).
- In June 1923 Morgan received an honorary doctorate from the University of Colorado, and was thereafter referred to as '**Dr. Arthur E. Morgan.**' The District never built his great "dry dam" with a notch in the center, but **Pueblo Dam**, a conventional year-round storage facility, was eventually constructed by the Bureau of Reclamation in 1974-77.

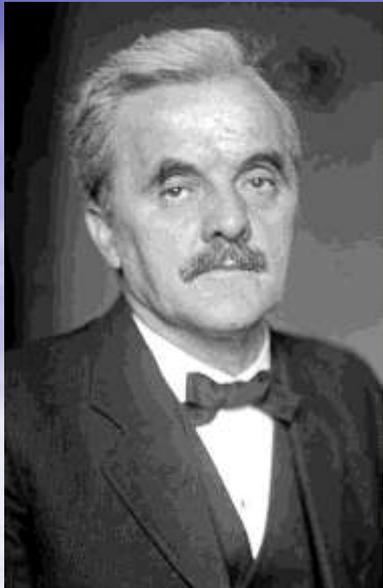
**Massive nitrate plant at Muscle Shoals, constructed during the First World War**



**Wilson Dam was built between 1918-25, but the hydroelectric generation plants were privately operated.**



- One of the biggest political problems facing the new **Roosevelt Administration in 1933** was the half-finished hydroelectric dam along the Tennessee River in northern Alabama at **Muscle Shoals**. Begun during the First World War to produce nitrates for gunpowder and fertilizer, it was only 35% complete when the war ended in November 1918.
- Between 1921 and 1933, 138 separate bills were introduced in Congress, seeking to complete the dam and new powerhouses at Muscle Shoals. The debate about government versus private generation of electricity was eventually settled by entry of the TVA in the electrical generation business, which was upheld by the courts.
- **The Tennessee Valley was a poor rural region, home to 2.5 million people.** Only one farmhouse in twenty-five had electricity. Public power advocates hoped Roosevelt would back completion of Muscle Shoals.
- This became the seed for a much more ambitious federal works program, which became the **Tennessee Valley Authority, today the largest public power provider in the United States, serving over 9 million customers.**



Senator George Norris



Dr. Arthur E. Morgan



Franklin D. Roosevelt



- George Norris' bill, which became the Tennessee Valley Authority Act, was introduced on April 10, passed by Congress on May 17, and signed into law by President Roosevelt on May 18, 1933, just 10 weeks after he took office.
- The TVA Act set comprehensive goals and unified government operations under one agency. It provided for development of the river for **flood control, navigation, land development to prevent erosion, the promotion of better farming methods, and affordable hydroelectric power.**
- Arthur Morgan was astonished when President Roosevelt invited him to the White House and offered him the chairmanship of TVA in March 1933. **"I like your vision,"** said FDR. Morgan dreamt of the perfect society, a utopia. He viewed his appointment to the TVA as a way to prove out his multidisciplinary vision for constructing a more perfect society in a scheme that could have enormous societal impact.
- Morgan was famous for two things that might seem to have nothing to do with each other: **building efficient hydraulic structures, and believing in the perfectibility of humankind.**

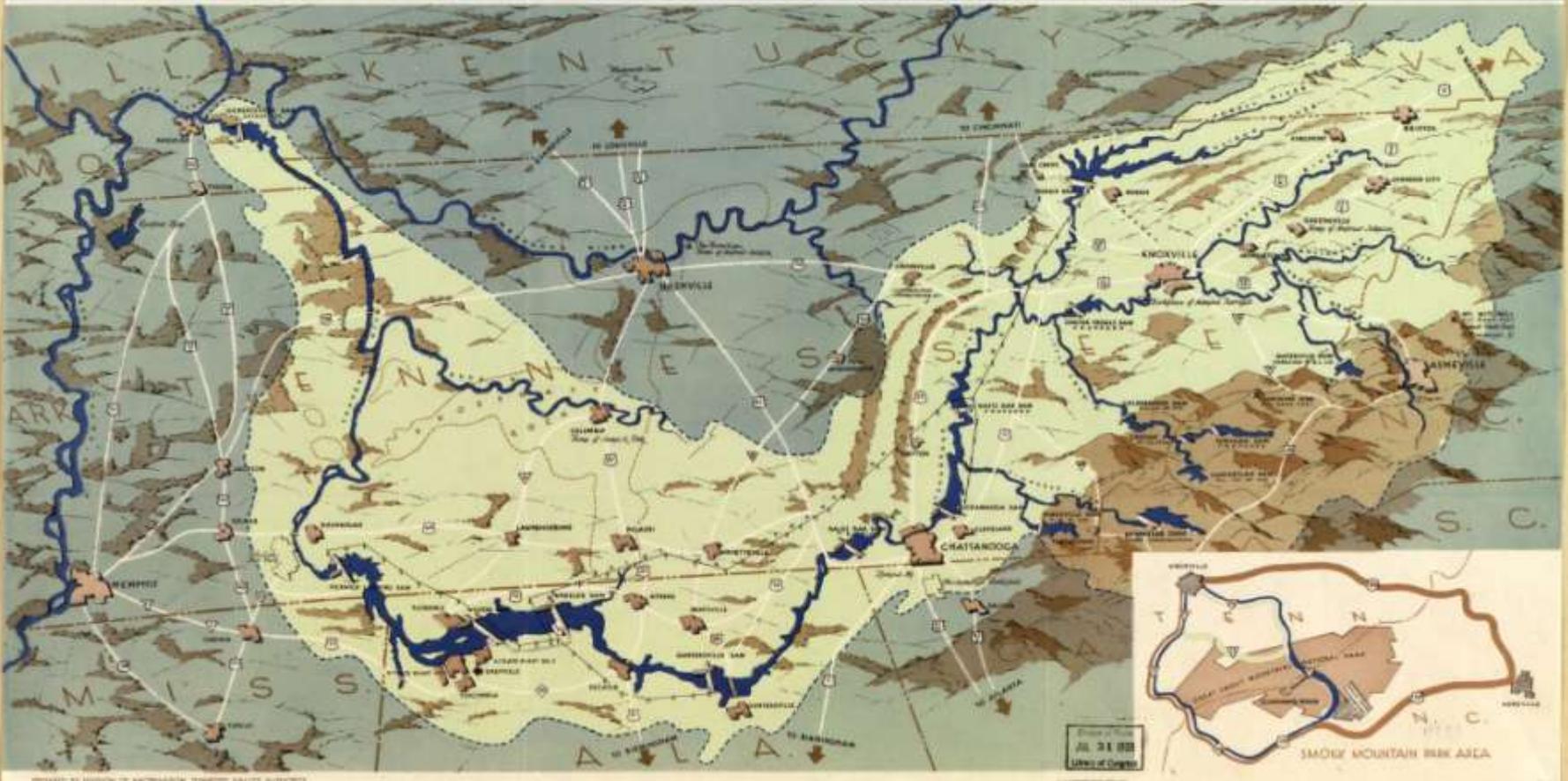
# TENNESSEE VALLEY AREA

VICTORIAL MAP - NO SCALE

*From "Investigation of the Tennessee Valley Authority", report of the Transportation Committee, 75th Cong., 1st Sess., July 22, 1917, p. 2 of Pl. 11, 11th Washington, 1917.*



PROFILE OF TENNESSEE & CLINCH RIVERS SHOWING EXISTING & PROPOSED DAMS



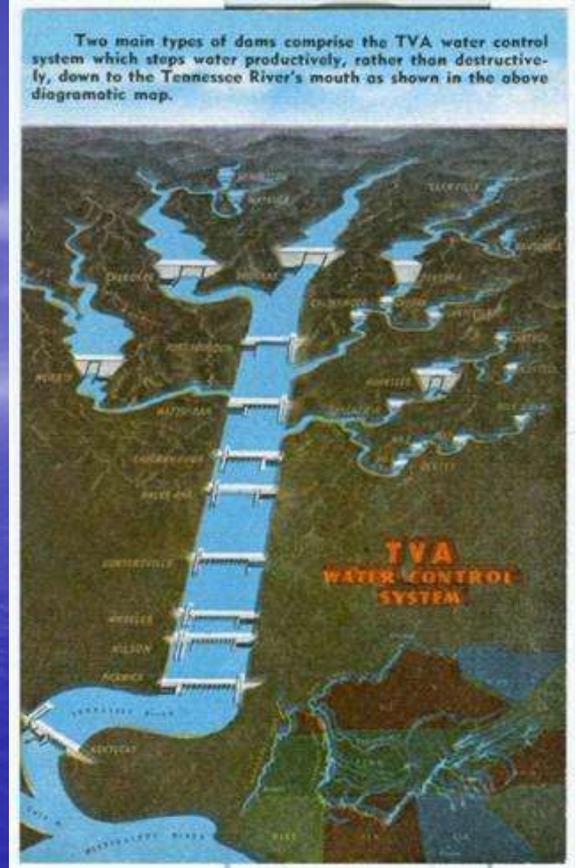
The Tennessee Valley is the first place in America where we can sit down and design a civilization.

—Arthur E. Morgan



Arthur Morgan with Franklin and Eleanor Roosevelt making their first inspection of the Tennessee Valley in 1933

- **The TVA was Morgan's golden opportunity to design a better civilization. It was a dream come true for a collectivist Utopian.**



- The three **TVA Directors** appointed by Roosevelt included civil engineer **Arthur E. Morgan** as its Chairman, renowned for his expertise in dams and flood control. The other members were intended to have expertise with electrical power generation and distribution and the other with southern agriculture. University of Tennessee President **Harcourt A. Morgan** had previously served as UT's Dean of the School of Agriculture and Harvard-trained attorney **David Lilienthal**, had previously served on Wisconsin's Public Service Commission under progressive Governor Phillip La Follette.

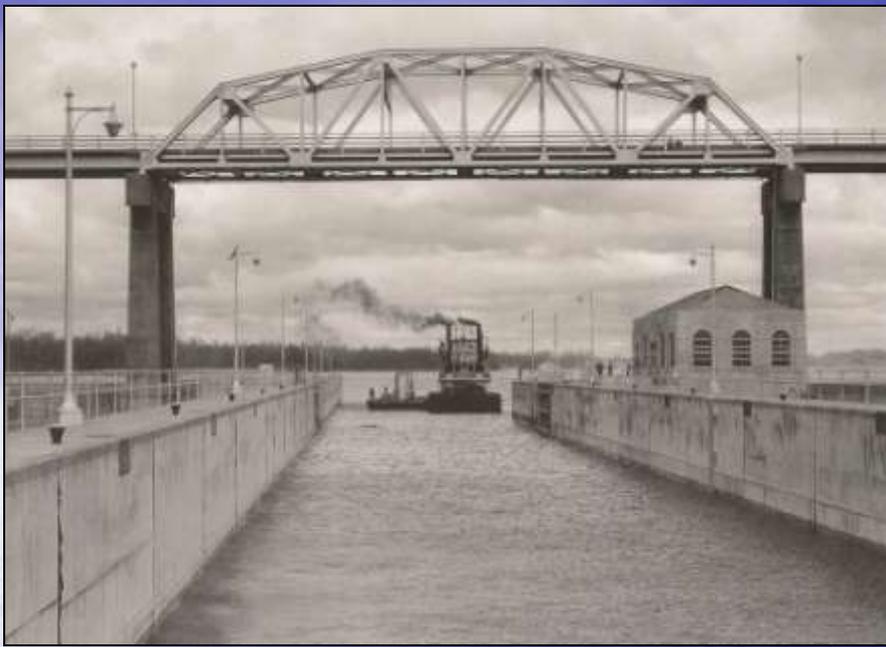


One of TVA's central roles was to **prevent flood damage**, which had periodically ravaged the valley

**The TVA  
constructed an  
integrated system  
of dams in just 25  
years, a feat never  
accomplished  
before or since**



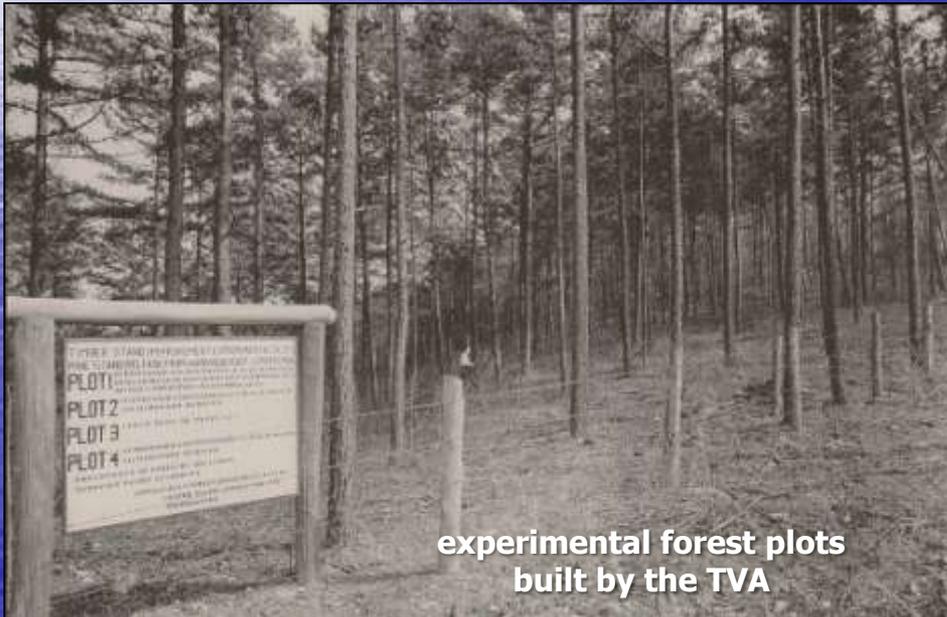
# The provision of riverine navigation was a key aspect of the TVA



Tree nursery for re-forestation



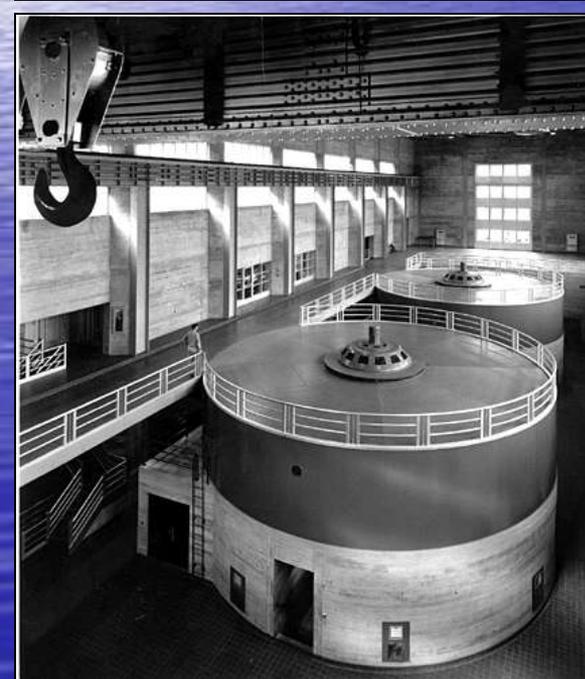
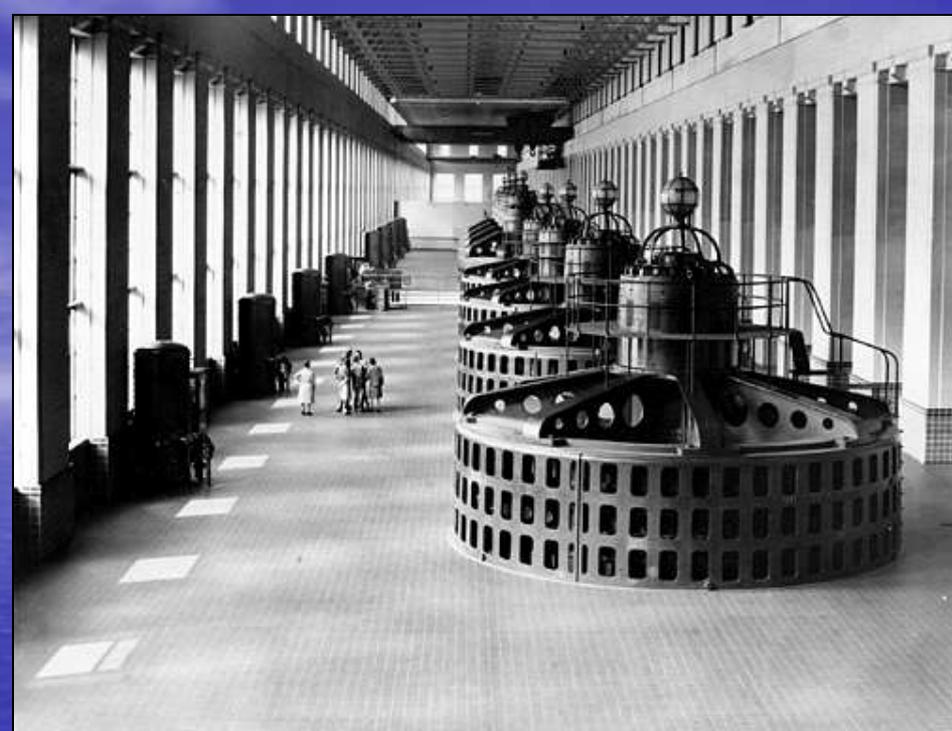
Barren hillside eroded by poor farming practices



experimental forest plots built by the TVA

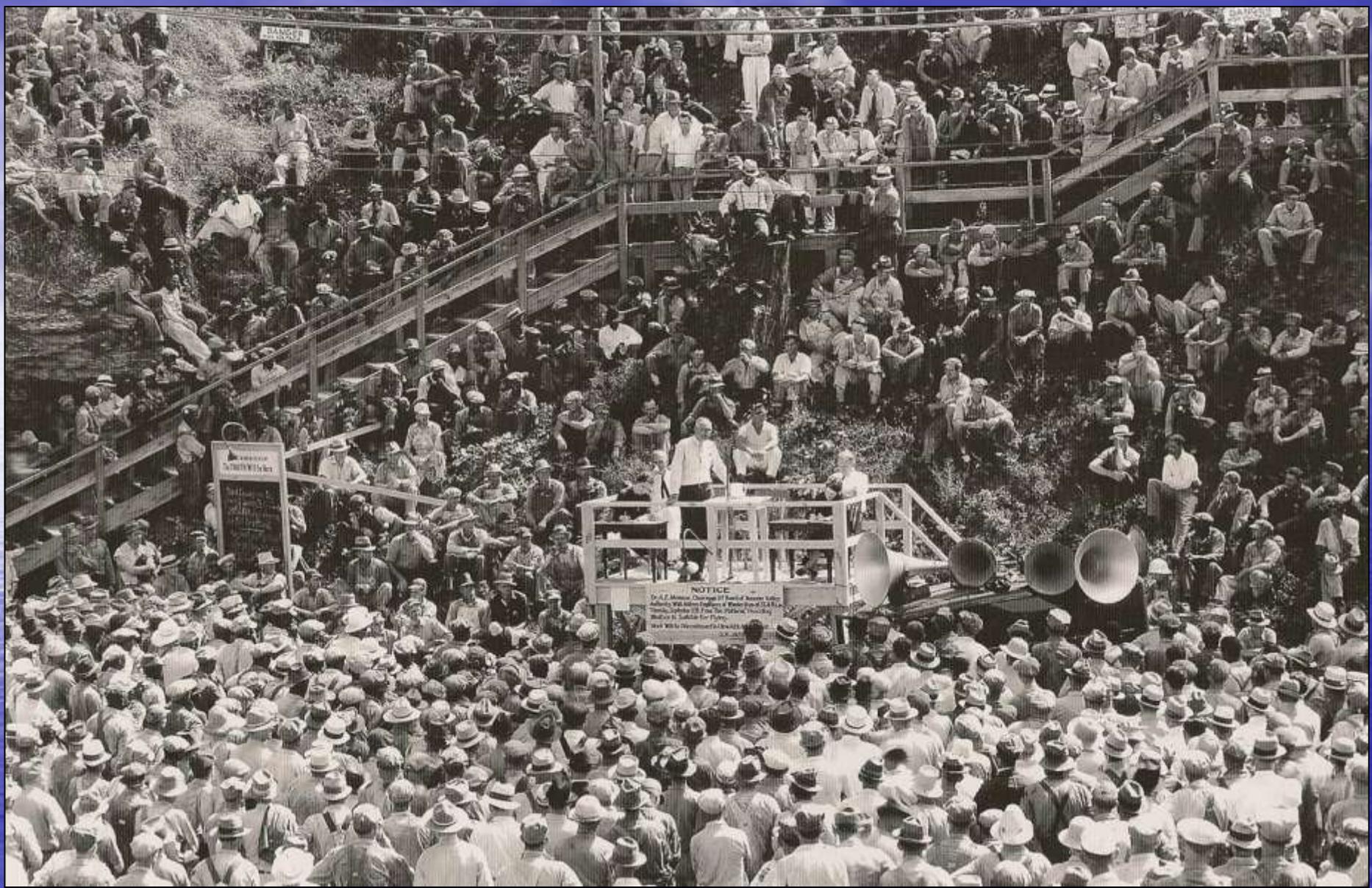


One of the TVA's other major thrusts was soil conservation and the enhancement of agriculture through better farming procedures and fertilizers

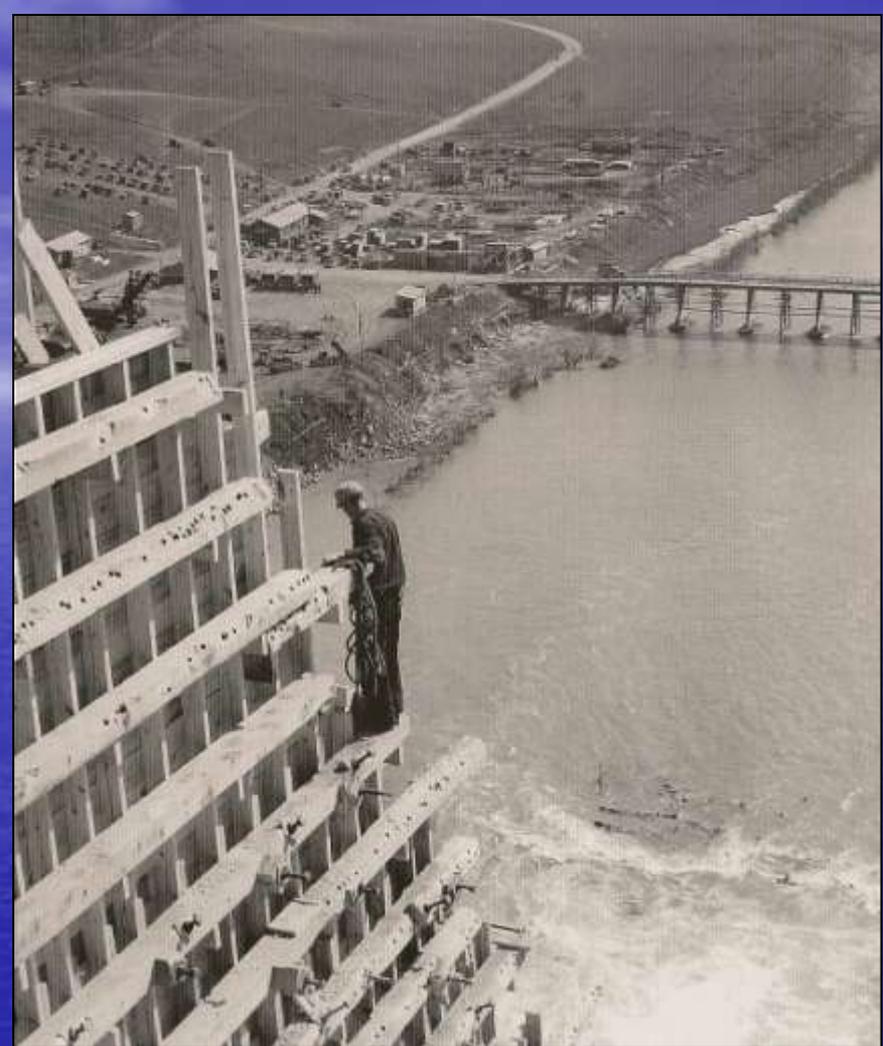
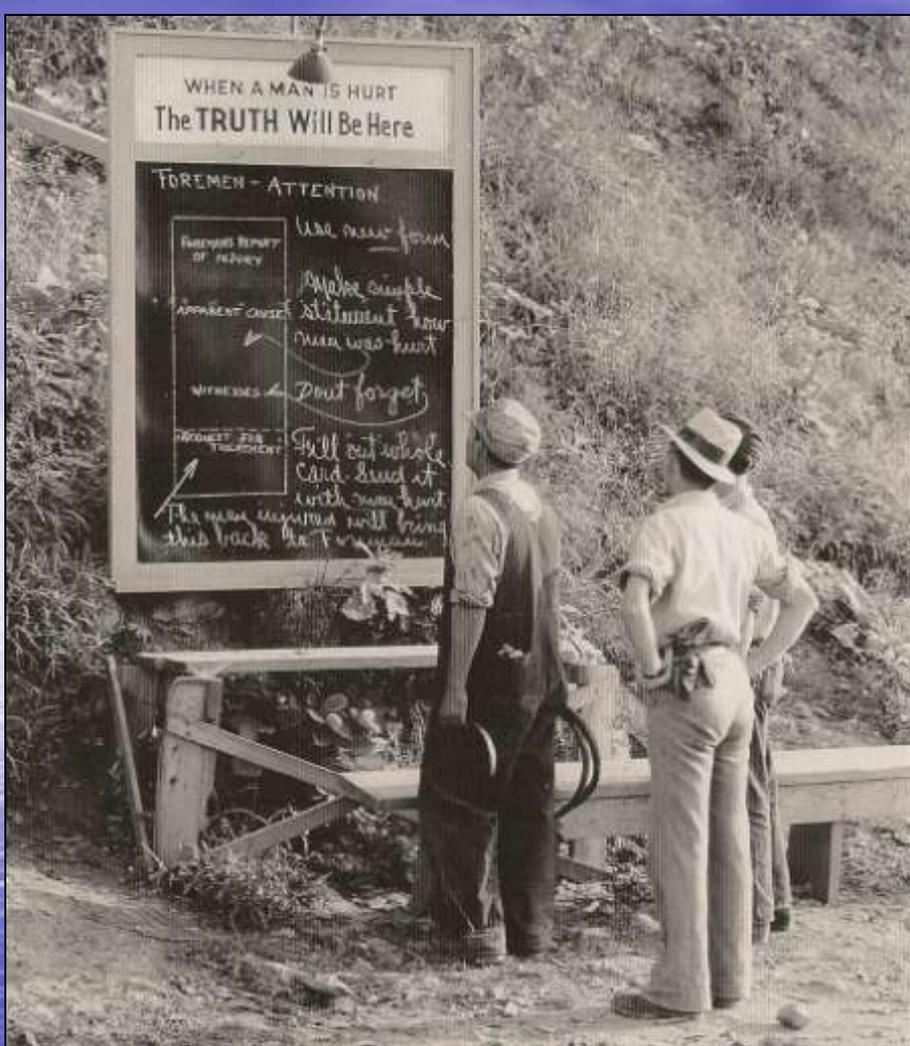


The most powerful and controversial aspect of the TVA was the **generation of hydroelectric power**, bringing the federal government into the role of power provider, and forcibly absorbing private powerplants along the Tennessee River. Passage of the **Bond Revenue Act** in 1959 made TVA completely self-supporting, through the sale of electricity.

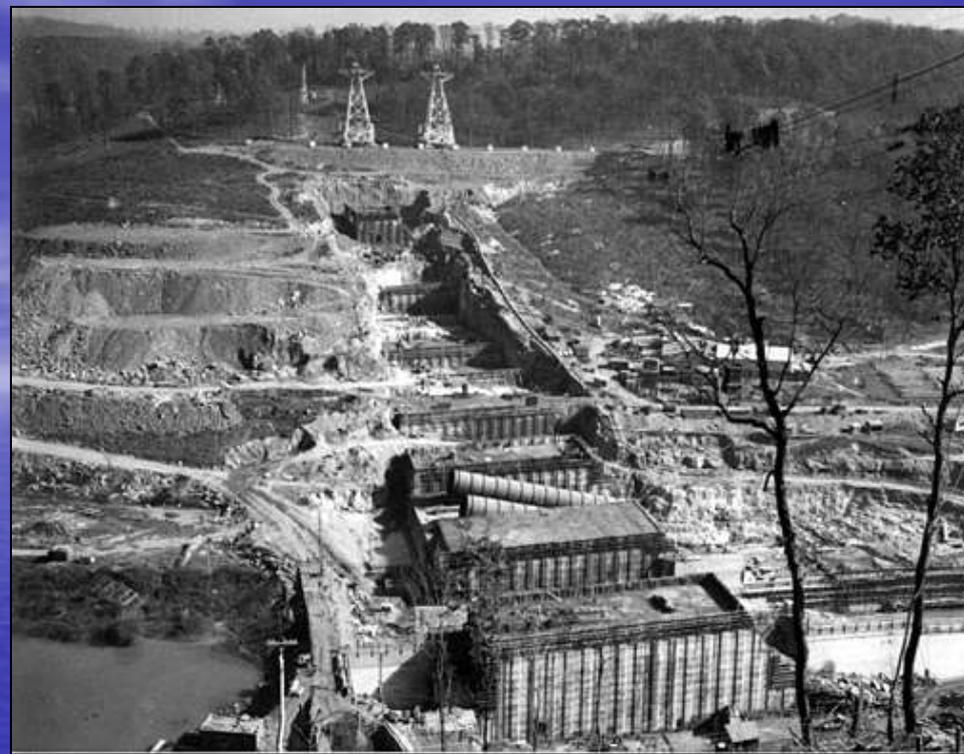




- Always the engineer with charisma, Morgan loved addressing the workers, in this case, regarding TVA's avowed transparency in being honest about reporting jobsite accidents.



- The 126 worker deaths during the construction of Hoover Dam allowed Morgan to set the **TVA's more humane safety program**.
- **Four six-hour shifts** not only reduced fatigue and injuries, they spread decent wages across more worker families during the depths of the Great Depression.



- **The TVA projects brought the most concentrated system of large public works projects to one part of the nation,** creating unprecedented materials demands. Creative procedures were developed to keep unit prices low.
- **When cement bids were submitted well above the industry norm, Morgan instructed TVA's to construct their own cement plant.**
- **This resulted in much more competitive bids, and Morgan was able to construct all of his dams within 1% of the TVA's pre-bid estimates, saving millions.**





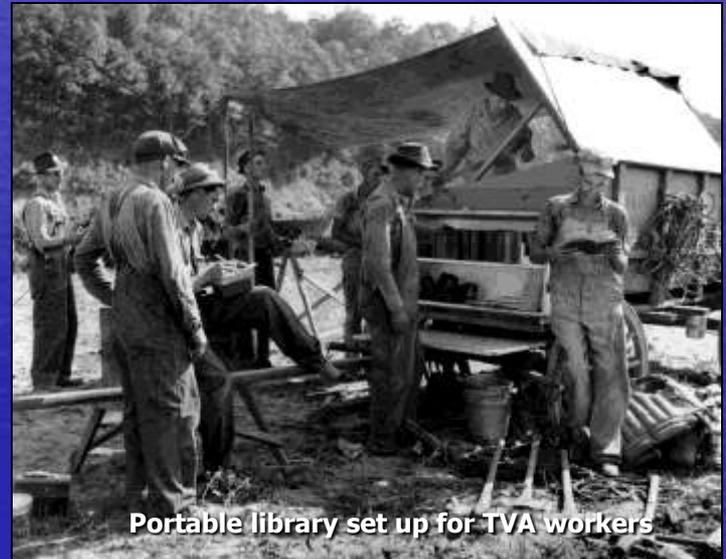
Dining hall at Norris Dam site



Sunday morning prayer service

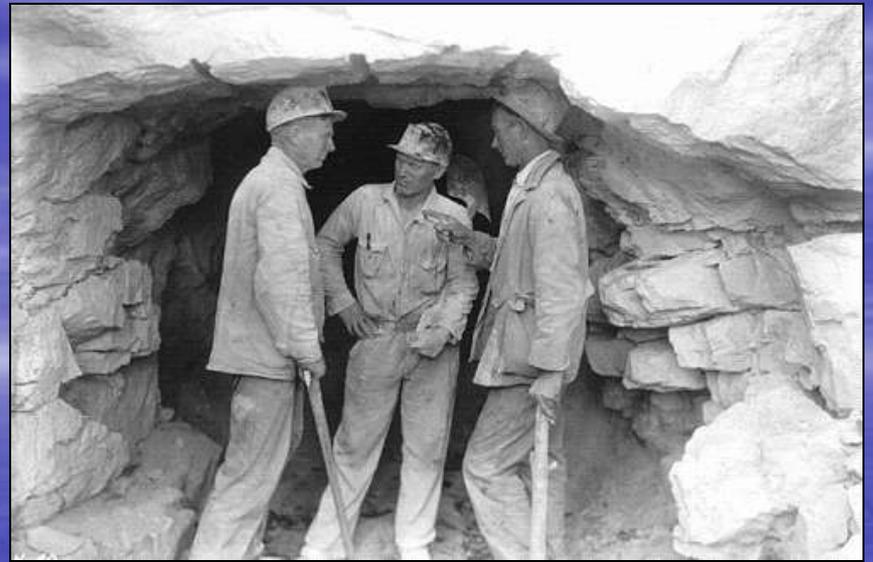


Safety training



Portable library set up for TVA workers

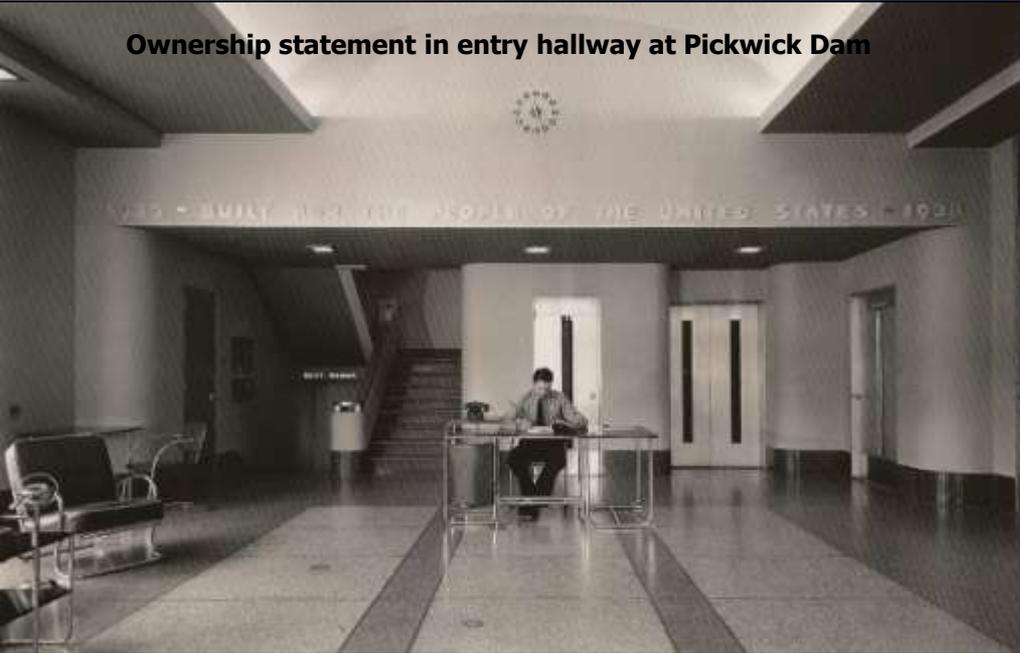
**Morgan continually stressed self-improvement.** He exercised paternal oversight of TVA workers, treating them like college students: providing reading materials for the dining halls, stressing non-denominational Sunday worship services, mandatory safety training, and optional skills training.



**Morgan loved to give an honest man a chance to prove himself.** As kind-hearted as he was, he wasn't above firing someone for being lazy. To him, laziness was the worst of all offenses.

# "Built for the People of the United States"

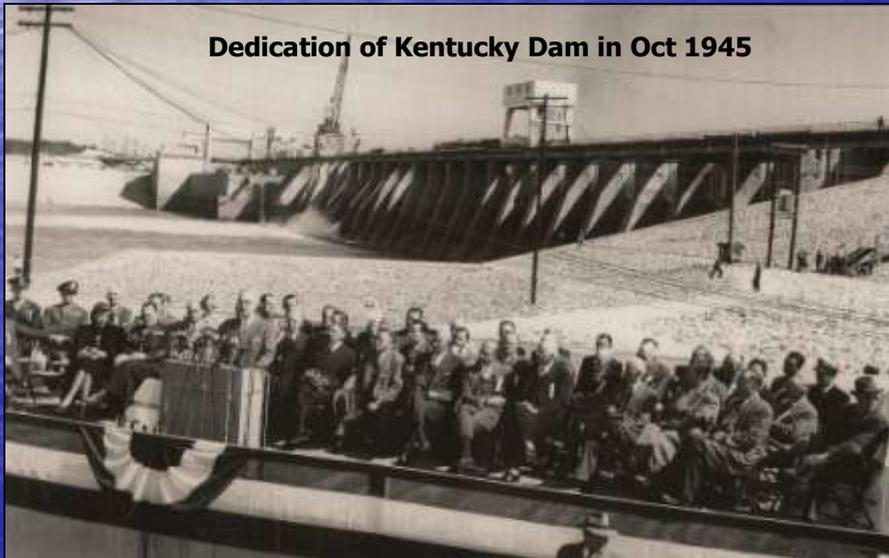
Ownership statement in entry hallway at Pickwick Dam



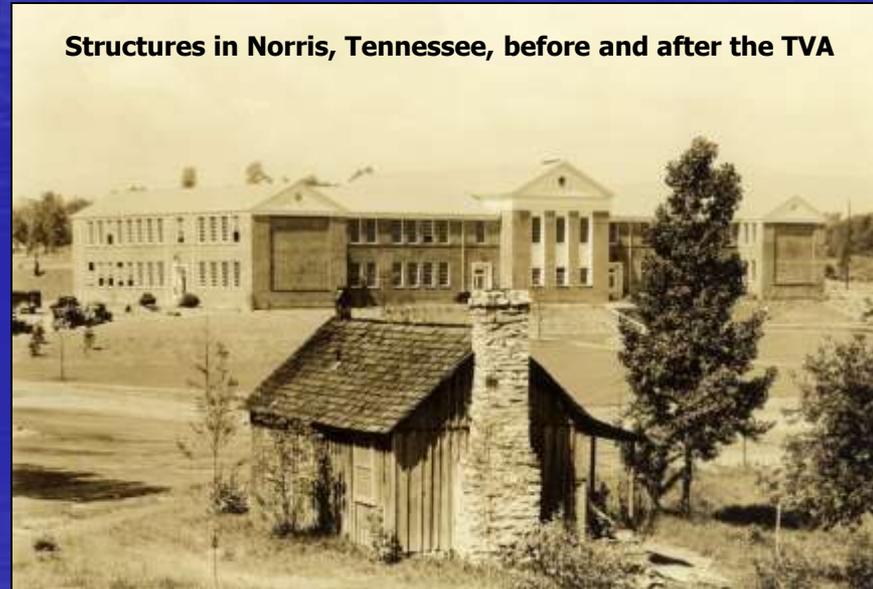
Roosevelt at Chickamauga Dam dedication in April 1940



Dedication of Kentucky Dam in Oct 1945



Structures in Norris, Tennessee, before and after the TVA



# Big projects- brought in on time and on budget



**In a feat seldom accomplished, before or since, the TVA succeeded in completing their first generation of dams (1933-47) within 1% of their budget estimates.**

# The Morgan-Lilienthal Controversy



- The TVA was established on the premise that the Federal government ought to bring cheap hydroelectric power to rural areas which had not previously enjoyed access to it. In 1921 private companies controlled 94% of the electricity produced in the United States, completely unregulated.
- TVA commissioner David Lilienthal felt very strongly that private utilities had essentially created cartels, by which a single provider could set whatever prices they felt the market would bear. He opposed any negotiations between TVA and the private utilities, which Morgan favored. This rift eventually led to Morgan's firing by FDR in late 1938.
- In the end, TVA delivered electricity at a rate about 40% less than that charged by the private utilities bounding TVA's service area. Lilienthal went onto head the Atomic Energy Commission after the Second World War.

# Summons to the White House for a showdown with Roosevelt and Lilienthal



- 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 far too concerned with “folk dancing and basket weaving,” not to mention his misplaced trust in the private power industry, who had engaged the TVA in expensive litigation.
- When Roosevelt was re-elected and Lilienthal reappointed, Morgan tendered his resignation, and Roosevelt summoned him to the White House for a face-to-face examination of Morgan and Lilienthal.
- This resulted in FDR firing Morgan for “contumacy,” the willful refusal to obey a superior's order.

# Back to Antioch College



Arthur and Lucy Morgan in November 1938

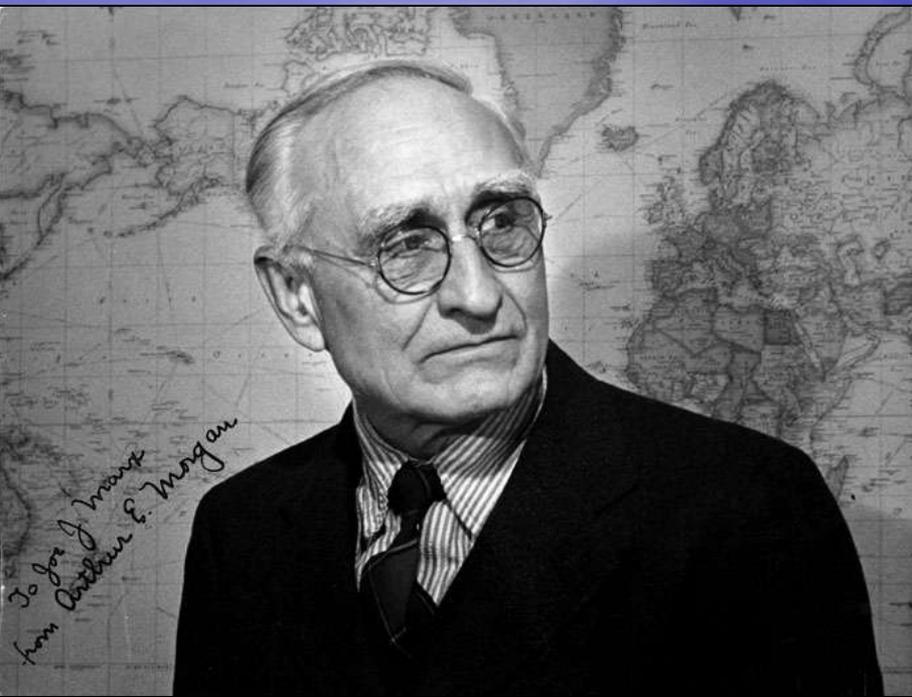
- At left: Rare smiles from Arthur and Lucy Morgan, back in Yellow Springs after the White House showdown with David Lilienthal and President Roosevelt in June 1938.
- Morgan was 60 at this time and most thought his career was over, but not Morgan himself, he seemed invigorated by the experience.

- 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." The small, self-sufficient community was the vision and desire of Arthur Morgan.

# The TVA: a true Arsenal of Democracy

During World War II the TVA produced electrical power critical for shipbuilding, munitions, twinning of aircraft aluminum, and powered the world's first nuclear reactor at the Oak Ridge National Laboratory



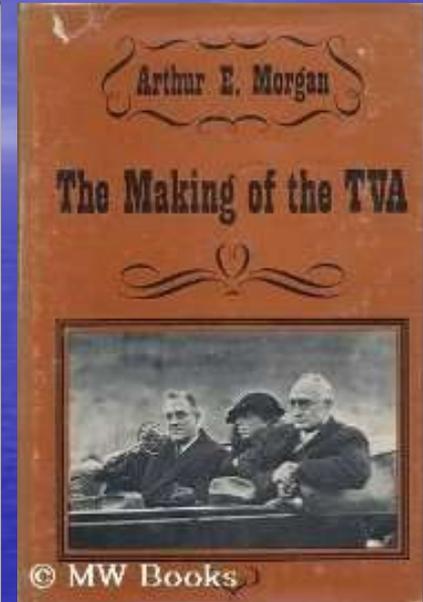
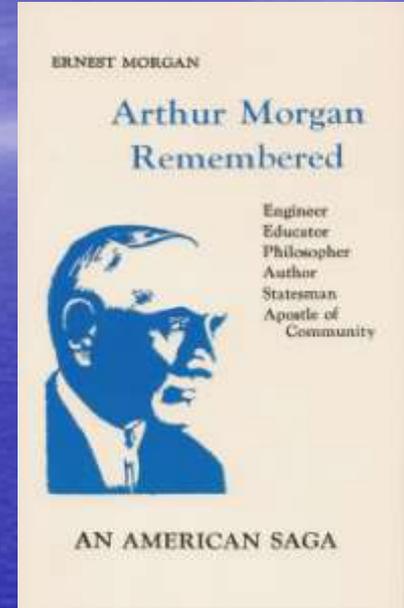
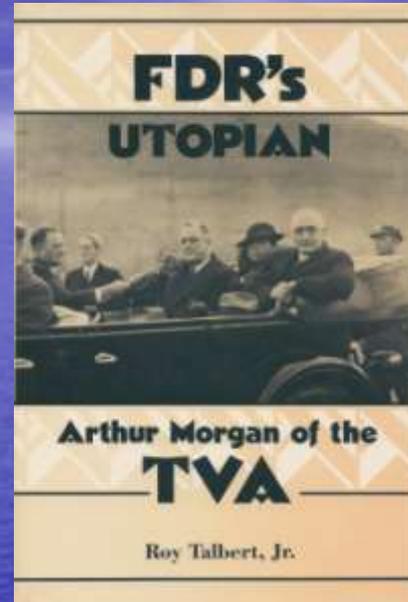
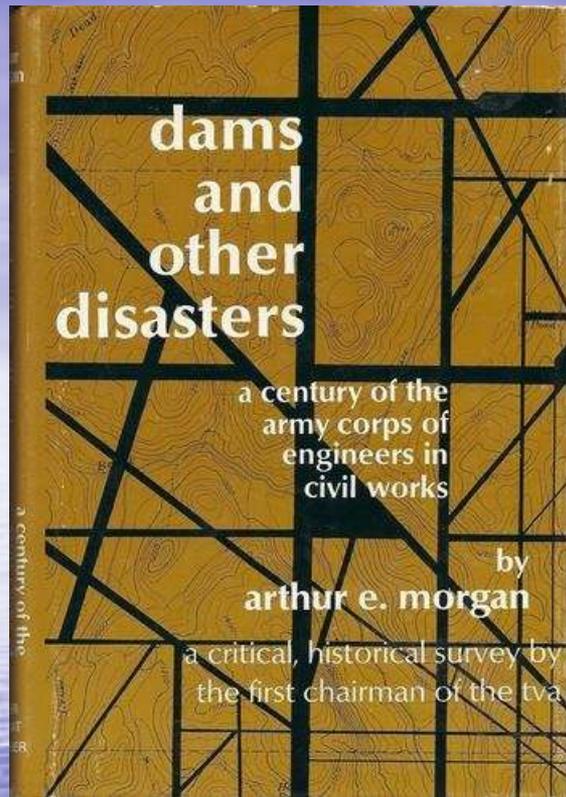


Morgan leading a civil rights march in 1963



- 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.

# Suggested Reading



- A great many books have been written about Arthur Morgan because he was one of the most controversial figures of the 20<sup>th</sup> Century.
- But, none of these literary efforts have been written by fellow engineers, nor have any of them focused on Morgan's his engineering prowess.

# **Special thanks to:**

**Ralph B. Peck, D.Eng., P.E., S.E., Dist.M.ASCE**

**Jerry R. Rogers, Ph.D., P.E., D.WRE, Dist.M.ASCE**

**ASCE History & Heritage Committee**

**Miami Conservancy District**

**Antioch University**

**Tennessee Valley Authority**

**Syracuse University Library**

**United States Military Academy Archives**

**National Archives and Records Service,**

**Southeast Region**

**Trent Dames Civil Engineering Heritage Fund**

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