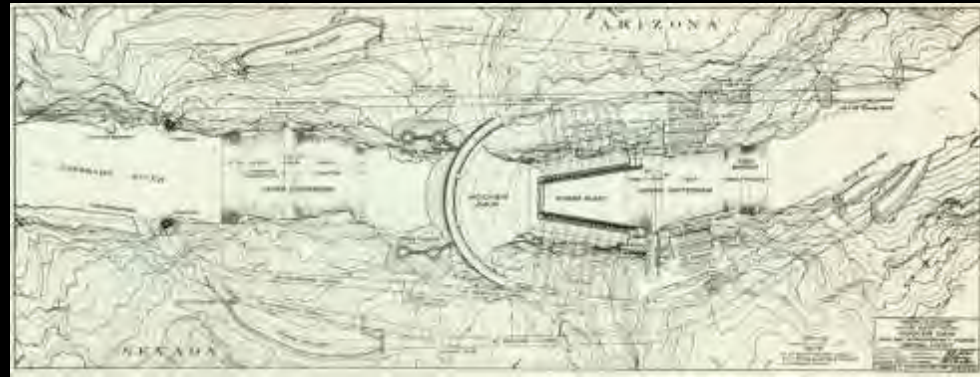
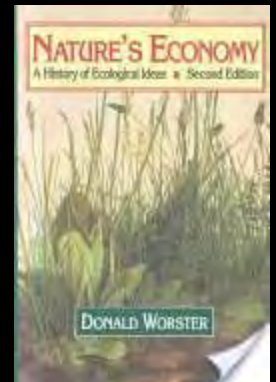
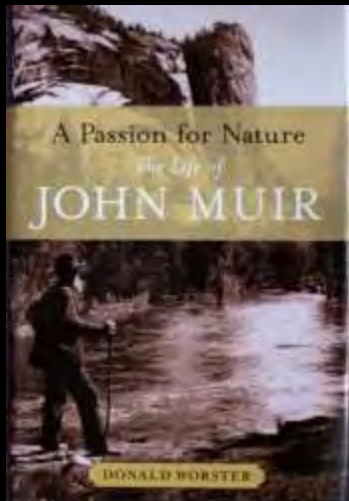
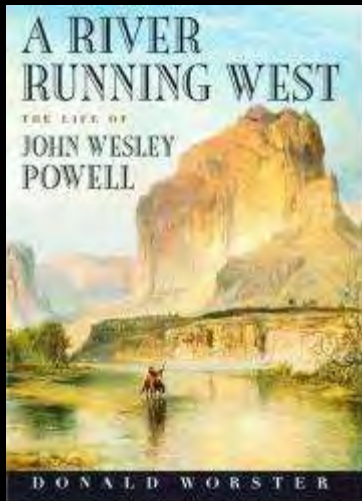
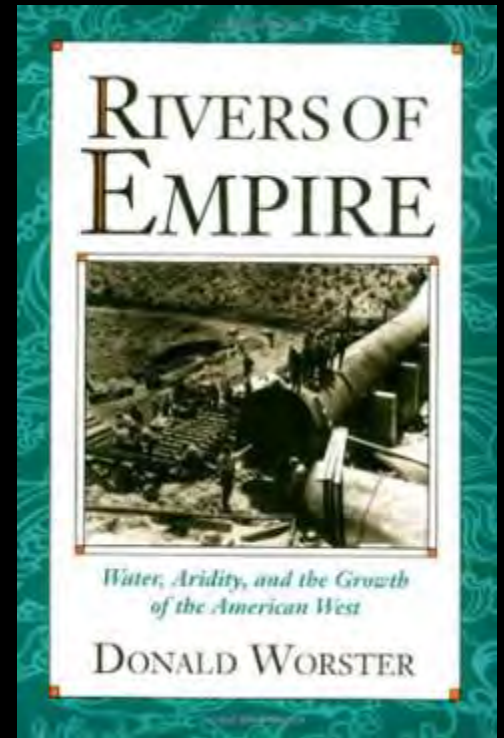


Rivers of Empire: American Rivers

Kevin Anderson, Ph.D.

Austin Water - Center for Environmental Research





The Geography of American Rivers

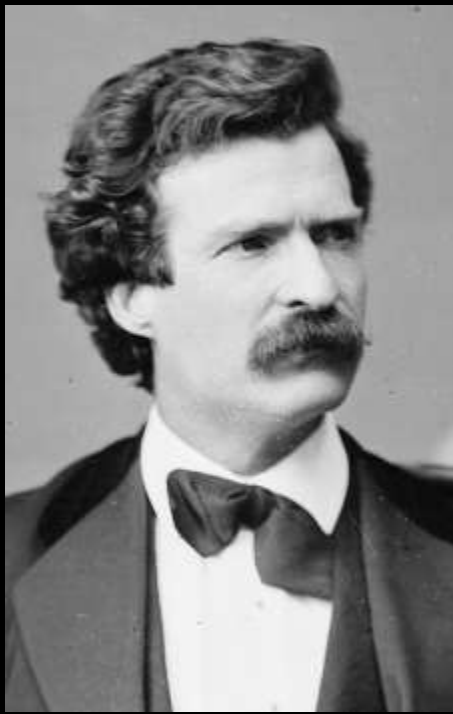
Central Drainage to Gulf of Mexico



Mark Twain - The Center

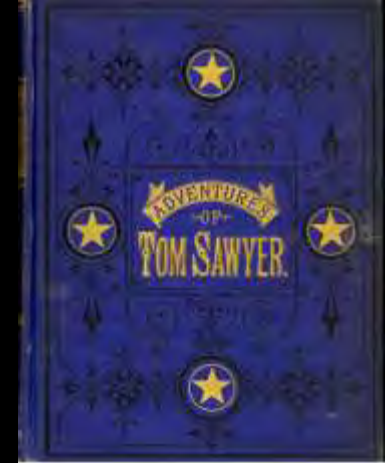
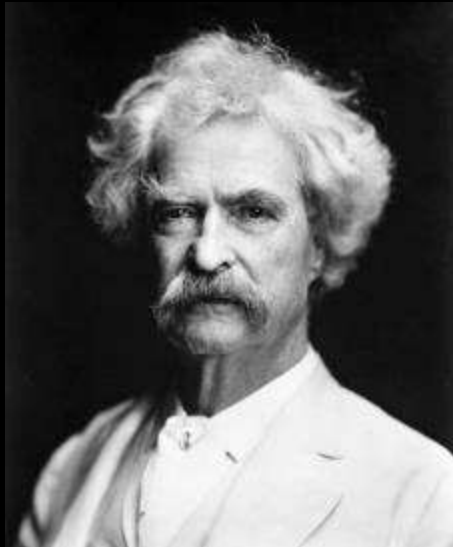
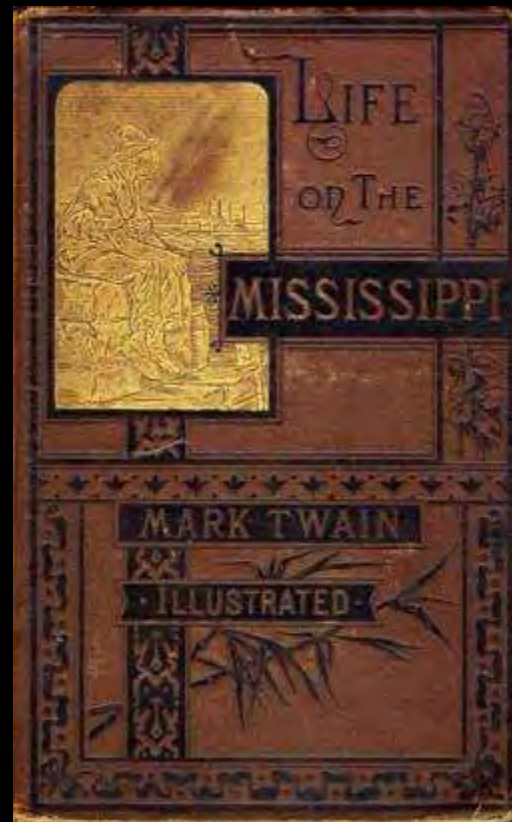
Mississippi

The River of Empire

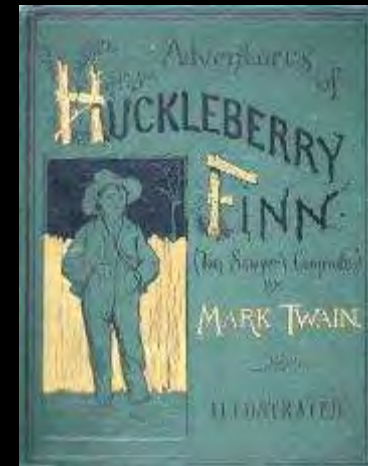


Life on the Mississippi is a memoir of his days as a steamboat pilot on the Mississippi River before the American Civil War, and also a travel book, recounting his trip along the Mississippi many years after the War.

Published 1883



Published 1876



Published 1884

Mark Twain's *Mississippi*



BUT the basin of the Mississippi is the BODY OF THE NATION.

All the other parts are but members, important in themselves, yet more important in their relations to this.





About 2,000 miles (3,219 km) across

0 200 400
Miles

0 500 1,000
Kilometers

Average Flow in cubic feet per second (cfs):

1,000 2,500 10,000 50,000 250,000 650,000



The Ancient North American Cultural Landscape

Beginning with the construction of Watson Brake about 3400 B.C. in present-day Louisiana, nomadic indigenous peoples started building earthwork mounds in North America nearly 1000 years before the pyramids were constructed in Egypt.

Serpent Mound in southern Ohio is a 1,348-foot mound built about 1070 A.D.



The Mississippian Culture reached its climax about 1200 A.D.





Cahokia – The Center of the Mississippian Culture

Located near present day St. Louis, Cahokia was the great city of the Mississippian Culture where groupings of pyramids and burial mounds cover five square miles.

Cahokia's population at its peak in the 1200s, and its ancient population would not be surpassed by any city in the United States until about the year 1800.

In 1200, its population was about 15,000, comparable to that of London or Paris during the same period.

“Anyone who traveled up the Mississippi in 1100 A.D. would have seen it looming in the distance: a four-level earthen mound bigger than the Great Pyramid of Giza...Cahokia was a busy port...Covering five square miles and housing at least fifteen thousand people. Cahokia was the biggest concentration of people north of the Rio Grande until the eighteenth century.”

Mann, 1491

Cahokia

The original site contained 120 earthen mounds over an area of six square miles, of which 80 remain today.

Thousands of workers over decades moved more than an estimated 55 million cubic feet of earth in woven baskets to create this network of mounds and community plazas.



Monks Mound

The largest earthen pyramid is 104 feet high and covers 16 acres.

It was topped by a massive 5,000sqft building another 50ft high.



Decline and Disappearance 1300 AD

Cahokia began to decline after 1300 AD. It was abandoned more than a century before Europeans arrived in North America.

Scholars have proposed environmental factors, such as over-hunting and deforestation as explanations.

“To obtain fuel and construction material and to grow food, they cleared trees and vegetation from the bluffs to the east and planted every inch of arable land. Because the city’s numbers kept increasing, the forest could not return. Instead people kept moving further out to get timber, which then had to be carried considerable distances...Meanwhile...the city began to outstrip its water supply...”

Mann, 1491

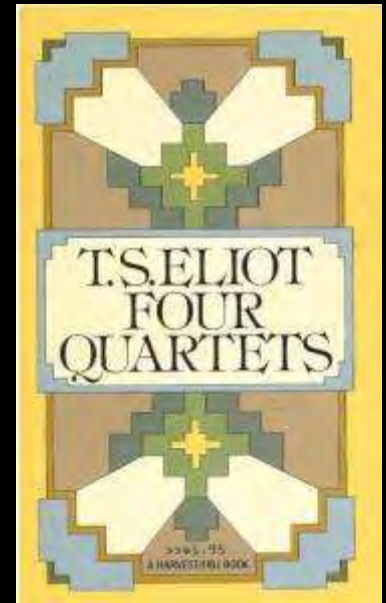


The Strong Brown God

The Mississippi River and

T.S. Eliot 1888-1965

Born in St. Louis



Four Quartets

“The Dry Salvages”

I do not know much about gods; but I think that the river
Is a strong brown god—sullen, untamed and intractable,

Patient to some degree, at first recognized as a frontier;
Useful, untrustworthy, as a conveyor of commerce;
Then only a problem confronting the builder of bridges.
The problem once solved, the brown god is almost forgotten
By the dwellers in cities—ever, however, implacable.
Keeping his seasons and rages, destroyer, reminder
Of what men choose to forget. Unhonored, unpropitiated
By worshippers of the machine, but waiting, watching and waiting.
His rhythm was present in the nursery bedroom,
In the rank ailanthus of the April dooryard,
In the smell of grapes on the autumn table,
And the evening circle in the winter gaslight.

The river is within us...



The Geography of American Rivers

The East – Discovery, Imagination, and Empire



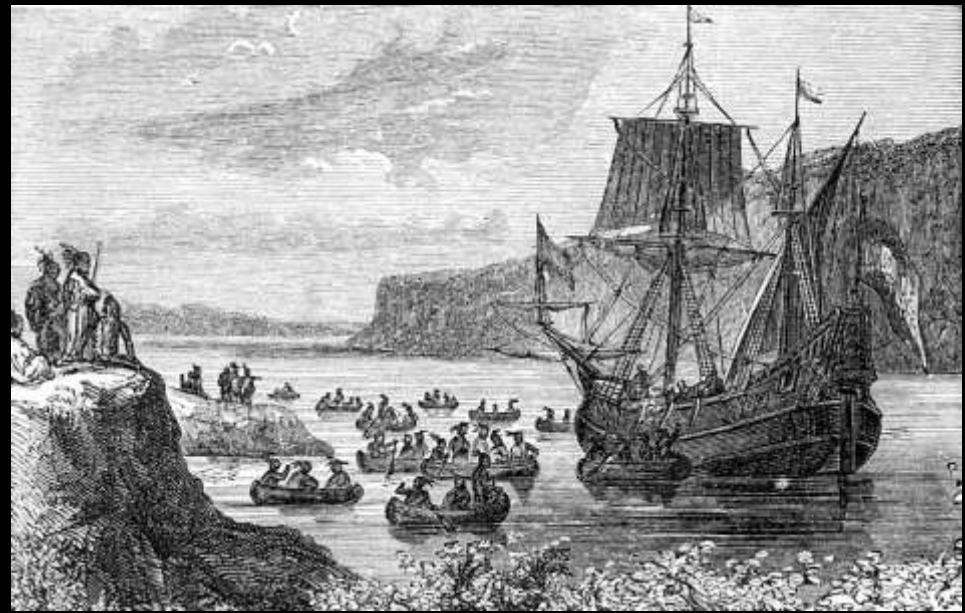
The East – Discovery and Imagination

The Hudson River

Another River

W. S. Merwin

The friends have gone home far up the valley
of that river into whose estuary
the man from England sailed in his own age
in time to catch sight of the late forests
furring in black the remotest edges
of the majestic water always it
appeared to me that he arrived just as
an evening was beginning and toward the end
of summer when the converging surface
lay as a single vast mirror gazing
upward into the pearl light that was
already stained with the first saffron
of sunset on which the high wavering trails
of migrant birds flowed southward as though there were
no end to them the wind had dropped and the tide
and the current for a moment seemed to hang
still in balance and the creaking and knocking
of wood stopped all at once and the known voices
died away and the smells and rocking
and starvation of the voyage had become
a sleep behind them as they lay becalmed
on the reflection of their Half Moon
while the sky blazed and then the tide lifted them
up the dark passage they had no name for



Henry Hudson and the River



Replica of Henry Hudson's ship Halve Maen, donated in 1909 by the Dutch to the United States on the occasion of the 300-year anniversary of the discovery of what is now New York.

Hudson explored the region around modern New York metropolitan area while looking for a western route to Asia under the auspices of the Dutch East India Company.

He explored the river which eventually was named for him, and laid thereby the foundation for Dutch colonization of the region.

On 4 August the ship was at Cape Cod, from which Hudson sailed south to the entrance of the Chesapeake Bay. Rather than entering the Chesapeake he explored the coast to the north, finding Delaware Bay but continuing on north.

On 3 September he reached the estuary of the river that initially was called the "North River" or "Mauritius" and now carries his name. He was not the first to discover the estuary, though, as it had been known since the voyage of Giovanni da Verrazano in 1524.

Hudson sailed into the upper bay on 11 September, and the following day began a journey up what is now known as the Hudson River.

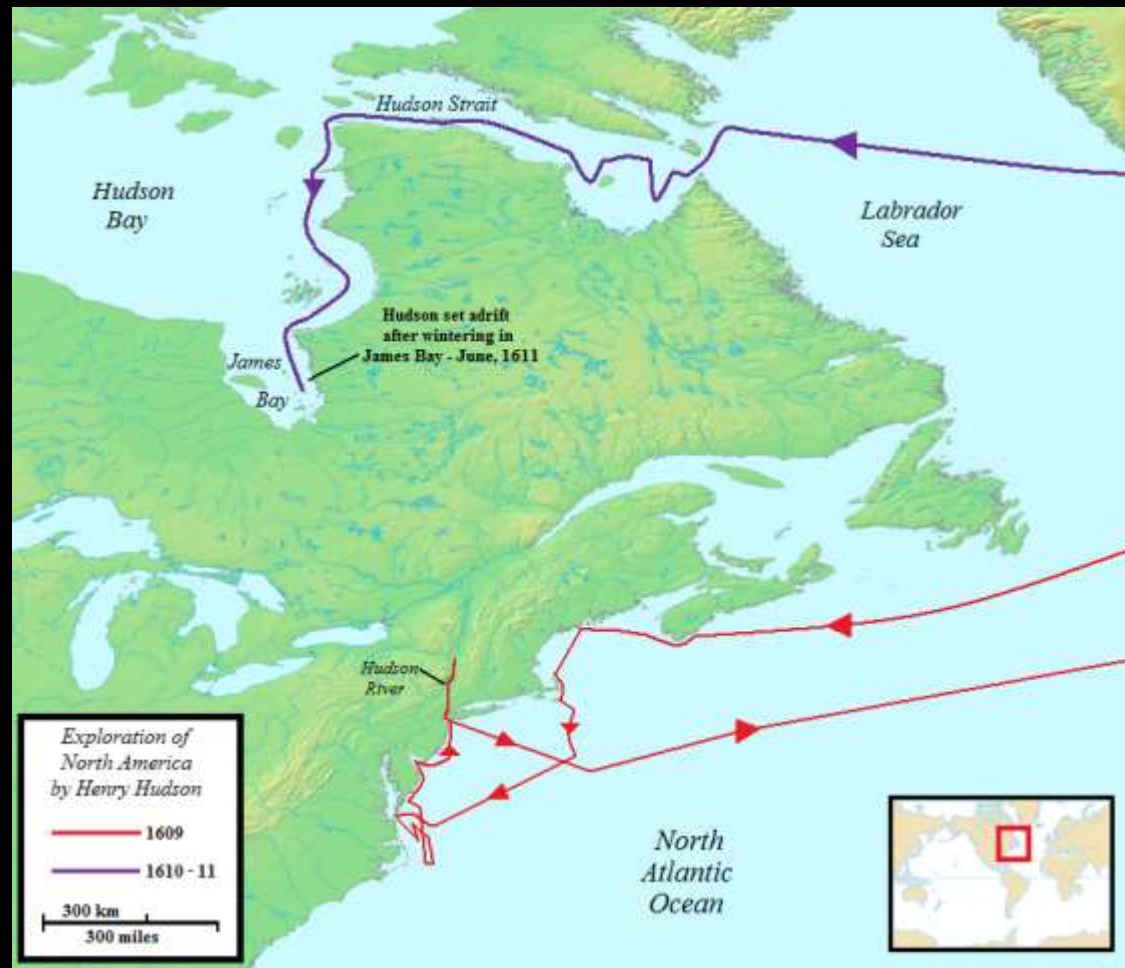
Over the next ten days his ship ascended the river, reaching a point about where the present-day capital of Albany is located.

Henry Hudson

In 1611, after wintering on the shore of James Bay, Hudson wanted to press on to the west, but most of his crew mutinied.

The mutineers cast Hudson, his son and 7 others adrift.

The Hudsons and those cast off at their side, were never seen again.



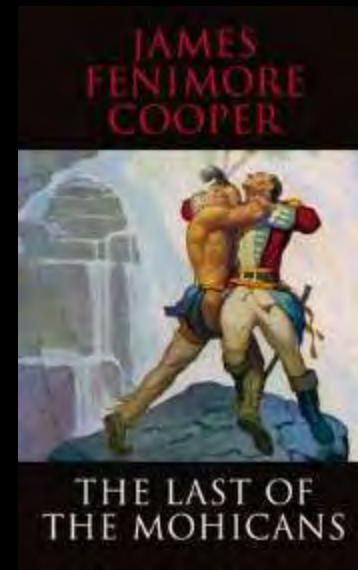
The Hudson River Valley and American Mythology

James Fenimore Cooper 1789 – 1851

Cooper was a prolific and popular American writer of the early 19th century. His historical romances of frontier and Indian life in the early American days created a unique form of American literature. He lived most of his life in Cooperstown, New York, established by his father William.

In 1823, he published *The Pioneers*, the first of the Leatherstocking series. The series features Natty Bumppo, a resourceful American woodsman at home with the Delaware Indians and their chief Chingachgook. Bumppo was also the main character of Cooper's most famous novel, *The Last of the Mohicans: A Narrative of 1757* (1826).

Written in New York City, where Cooper and his family lived from 1822 to 1826, the book became one of the most widely read American novels of the 19th century.



Illustrated by N. C. Wyeth. *The Last of the Mohicans: A Narrative of 1757*. New York: C. Scribner's Sons, 1919.

Riverine Landscapes and the Myth of America - Hudson River School

The Hudson River School was a mid-19th century American art movement embodied by a group of landscape painters whose aesthetic vision was influenced by romanticism. The Hudson River School was America's first true artistic fraternity.

Its name was coined to identify a group of New York City-based landscape painters that emerged about 1850 under the influence of the English émigré Thomas Cole and flourished until about the time of the Centennial.

Because of the inspiration exerted by his work, Cole is usually regarded as the "father" or "founder" of the school, though he himself played no special organizational or fostering role except that he was the teacher of Frederic Edwin Church.



American Landscapes and Scenic Wonders

Frederic Edwin Church enjoyed the privilege and distinction of being Cole's student (1844–46), but supplanted his teacher's literary and historical conceits with scientific and expeditionary ones.

He established his reputation with outsize depictions of North American scenic wonders such as Niagara Falls.

Along with Albert Bierstadt, Church was the most successful painter of the school until its decline.



Niagara Falls

1857

Frederic Edwin Church

Albert Bierstadt 1830 – 1902

Bierstadt's first journey to the Rockies of Wyoming with the government survey expedition of 1859 lead by Colonel Frederick W. Lander.



Small canvas, The Rocky Mountains, Lander's Peak, 1863



Yosemite Valley, Yosemite Park, c. 1868,



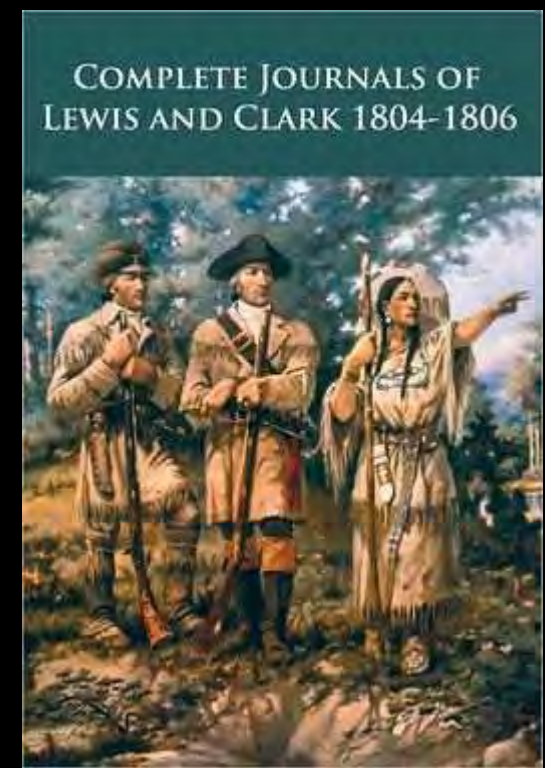
The Rocky Mountains, Lander's Peak, completed in 1863, was purchased for \$25,000 in 1865.

In the words of historian Anne F. Hyde: "Bierstadt painted the West as Americans hoped it would be, which made his paintings vastly popular and reinforced the perception of the West as either Europe or sublime Eden."

The West - River Exploration and Discovery Myths

The Lewis and Clark Expedition, also known as the Corps of Discovery Expedition (1804–1806), was the first transcontinental expedition to the Pacific coast undertaken by the United States.

Commissioned by President Thomas Jefferson, it was led by Meriwether Lewis and William Clark.

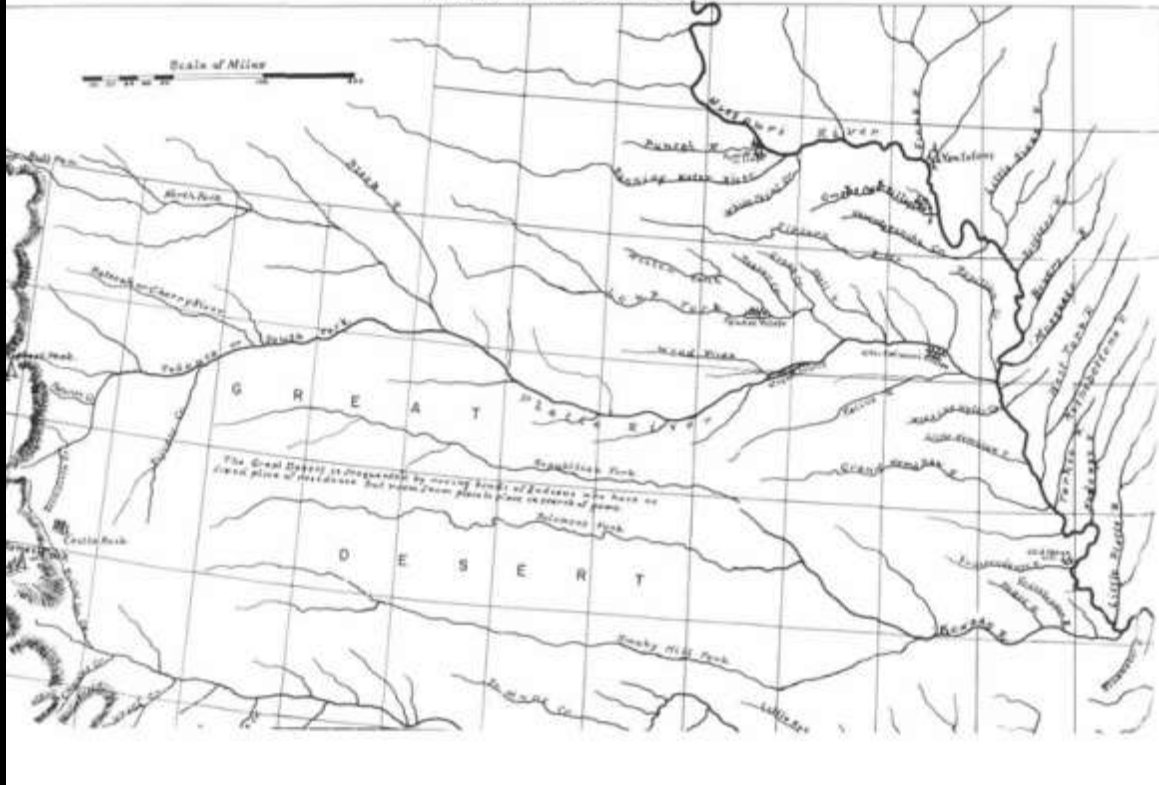




The Journey of the Corps of Discovery
 A Film by Ken Burns
 A GENERAL MOTORS
 MARK OF EXCELLENCE PRESENTATION



THE GREAT AMERICAN DESIERT
MAPPED AND NAMED BY
MAJOR S. H. LONG 1819-1820.



The Long Survey and the Great American Desert

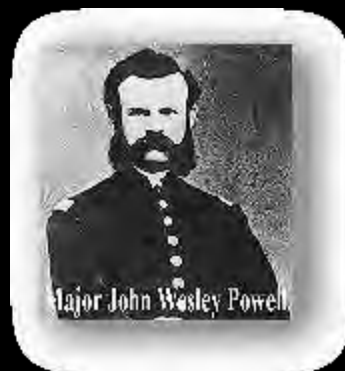
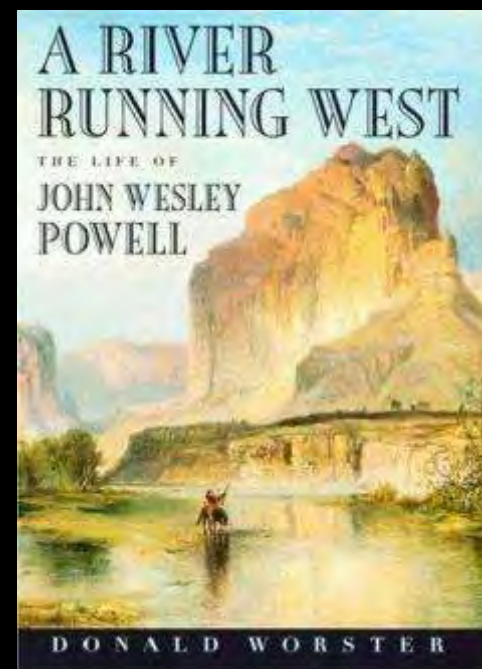
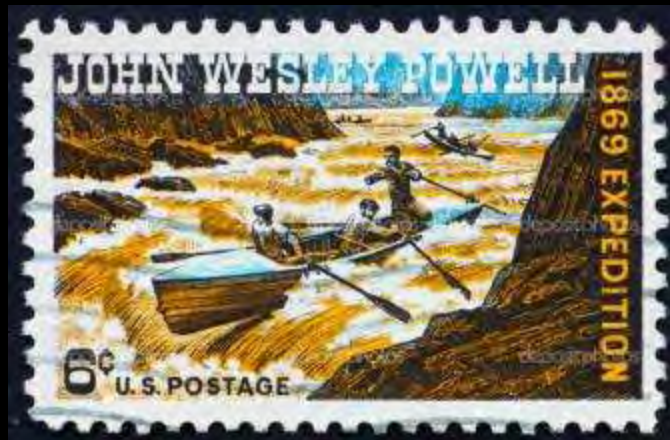
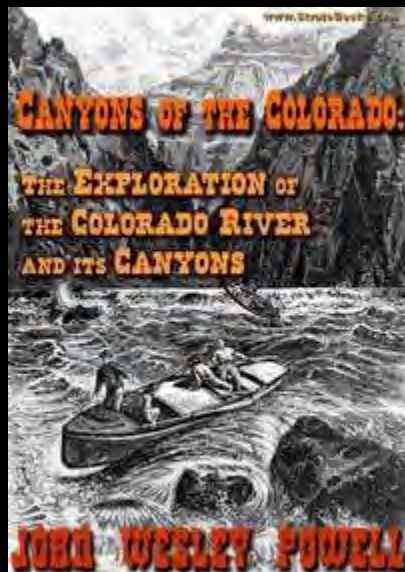
In 1823, Major Stephen Long, a government surveyor and leader of the expedition, produced a map labeling the area the Great American Desert. In the report that accompanied the map, the party's geographer Edwin James wrote of the region:

I do not hesitate in giving the opinion, that it is almost wholly unfit for cultivation, and of course, uninhabitable by a people depending upon agriculture for their subsistence. Although tracts of fertile land considerably extensive are occasionally to be met with, yet the scarcity of wood and water, almost uniformly prevalent, will prove an insuperable obstacle in the way of settling the country.

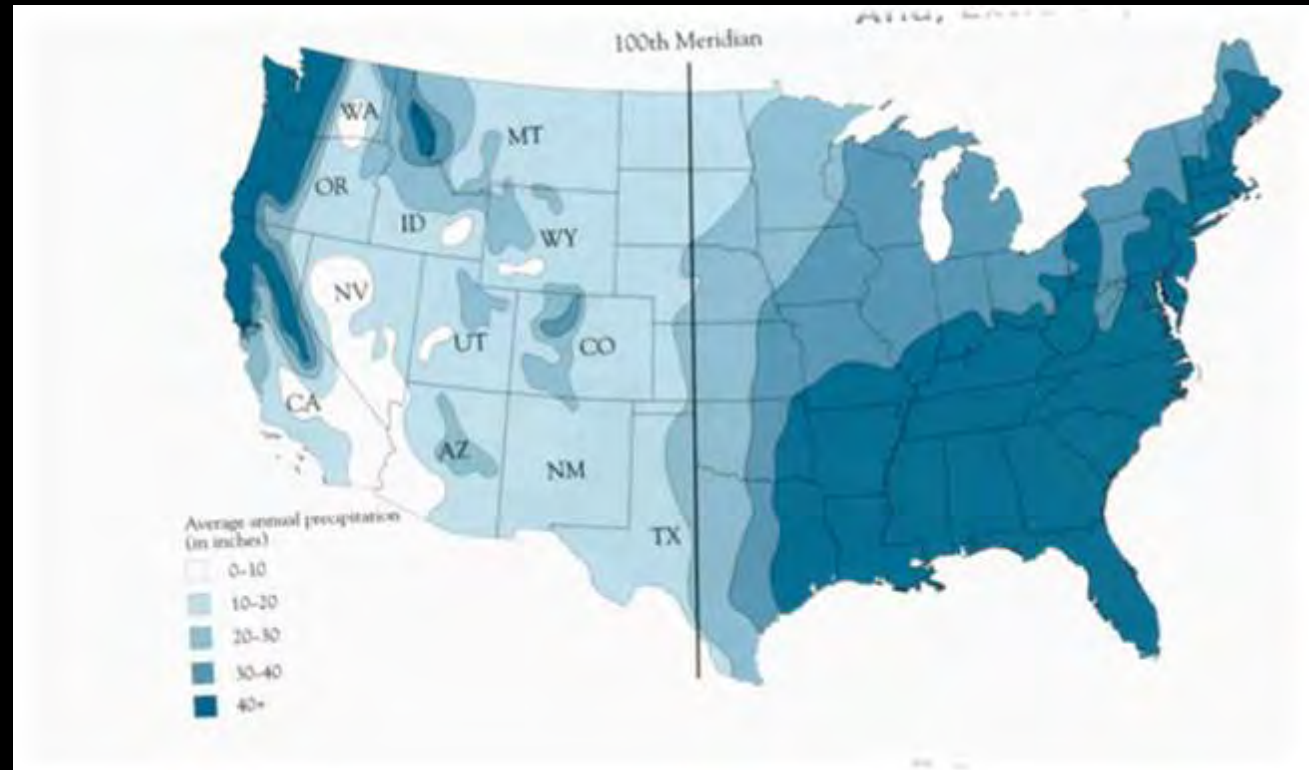
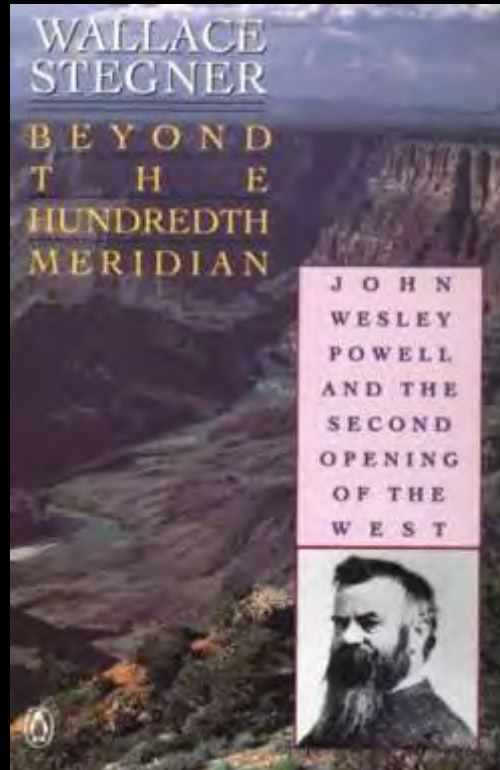
John Wesley Powell and the 100th Meridian

The Powell Geographic Expedition in 1869 was a groundbreaking exploratory expedition of the American West, led by John Wesley Powell.

It was the first-ever thorough investigation of the Green and Colorado rivers, including the first known passage through the Grand Canyon. Powell retraced the route in 1871–1872 with another expedition, resulting in photographs, an accurate map and various papers.



Beyond the 100th Meridian and The Great American Desert



Powell's expeditions led to his belief that the arid West was not suitable for agricultural development, except for about 2% of the lands that were near water sources.

His *Report on the Lands of the Arid Regions of the United States* proposed irrigation systems and state boundaries based on watershed areas (to avoid squabbles).

For the remaining lands, he proposed conservation and low-density, open grazing.

“Rain follows the plow”

Railroad companies, who owned vast tracts of lands granted in return for building the lines, did not agree with his opinion.

They aggressively lobbied Congress to reject Powell's policy proposals and to encourage farming instead, as they wanted to develop their lands. The politicians agreed and developed policies that encouraged pioneer settlement based on agriculture.

They based such policy on a theory developed by Professor Cyrus Thomas and promoted by Horace Greeley. He suggested that agricultural development of land causes arid lands to generate higher amounts of rain - “Rain follows the plow”

At an 1883 irrigation conference, Powell would remark: "Gentlemen, you are piling up a heritage of conflict and litigation over water rights, for there is not sufficient water to supply the land."

Powell's recommendations for development of the West were largely ignored until after the Dust Bowl of the 1920s and 1930s, resulting in untold suffering associated with pioneer subsistence farms that failed due to insufficient rain.





Walter Prescott Webb 1888-1963

Webb maintains that the Great Plains stand as a distinct environmental entity radically different from the wet timbered areas of the East.

Three characteristics differentiated the Plains from the East:

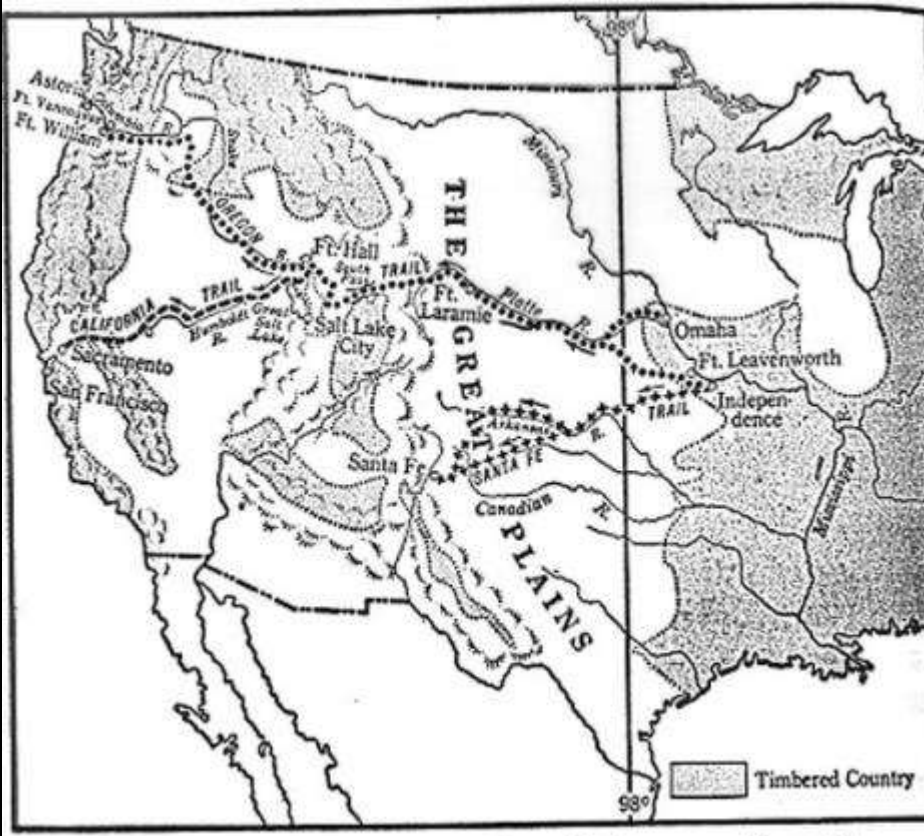
- 1. their level nature,
- 2. the scarcity of timber,
- 3. their semi-arid climate.

Webb argues that between the 98th meridian and the western slope of the Rocky Mountain system from Canada to Mexico the two most important elements of life in the eastern United States - abundant rainfall or available water and large stands of timber - were missing.

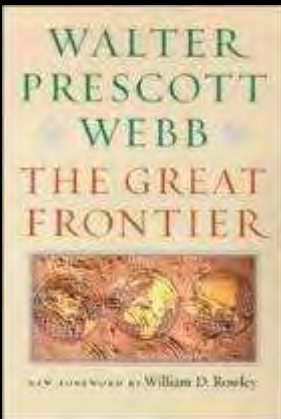
This environment was absolutely foreign to the citizen of the United States, who found the Plains impossible to cope with for a long period of time.

Settlement, therefore, jumped from the wet forests of the East to the Western Pacific Slope of California and Oregon.

Thus, for a period of time, the United States was a two-ocean land mass with an enormous corridor known as the "Great American Desert" that lay uninhabited and undeveloped by the citizens of the nation.



The trans-Plains trails, usually called transcontinental

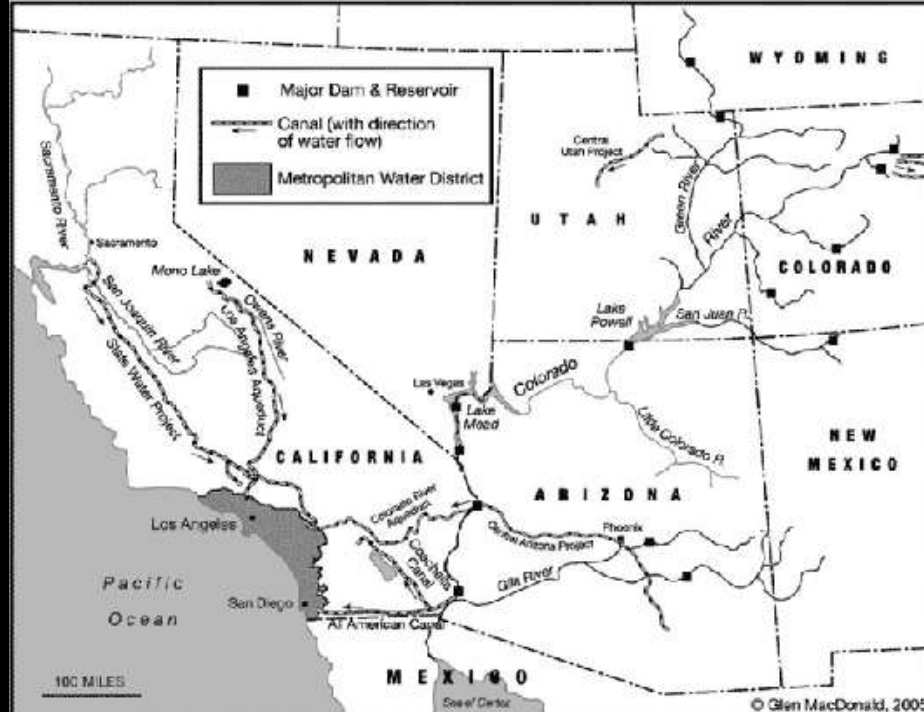
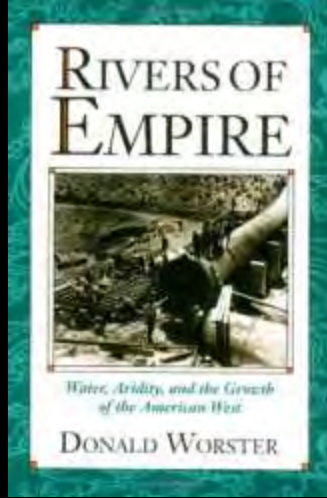


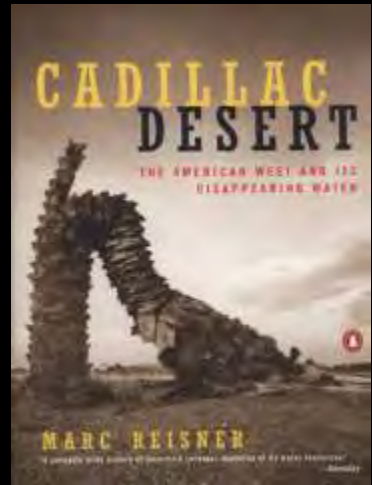
Donald Worster – Rivers of Empire

Government-sponsored reclamation is a key factor in the growth and development of the West.

Worster argues that rivers were manipulated to create an American hydraulic empire, but along with the creation came a host of social, economic, and political problems.

Worster's argument is principally applicable to the rise of the agricultural industry in California, which served the rich and powerful rather than contributing to the common good.





Return East: Canals and the Forgotten Hydraulic Empire

The Erie Canal originally ran about 363 miles from Albany, New York, on the Hudson River to Buffalo, New York, at Lake Erie, at the time completing a navigable water route from New York City and the Atlantic Ocean to the Great Lakes.

The canal contains 36 locks and encompasses a total elevation differential of approximately 565 ft., and is widely regarded a chief cause that New York eclipsed Philadelphia as the largest city and port on the Eastern Seaboard of the United States.

First proposed in 1807, it was under construction from 1817 to 1825 when it officially opened on October 26, 1825.

<http://www.americancanals.org/>



Ohio Canal

Construction of the canal began on July 4, 1825 with a ground breaking at Licking Summit near Newark, Ohio.

The canal was dug using basic hand tools and lots of backbreaking labor.

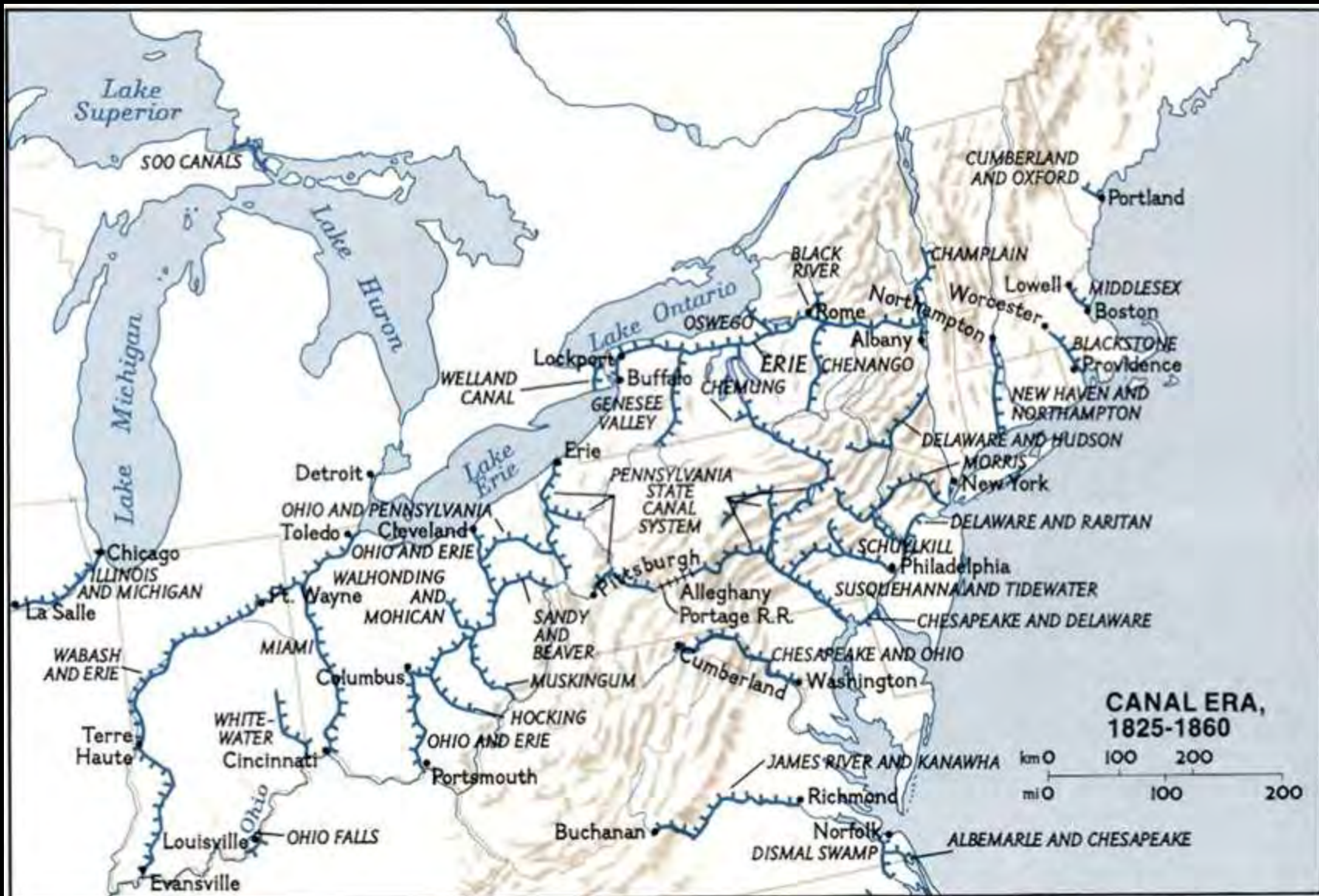
The Cleveland to Akron connection was completed by 1827 and the connection all the way to Portsmouth completed by 1832.

The entire canal system was 308 miles long with 146 lift locks and a rise of 1,206 feet.

In addition, there were five feeder canals that added 24.8 miles and 6 additional locks

Ohio and Erie Canal







Hydraulic Empire: Beginnings of Hydroelectricity at Niagara Falls

The earliest hydroelectric power generation in the US was utilized for lighting and employed direct current (DC) system to provide the electrical flow.

It did not flow far however, with ten miles being the system's limit; solving electricity's transmission problems would come later and be the greatest incentive to the new hydroelectric water-power developments.



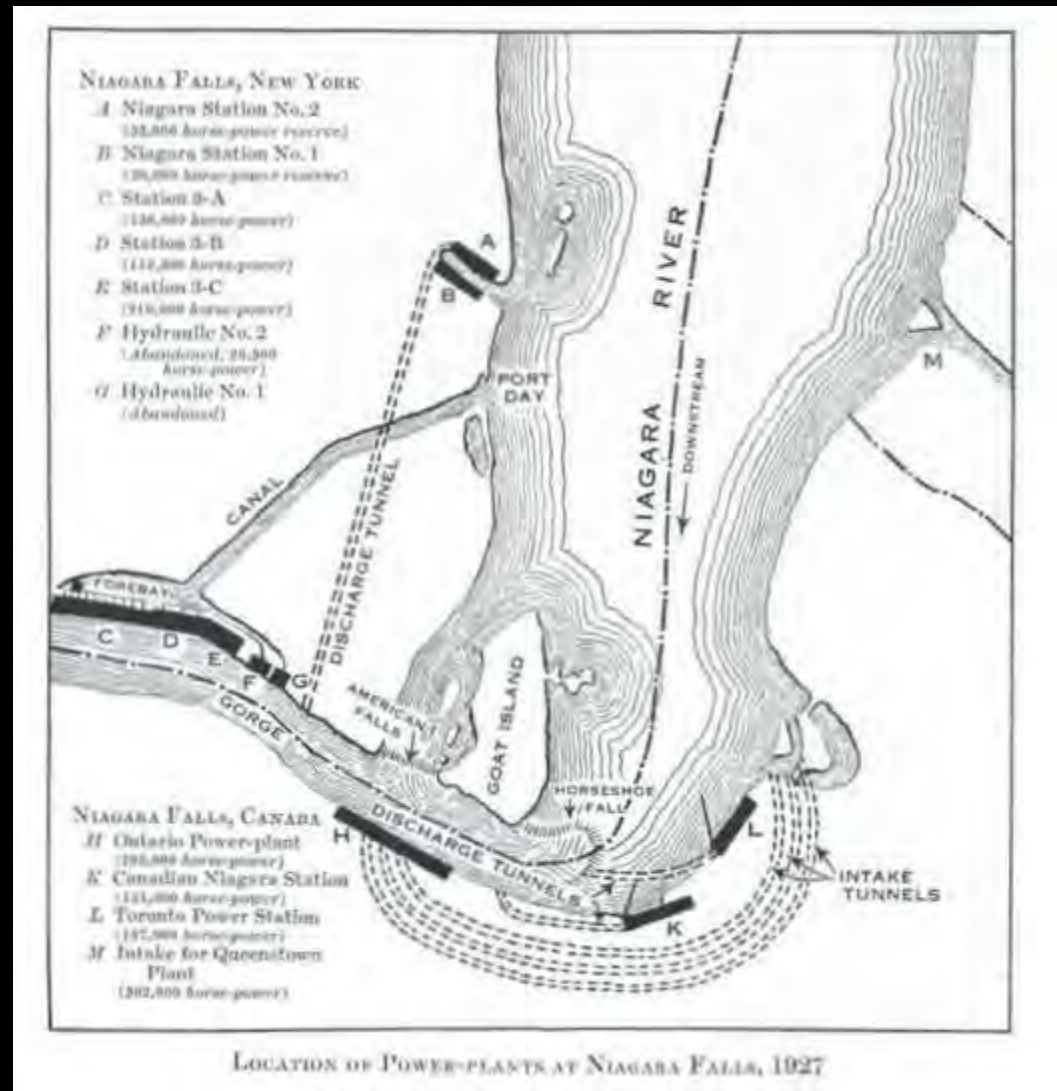
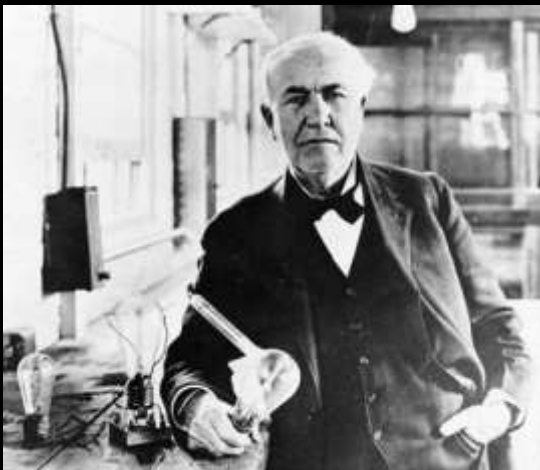
In 1880, Thomas Edison produced the incandescent filament light bulb.

In 1881, using DC, the first electricity for lighting at Niagara Falls, provided nighttime illumination for tourists.

Against the advice of Thomas Edison and William Kelvin, alternating electrical current (AC) was selected as the standard to be used on May 6, 1893.

Westinghouse was selected as the builder for the first 2 A-C generators.

The plant was completed in 1895 and in 1896, electricity transmission 20 miles away to Buffalo, New York began.



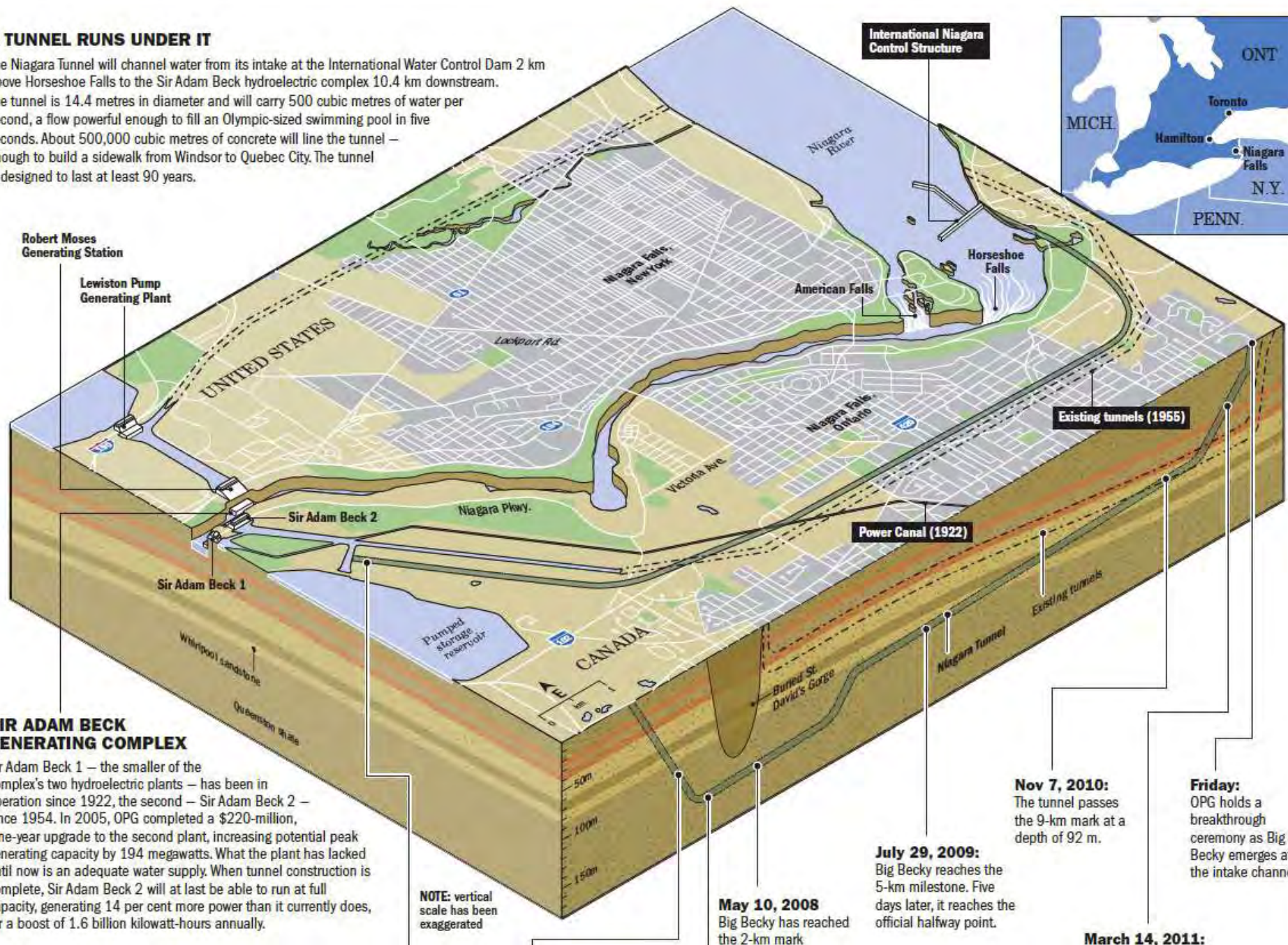
A TUNNEL RUNS UNDER IT

The Niagara Tunnel will channel water from its intake at the International Water Control Dam 2 km above Horseshoe Falls to the Sir Adam Beck hydroelectric complex 10.4 km downstream. The tunnel is 14.4 metres in diameter and will carry 500 cubic metres of water per second, a flow powerful enough to fill an Olympic-sized swimming pool in five seconds. About 500,000 cubic metres of concrete will line the tunnel – enough to build a sidewalk from Windsor to Quebec City. The tunnel is designed to last at least 90 years.

Robert Moses Generating Station

Lewiston Pump Generating Plant

International Niagara Control Structure



UNITED STATES

CANADA

Existing tunnels (1955)

Power Canal (1922)

Existing tunnels

Niagara Tunnel

Sir Adam Beck 1

Sir Adam Beck 2

Niagara Pkwy.

Pumped storage reservoir

Whirlpool sandstone

Queenston shales

SIR ADAM BECK GENERATING COMPLEX

Sir Adam Beck 1 – the smaller of the complex's two hydroelectric plants – has been in operation since 1922, the second – Sir Adam Beck 2 – since 1954. In 2005, OPG completed a \$220-million, nine-year upgrade to the second plant, increasing potential peak generating capacity by 194 megawatts. What the plant has lacked until now is an adequate water supply. When tunnel construction is complete, Sir Adam Beck 2 will at last be able to run at full capacity, generating 14 per cent more power than it currently does, for a boost of 1.6 billion kilowatt-hours annually.

NOTE: vertical scale has been exaggerated

May 10, 2008
Big Becky has reached the 2-km mark

July 29, 2009:
Big Becky reaches the 5-km milestone. Five days later, it reaches the official halfway point.

Nov 7, 2010:
The tunnel passes the 9-km mark at a depth of 92 m.

March 14, 2011:

Friday:
OPG holds a breakthrough ceremony as Big Becky emerges at the intake channel.

Harnessing American Rivers



0 200 400
Miles

0 500 1,000
Kilometers

Average Flow in cubic feet per second (cfs):

1,000 2,500 10,000 50,000 250,000 650,000



Army Corps of Engineers

The United States Army Corps of Engineers is a U.S. federal agency under the Department of Defense and a major Army command made up of some 36,500 civilian and military personnel, making it the world's largest public engineering, design, and construction management agency. Although generally associated with dams, canals and flood protection in the United States.

The General Survey Act of 1824 authorized the use of Army engineers to survey road and canal routes. That same year, Congress passed an "Act to Improve the Navigation of the Ohio and Mississippi Rivers" and "to remove sand bars on the Ohio and planers, sawyers, and snags on the Mississippi" for which the Corps' was the responsible agency.

The Rivers and Harbors Acts of 1890 and 1899 required that dam sites and plans be approved by the secretary of war and the Corps of Engineers before construction.



Bureau of Reclamation

The United States Bureau of Reclamation is a federal agency under the U.S. Department of the Interior, which oversees water resource management, specifically as it applies to the oversight and operation of the diversion, delivery, and storage projects that it has built throughout the western United States for irrigation, water supply, and attendant hydroelectric power generation.

From 1902 to 1907, Reclamation began about 30 projects in Western states. Then, in 1907, the Secretary of the Interior separated the Reclamation Service from the USGS and created an independent bureau within the Department of the Interior. Frederick Haynes Newell was appointed the first director of the new bureau.

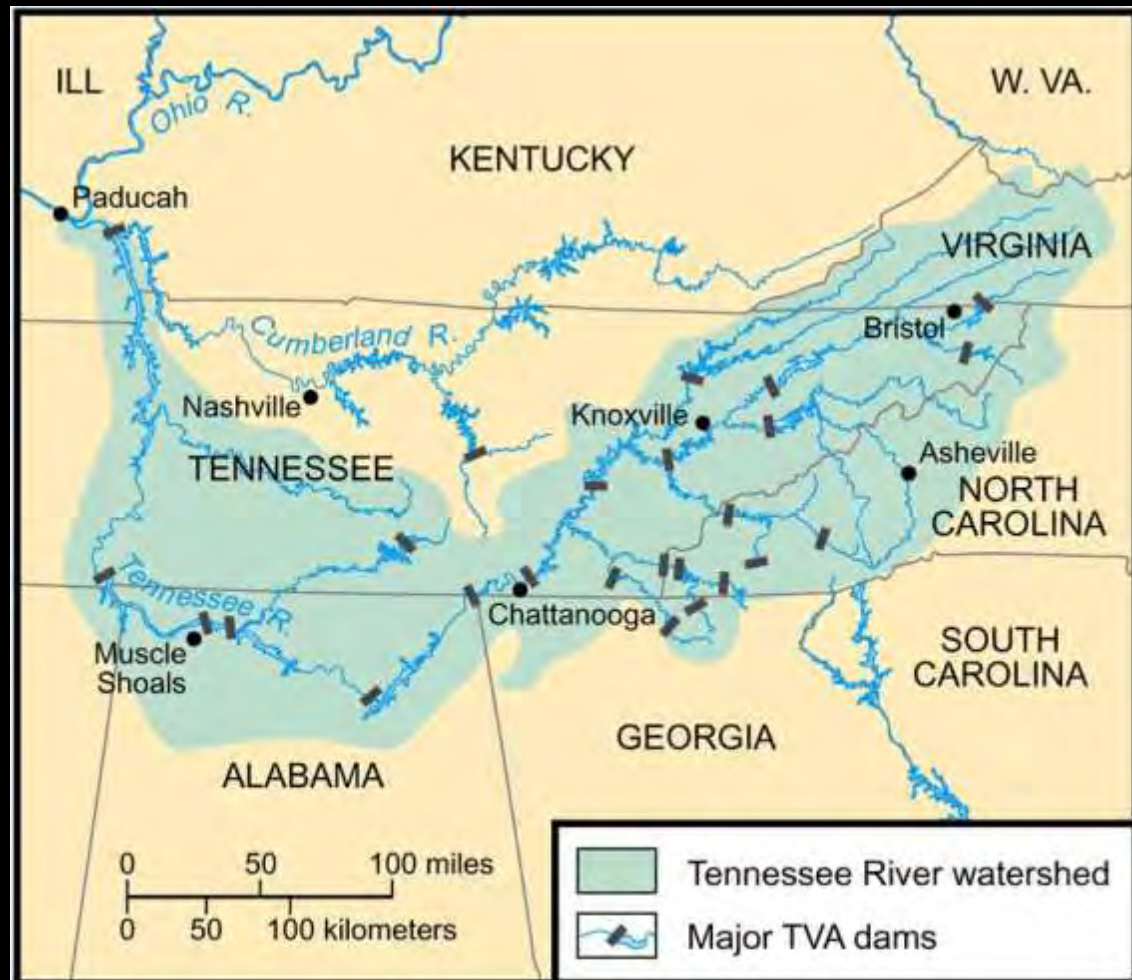
Currently USBR is the largest wholesaler of water in the country, bringing water to more than 31 million people, and providing one in five Western farmers with irrigation water for 10 million acres of farmland. USBR is also the second largest producer of hydroelectric power in the western United States



The Tennessee Valley Authority (TVA)

a federally owned corporation in the United States created by congressional charter in May 1933 to provide navigation, flood control, electricity generation, fertilizer manufacturing, and economic development in the Tennessee Valley.

The TVA created numerous dams and, controversially, flooded large areas.

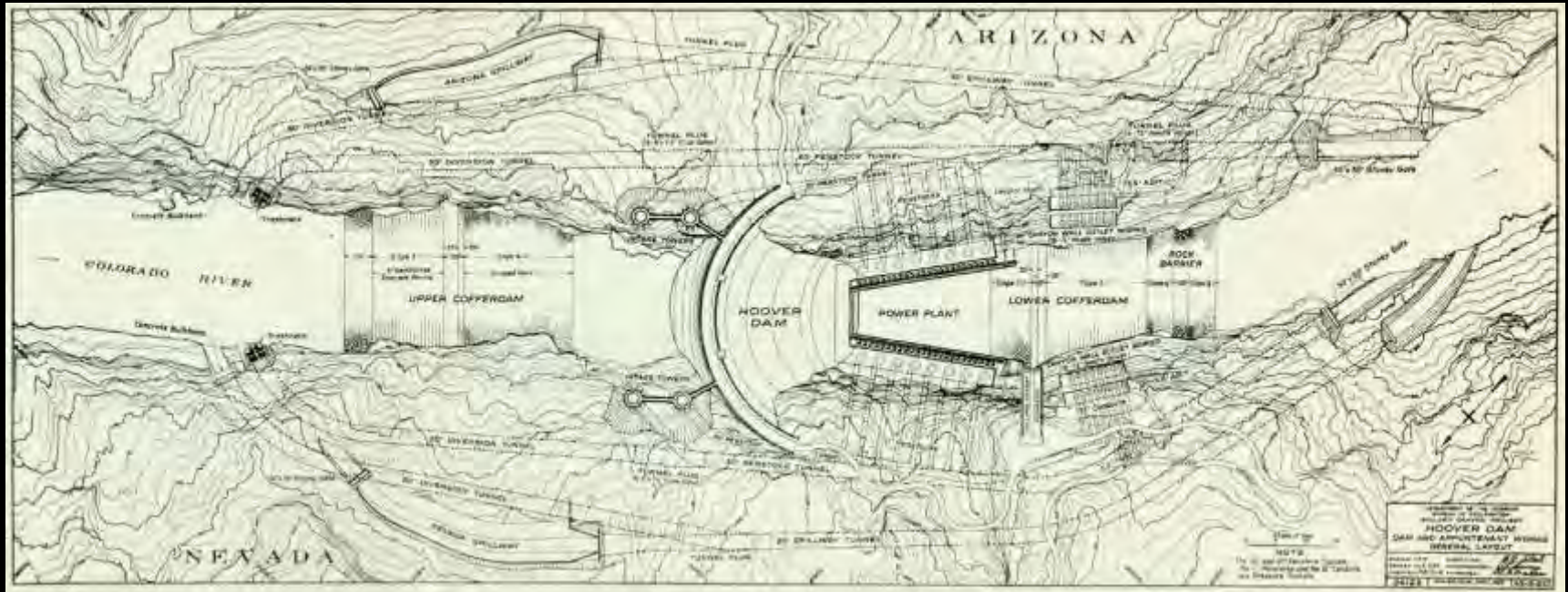


THE TENNESSEE VALLEY AUTHORITY



The Colorado River and Hoover Dam

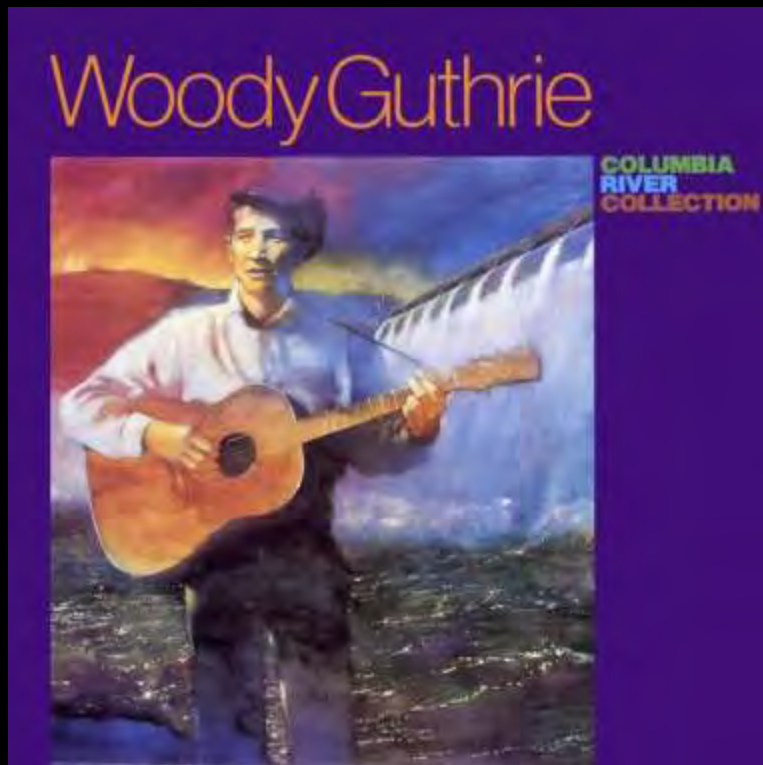
In the 1930s, the need for power in the Southwest led to the building of the largest concrete construction in the world at that time, the Hoover Dam.



The Columbia River and Woody Guthrie

In 1941, Woody age 28, was hired by the Bonneville Power Administration in Portland, Oregon to write music for a film about the Columbia River and public power. This collection presents all known recordings of Woody singing his Columbia River songs, including *Roll On Columbia*, *The Biggest Thing That Man Has Done*, and *Grand Coulee Dam*.

Roll on, Columbia, roll on, roll on, Columbia, roll on
Your power is turning our darkness to dawn
Roll on, Columbia, roll on.







Out with the old, in with the new...

Generator

Turbine

Here is how a turbine works to bring power to your home...

1. Water flowing through the powerhouse spins the turbine.
2. The turbine spins part of the generator called the rotor.
3. Magnets on the outer edge of the rotor spin past copper coils existing electrons to flow in the coils.
4. Electricity flows from the copper coils through transformers and power lines to homes and businesses throughout the Northwest.





Dam building peaked in the 1960s and few dams were built in the 1970s.

The growing awareness of environmental issues with dams saw the removal of some older and smaller dams and the installation of fish ladders at others. Instead of new dams, repowering old plants has increased the capacity of several facilities.

For instance, Hoover Dam replaced its generators between 1986 and 1993.

The need to alter downstream water flow for ecological reasons (eliminating invasive species, sedimentation, etc.) has led to regulated seasonal drawdowns at some dams, changing the availability of water for power generation.

Droughts and increased agricultural use of water can also lead to generation limits.

Above Hoover Dam - Lake Mead 2011



“American Rivers”
Tom Russell



Ain't no more cane on the Brazos
Yeah, yeah, yeah
It's all been ground down to molasses
Yeah, yeah, yeah

I saw a red iron sunset from a rust iron bridge
In the Indian country of the mockingbird kid
I saw the moon in a boxcar being carried as freight
Through 62 winters through 48 states
And in an old Chinese graveyard I slept in the weeds
When a song and a story were all a kid needs
Hear the rhymes and the rattles of those runaway trains
And the songs of the cowboy and the sound of the rain

And it's mamma I miss you
I woke up and screamed
American rivers roll deep through my dreams
Colorado, Allegheny, Shenandoah, Susquehanny
And the Wabash and the Hudson and the brave Rio Grande
I was a kid there asleep in sand and your water

We named them for Indians our guilt to forsake
The Delaware, the Blackfoot, The Flathead and Snake
Now they flow past casinos and hamburger stands
They are waving farewell to the kid on the land...
With their jig-sawed old arteries
So clogged and defiled no open heart miracle's
Gonna turn 'em back wild

Past towns gone to bankers past fields gone to seed
All cut up and carved out so divided by greed
And old grandfather catfish with his whiskers so long
And his life is a struggle cuz the oxygen's gone

