

---

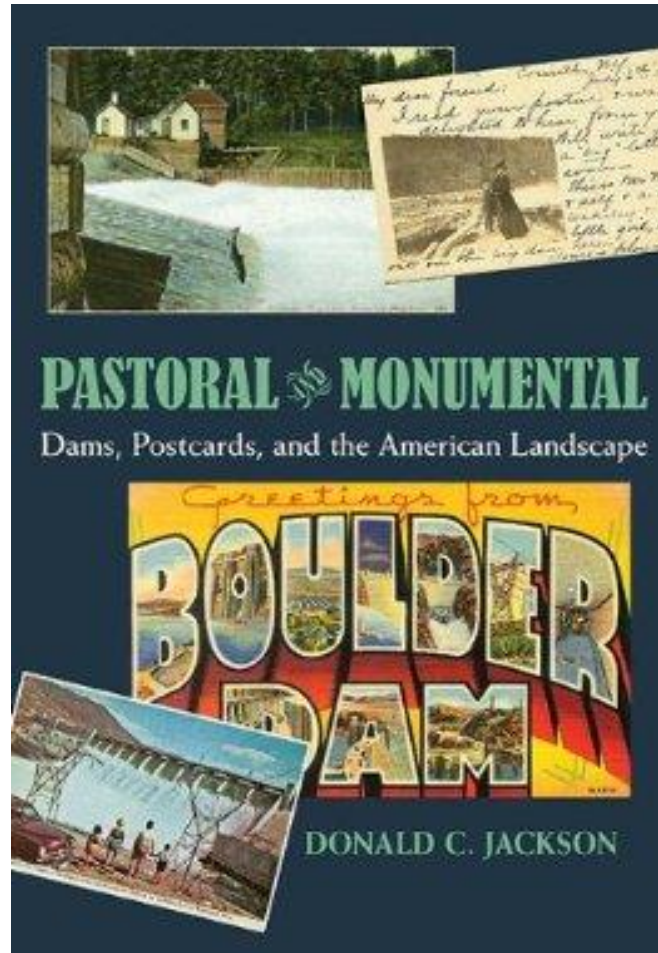
# Dams Water Energy & Sustainability: A Historical Context

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DC Jackson – Lafayette College  
National Academy of Sciences  
Water/Energy Roundtable  
May 20, 2014

# Dams Water Energy...

## Dams and the (Cultural) Landscape...





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# Dams Water Energy...

## Water & Power - An American Tradition





# Dams Water Energy...

## Rural Grist Mill – Hudson River Valley

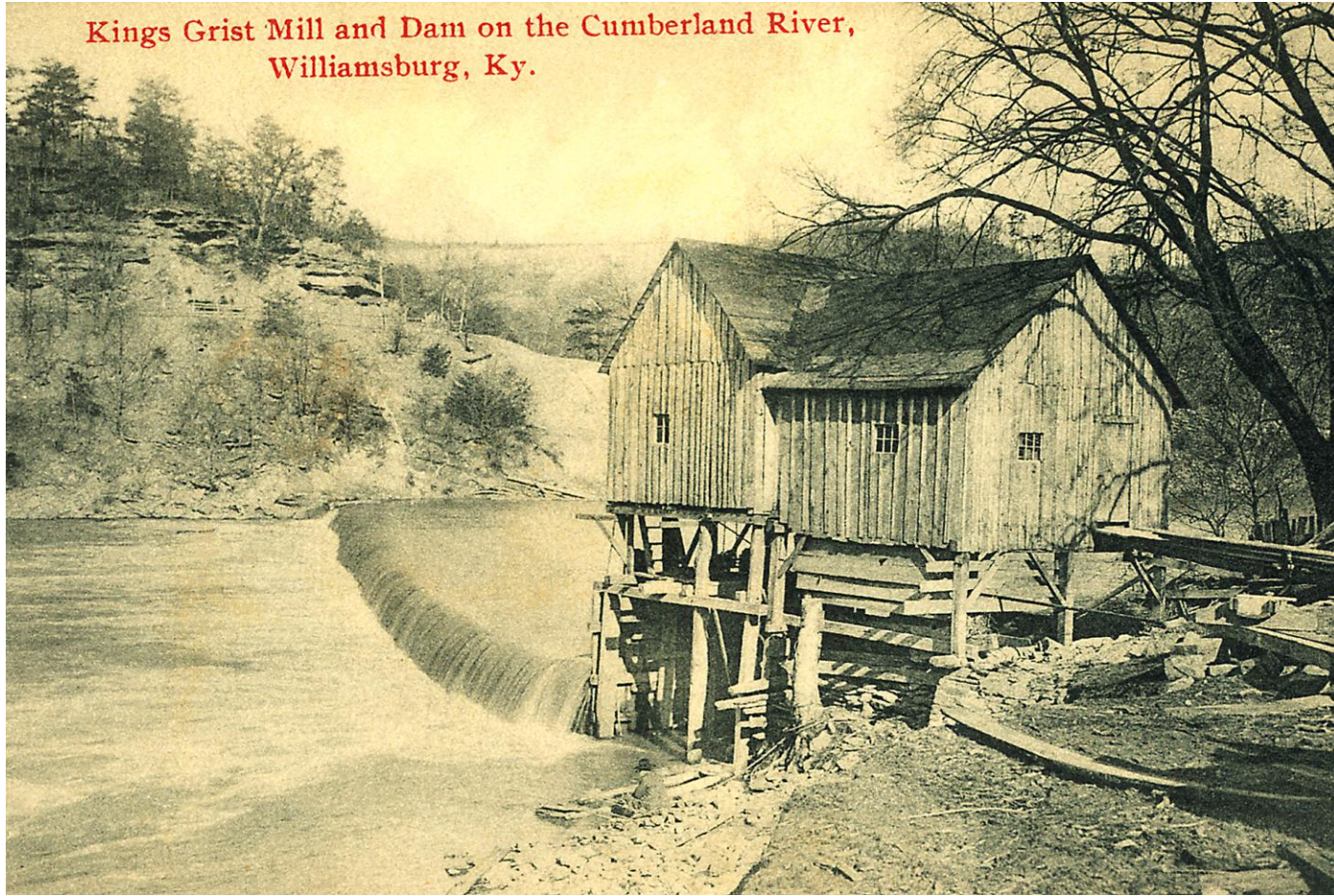




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# Dams Water Energy...

## Rural Grist Mill - Kentucky





# Dams Water Energy...

## Rural Grist Mill - Georgia



MILL RACE, INDIAN SPRINGS, GA.



# Dams Water Energy...

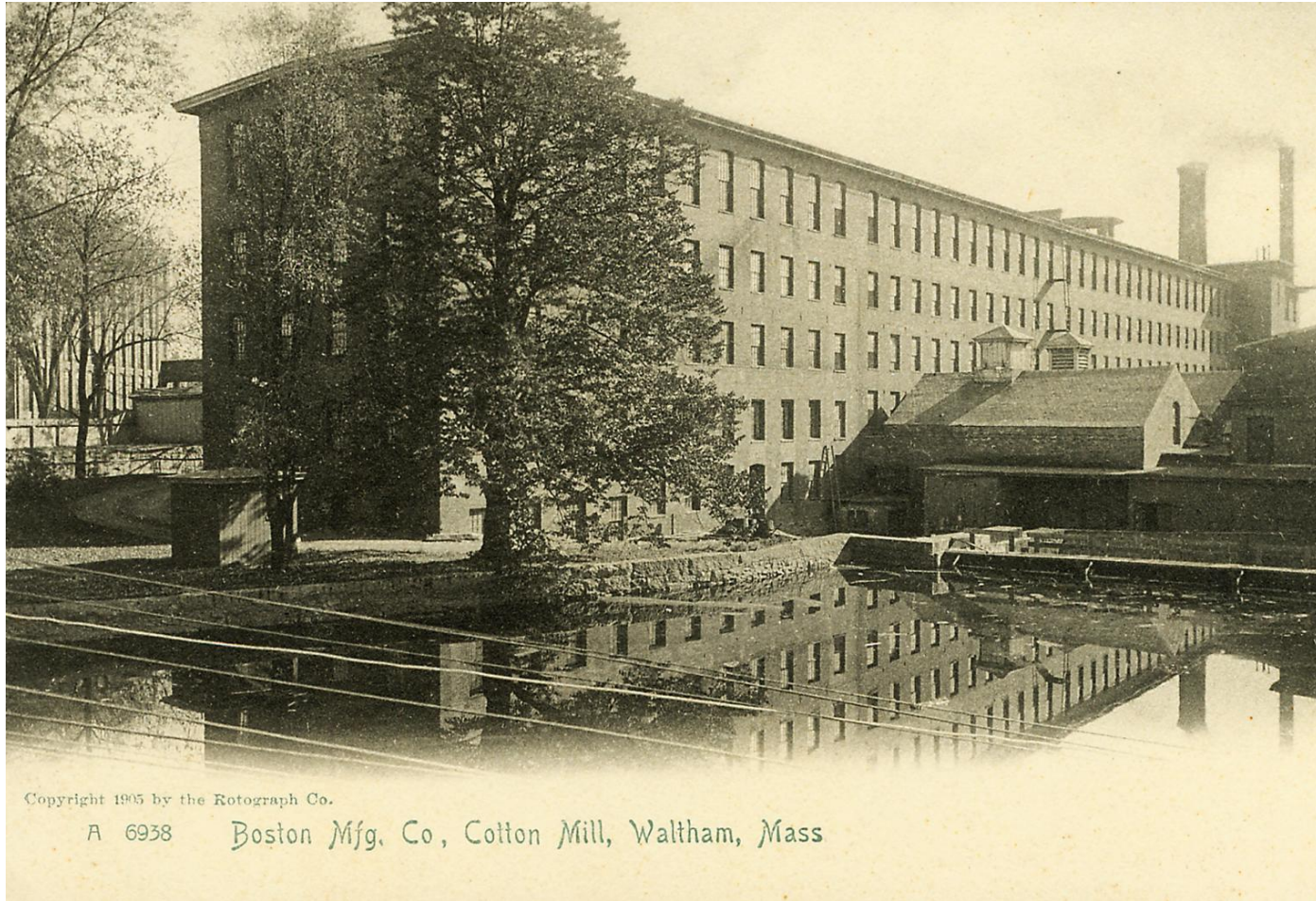
## Slater Mill: 1793 Textile Mill Dam





# Dams Water Energy...

## Waltham Mill – Charles River 1814



Copyright 1905 by the Rotograph Co.

A 6938 Boston Mfg. Co., Cotton Mill, Waltham, Mass



# Dams Water Energy...

## Lowell: Merrimack River 1820s

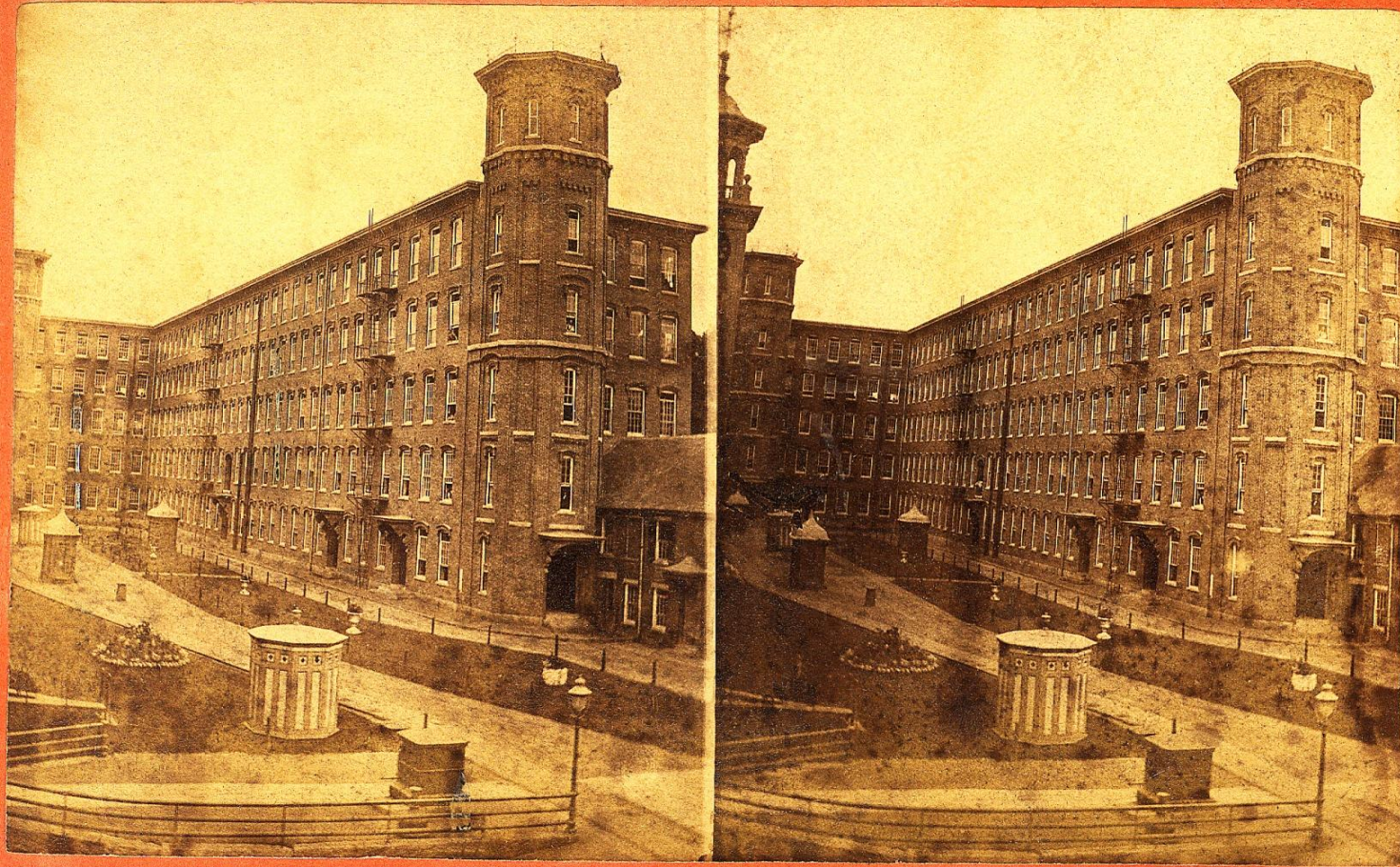




# Dams Water Energy...

## Boott Mill – Lowell 1820s

NEW SERIES, LOWELL, MASS.

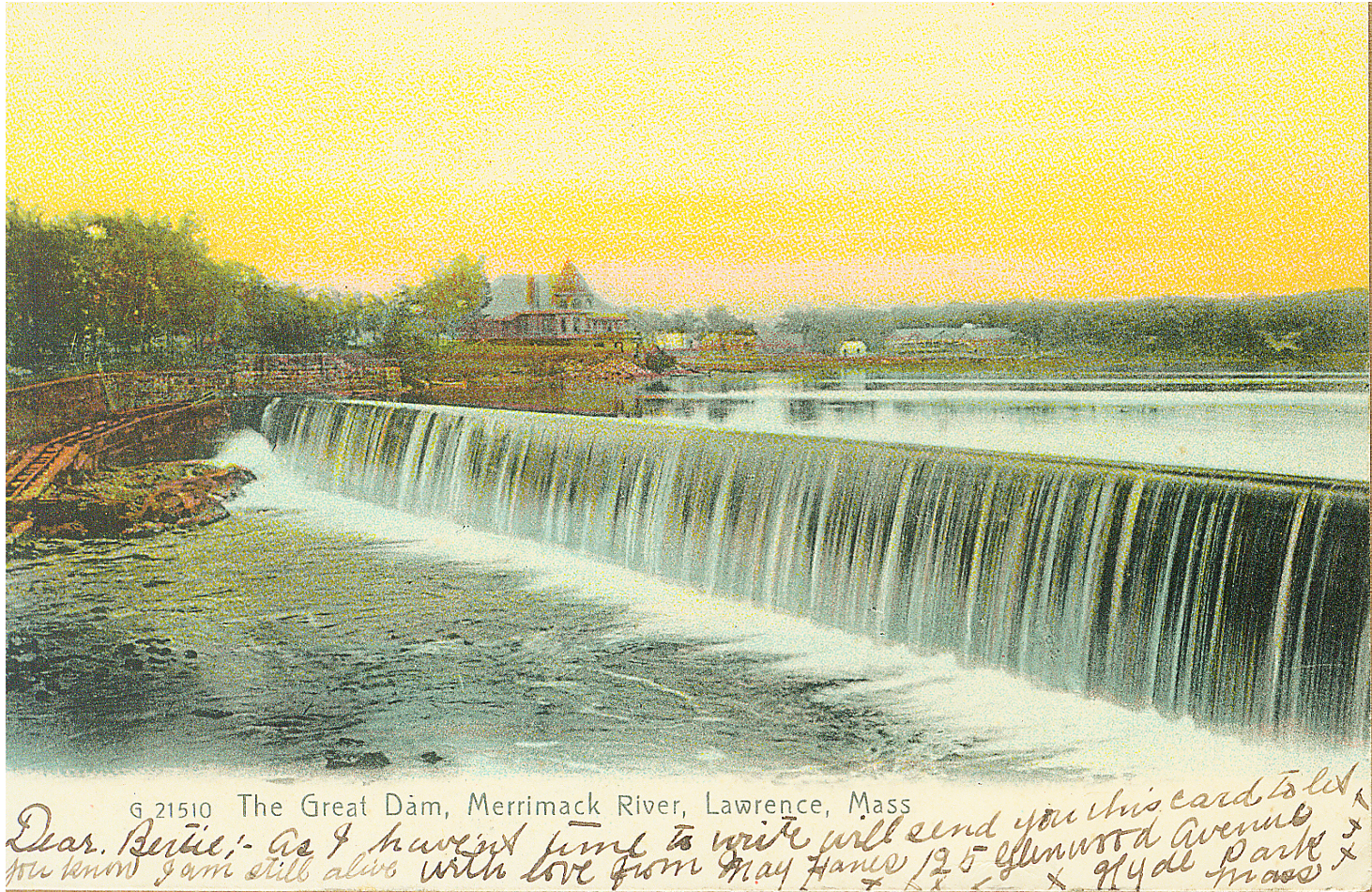


MARSTON & PRINCE, 90 MERRIMACK ST.



# Dams Water Energy...

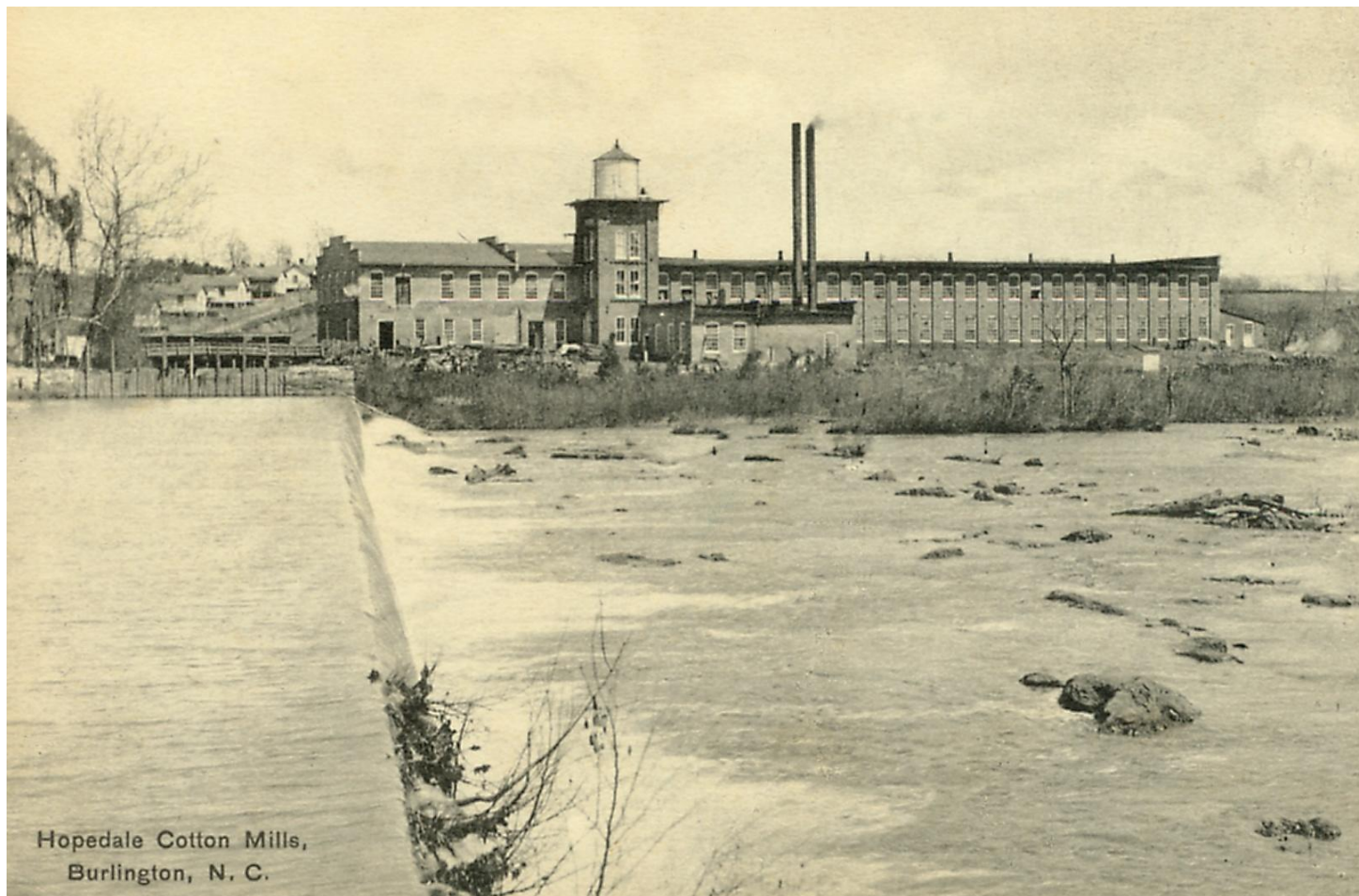
## Lawrence MA: Great Stone Dam 1848





# Dams Water Energy...

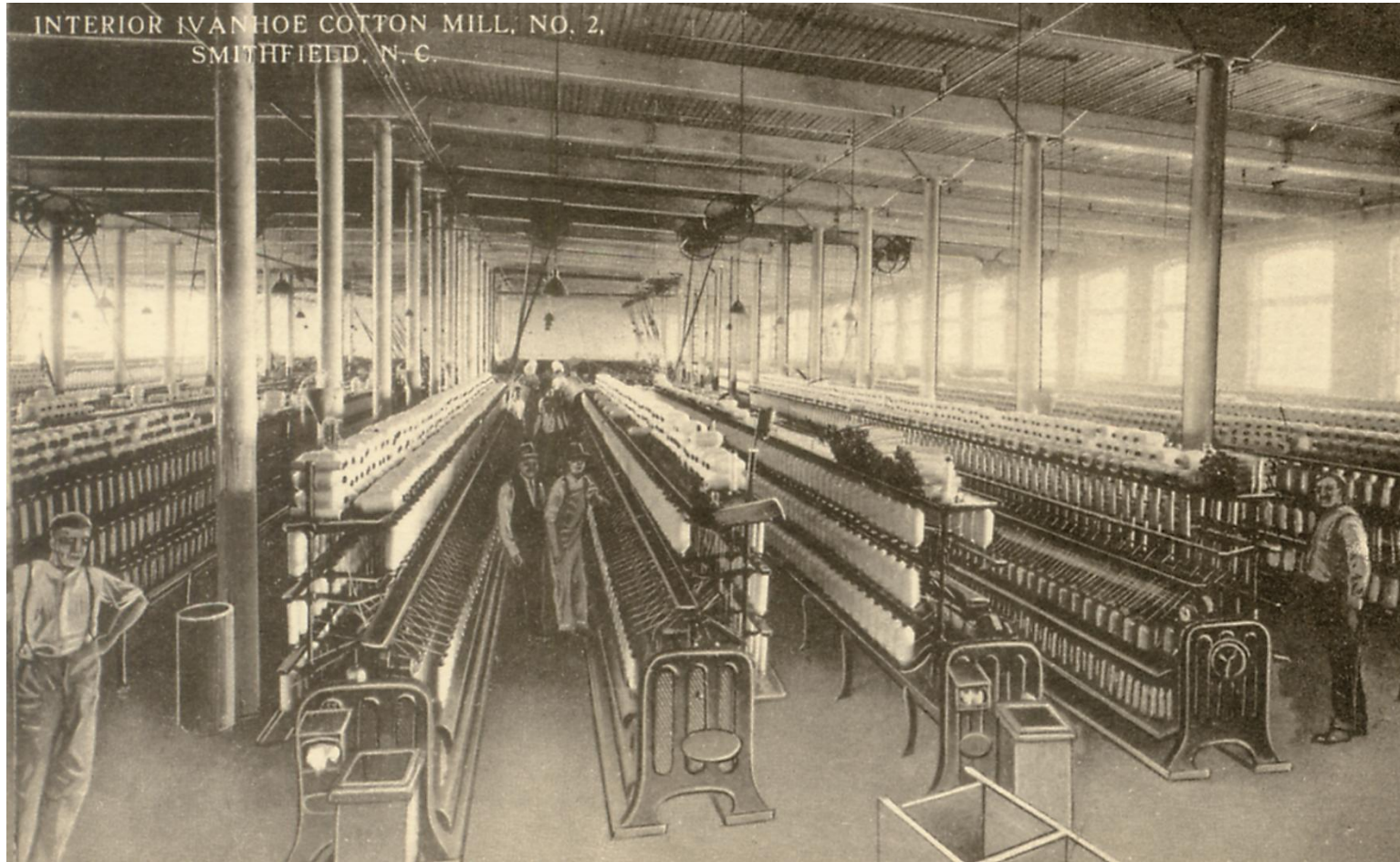
## **Textile Mills Move South – 1890s**



Hopedale Cotton Mills,  
Burlington, N. C.

# Dams Water Energy...

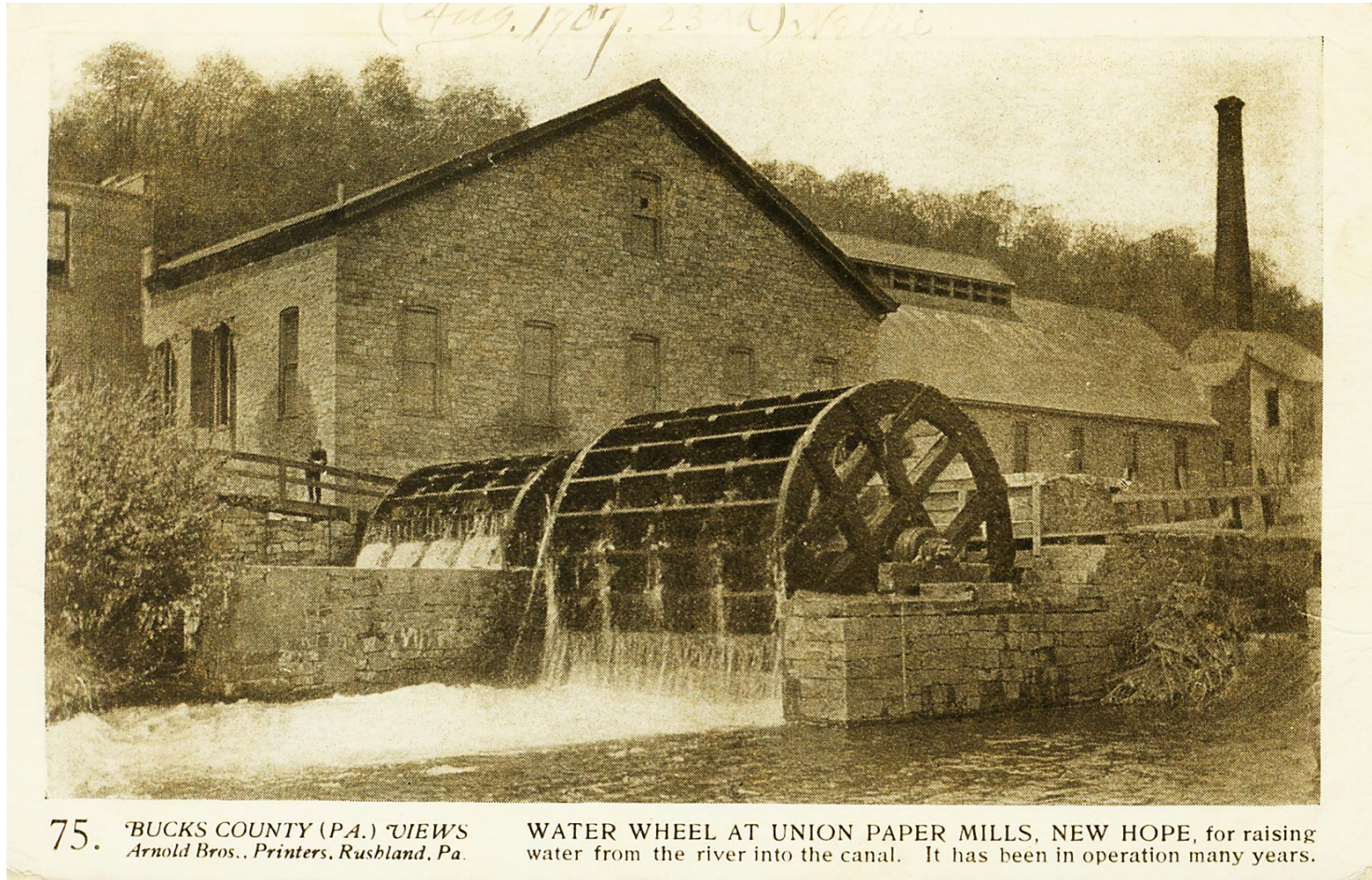
## 19<sup>th</sup> Cent. Mechanical Power Transmission





# Dams Water Energy...

## Breast Wheel Technology



75. BUCKS COUNTY (PA.) VIEWS  
*Arnold Bros., Printers, Rusbland, Pa.*

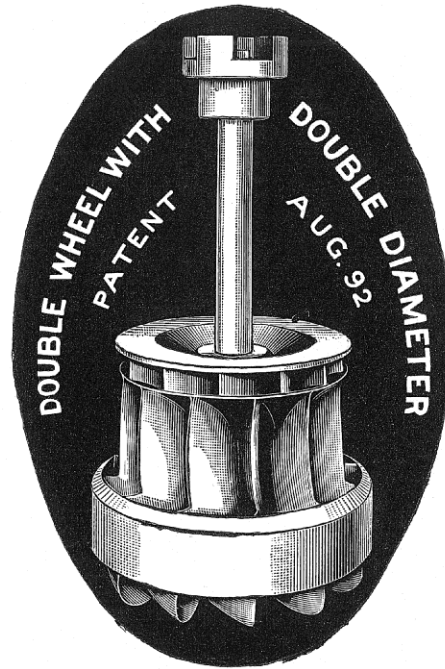
WATER WHEEL AT UNION PAPER MILLS, NEW HOPE, for raising water from the river into the canal. It has been in operation many years.



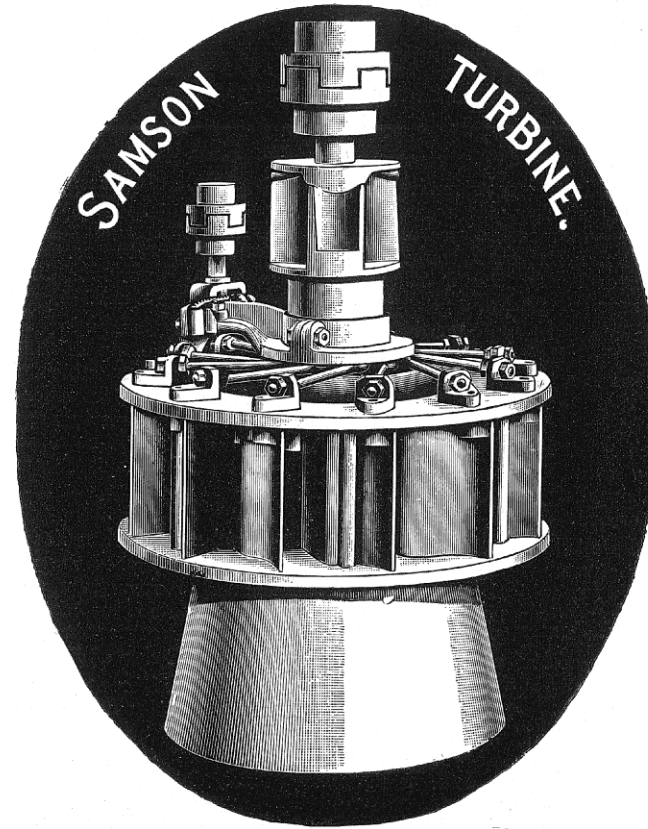
# Dams Water Energy...

## Water Turbine Technology

COPYRIGHT SECURED, and TRADE-MARK REGISTERED  
1893, BY



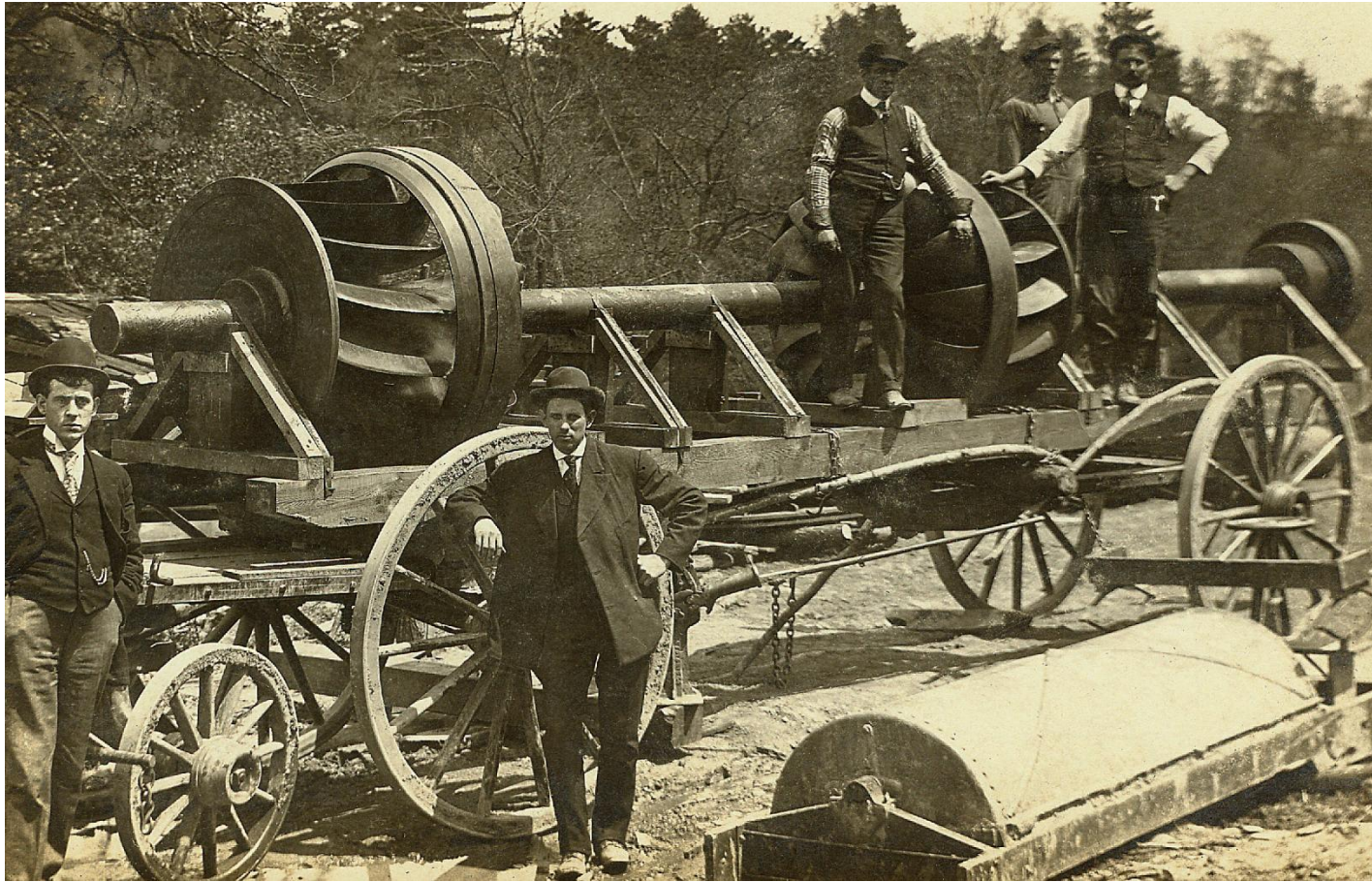
JAMES LEFFEL & CO., SPRINGFIELD, OHIO.



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# Dams Water Energy...

## Water Turbine Technology





# Dams Water Energy...

## Water Turbine Technology



211. THE MILL, FORRESTVILLE, IA.



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# Dams Water Energy...

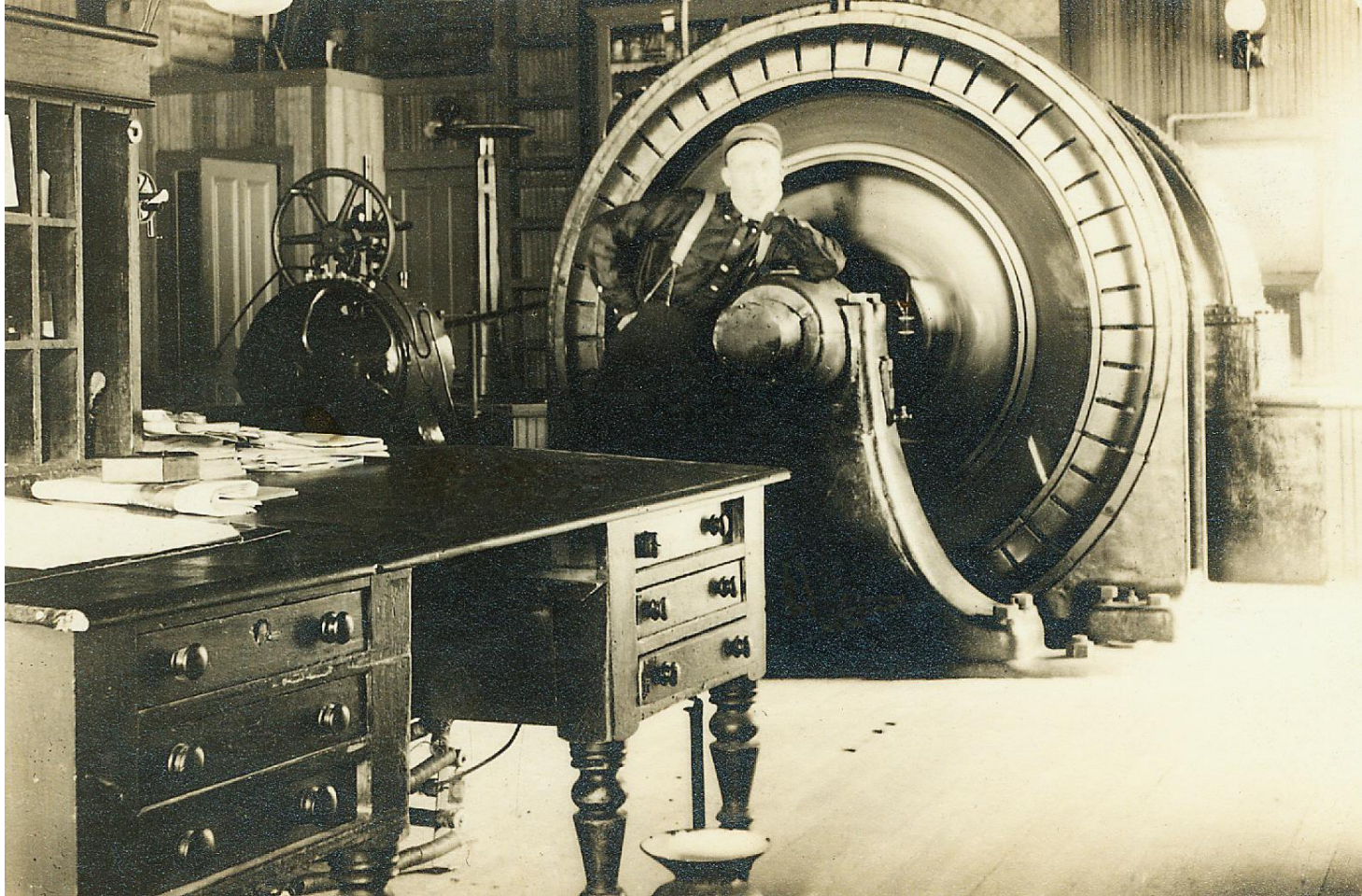
**Hydroelectric Power – 1880s onward...**





# Dams Water Energy...

## Hydroelectric Power – Pastoral Scale

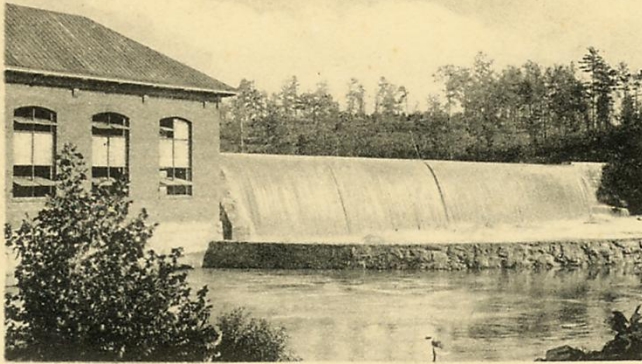




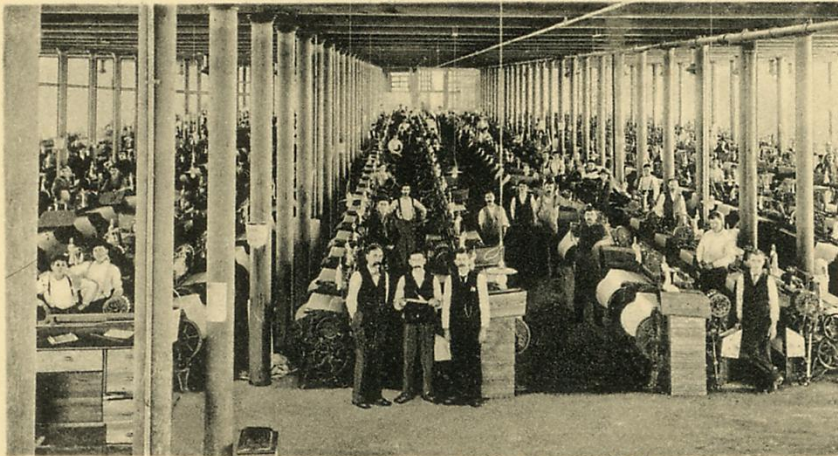
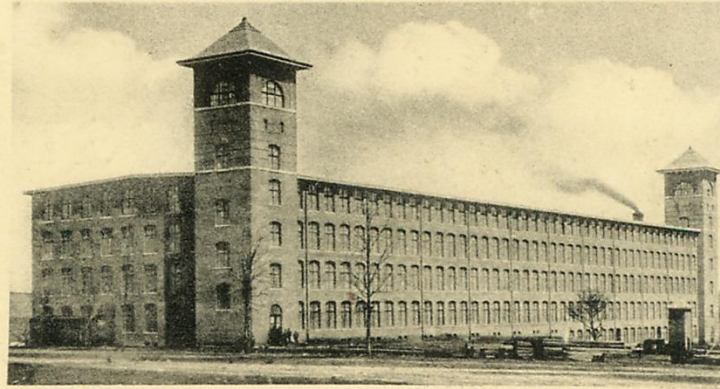
# Dams Water Energy...

## Hydroelectric Power - Industrial

Dam and Power House. Pelzer, S. C.



Cotton Mill No. 4. Pelzer, S. C.



Weave Room, Mill No. 4. Pelzer, S. C.

# Dams Water Energy...

## Hydroelectricity & Regional Networks

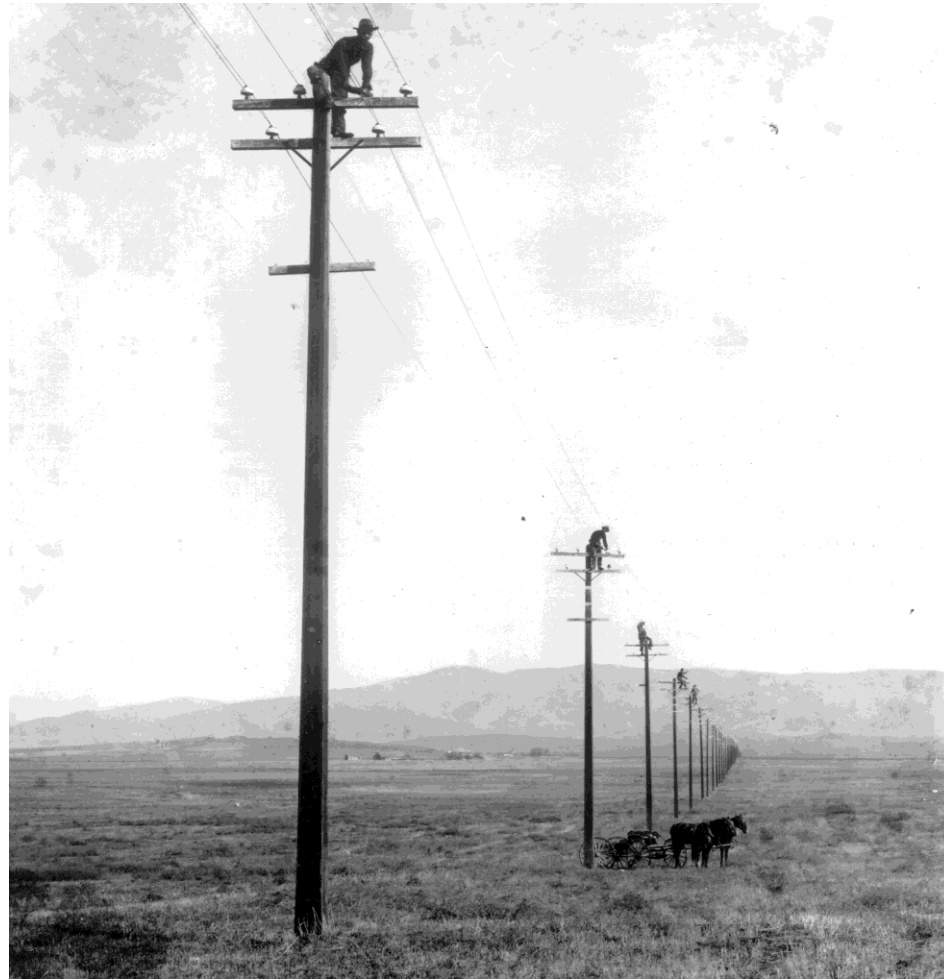
### San Joaquin Electric Company 1895





# Dams Water Energy...

**1896 - Fresno's 34 mile, 11KV AC line**



# Dams Water Energy...

## Prairie du Sac Wisconsin - 1914

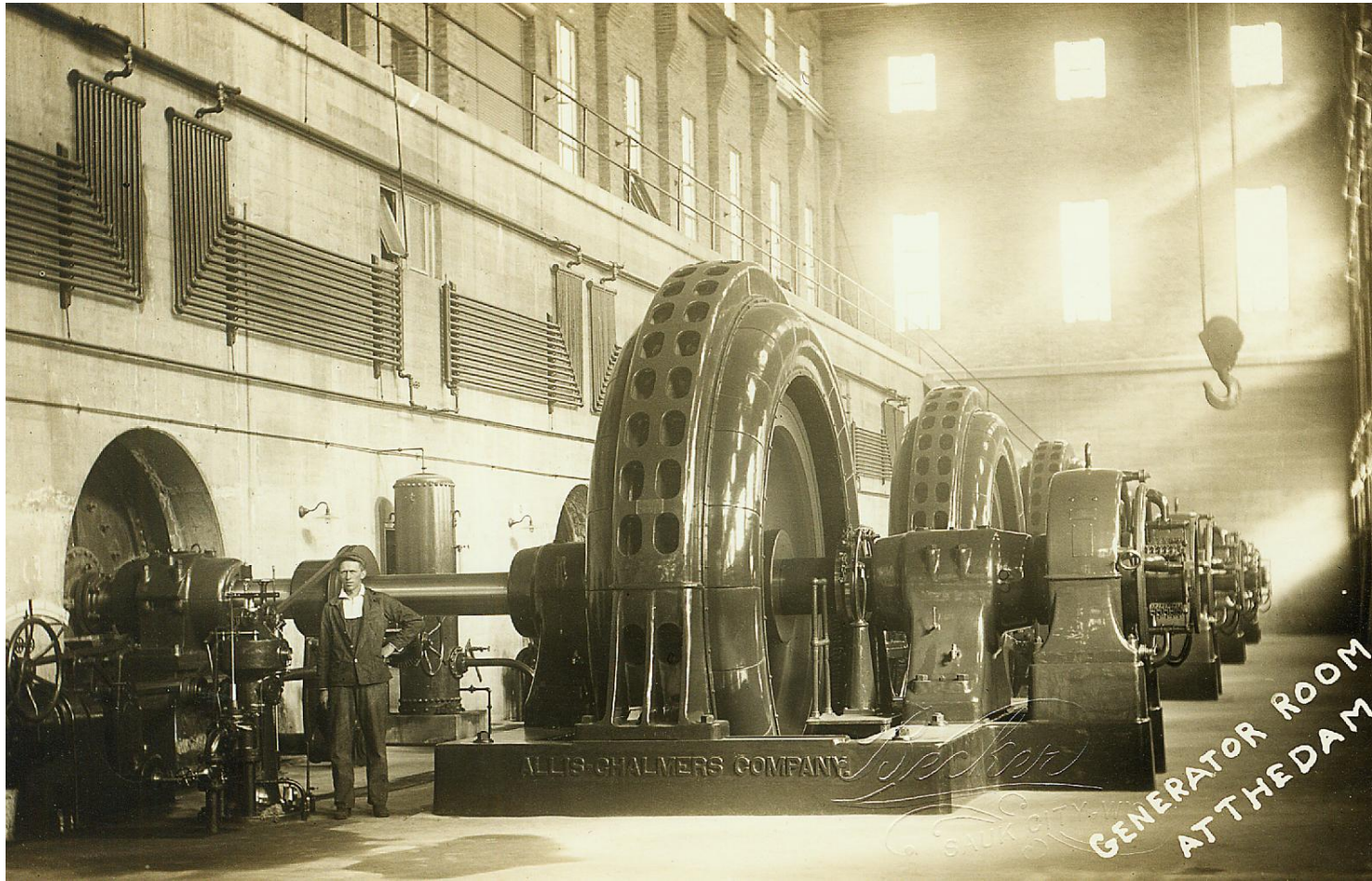


#220. COMPLETED POWER HOUSE AND DAM, PRA. DU SAC, WIS. PHOTO BY F.S. EBERHART, FEB. 28, 1915.



# Dams Water Energy...

## Prairie du Sac Wisconsin - 1914





# Dams Water Energy...

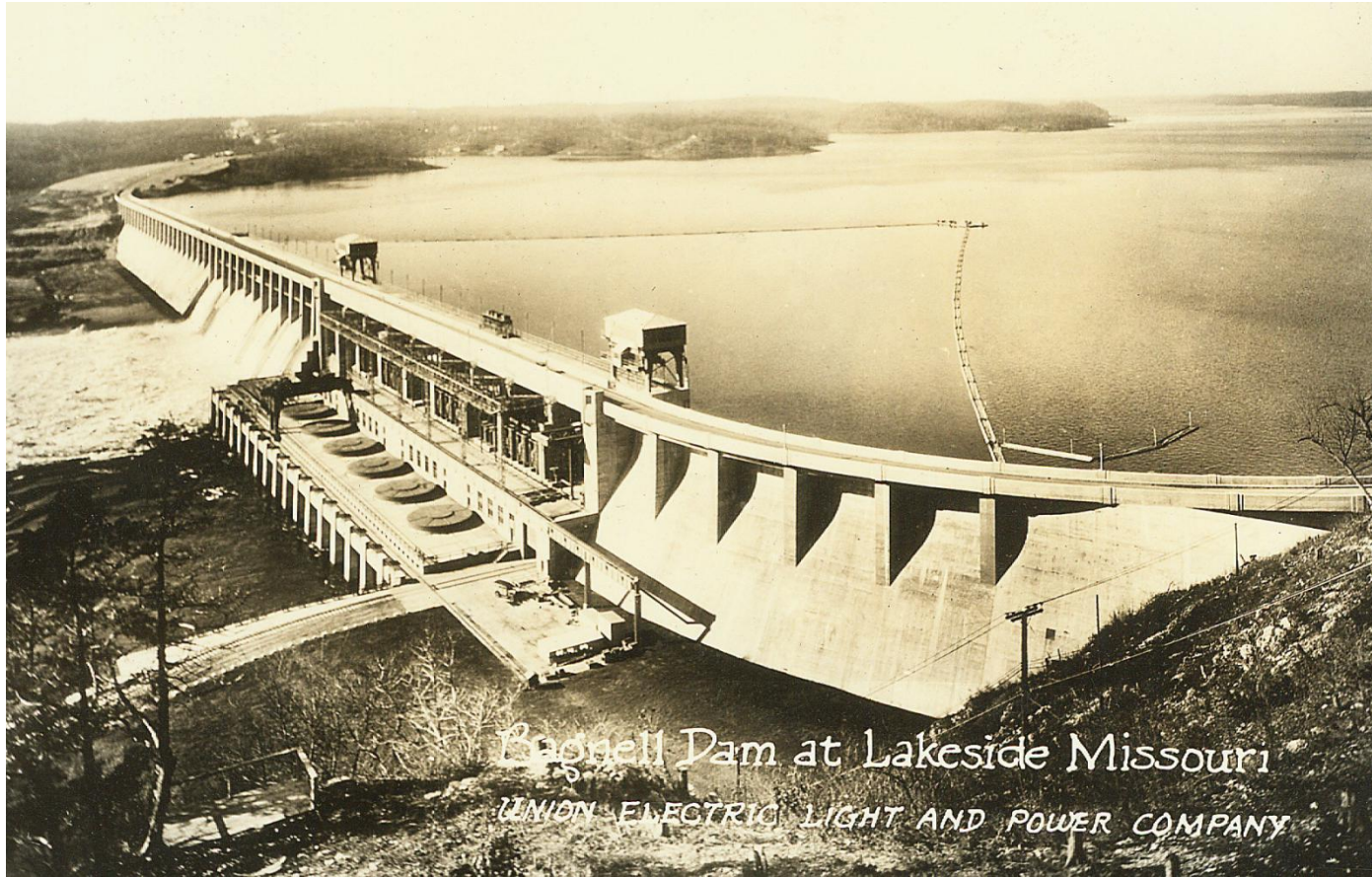
## Great Falls Montana 1915





# Dams Water Energy...

## Bagnell Dam Missouri 1930 (Stone & Webster)



Bagnell Dam at Lakeside Missouri  
UNION ELECTRIC LIGHT AND POWER COMPANY



---

# Dams Water Energy...

## **“Multiple Uses” of Dams**

**Navigation/Canals**

**Logging**

**Irrigation**

**Mining**

**Municipal Water Supply**

**Flood Control**

**Recreation**

---

---

# Dams Water Energy...

## **“Multi-Purpose” Dams**

**can be used for many purposes,  
but “multi-use” limits operational efficiency  
of any single use**

**For example...**

**Storing water for seasonal irrigation  
conflicts with releasing water to maximize  
the value of hydroelectric power  
generation**

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Dams Water Energy...

## **New Deal Dams**

**The Ascendancy of “Multi-Purpose” dams  
as Monuments of Civic Enterprise**

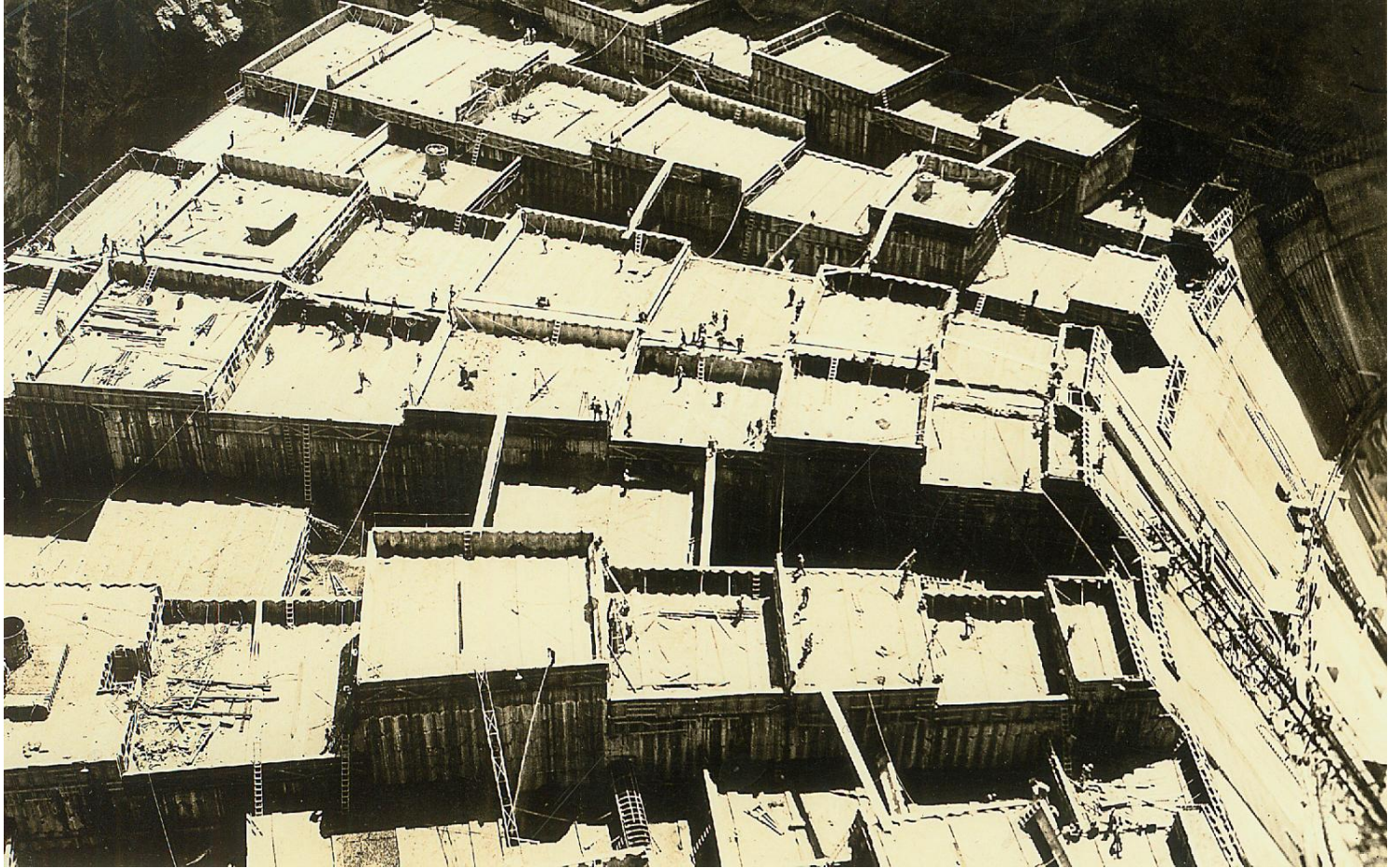
**Human Accomplishment in the Face of  
Economic Hardship...**

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# Dams Water Energy...

## **Boulder/Hoover Dam 1931-35**





# Dams Water Energy...

## FDR and Dam Politics



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# Infrastructure Politics...

**Pres. Obama at Hoover Dam Oct 2, 2012**

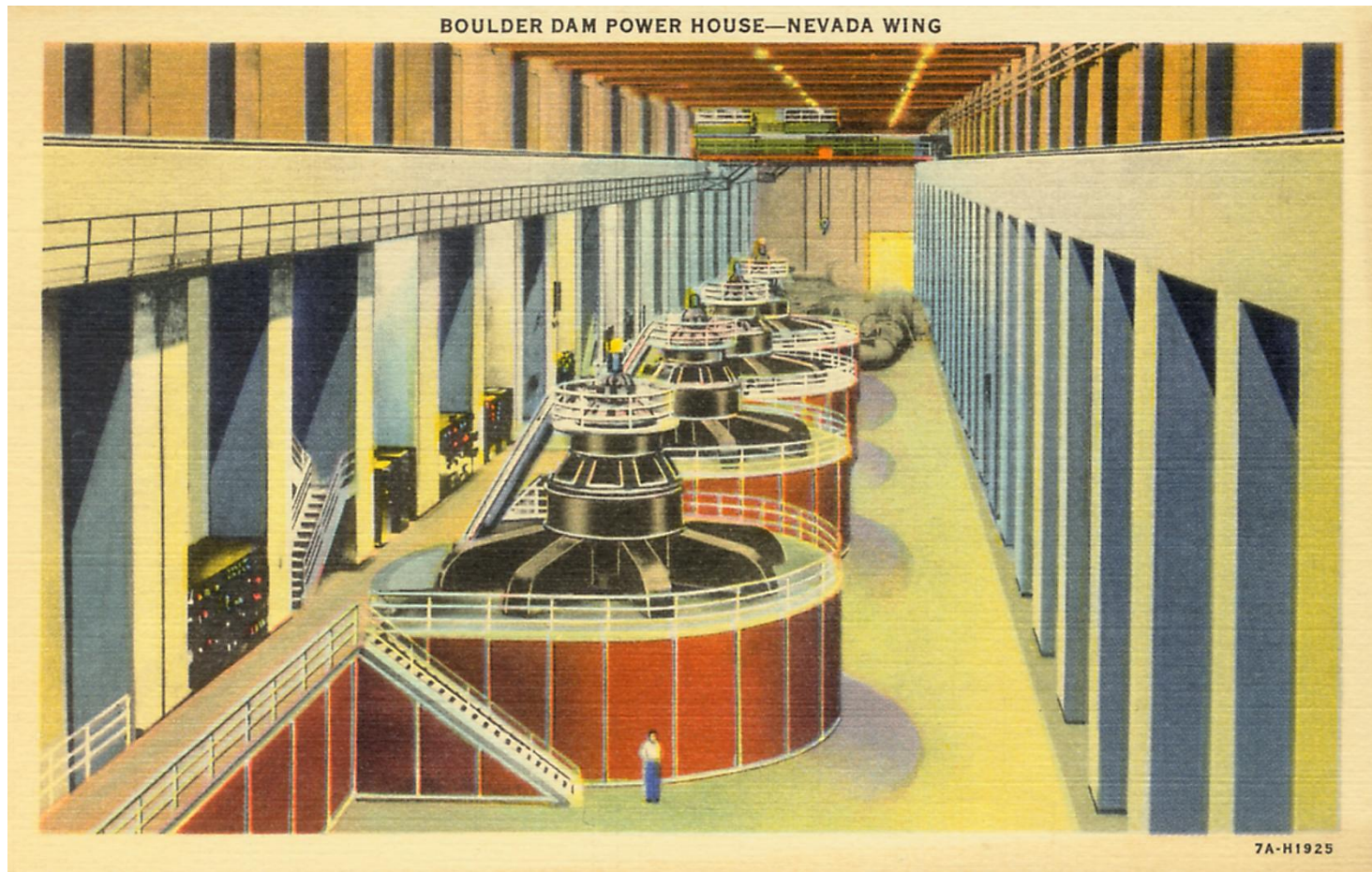
**Who built that?**





# Dams Water Energy...

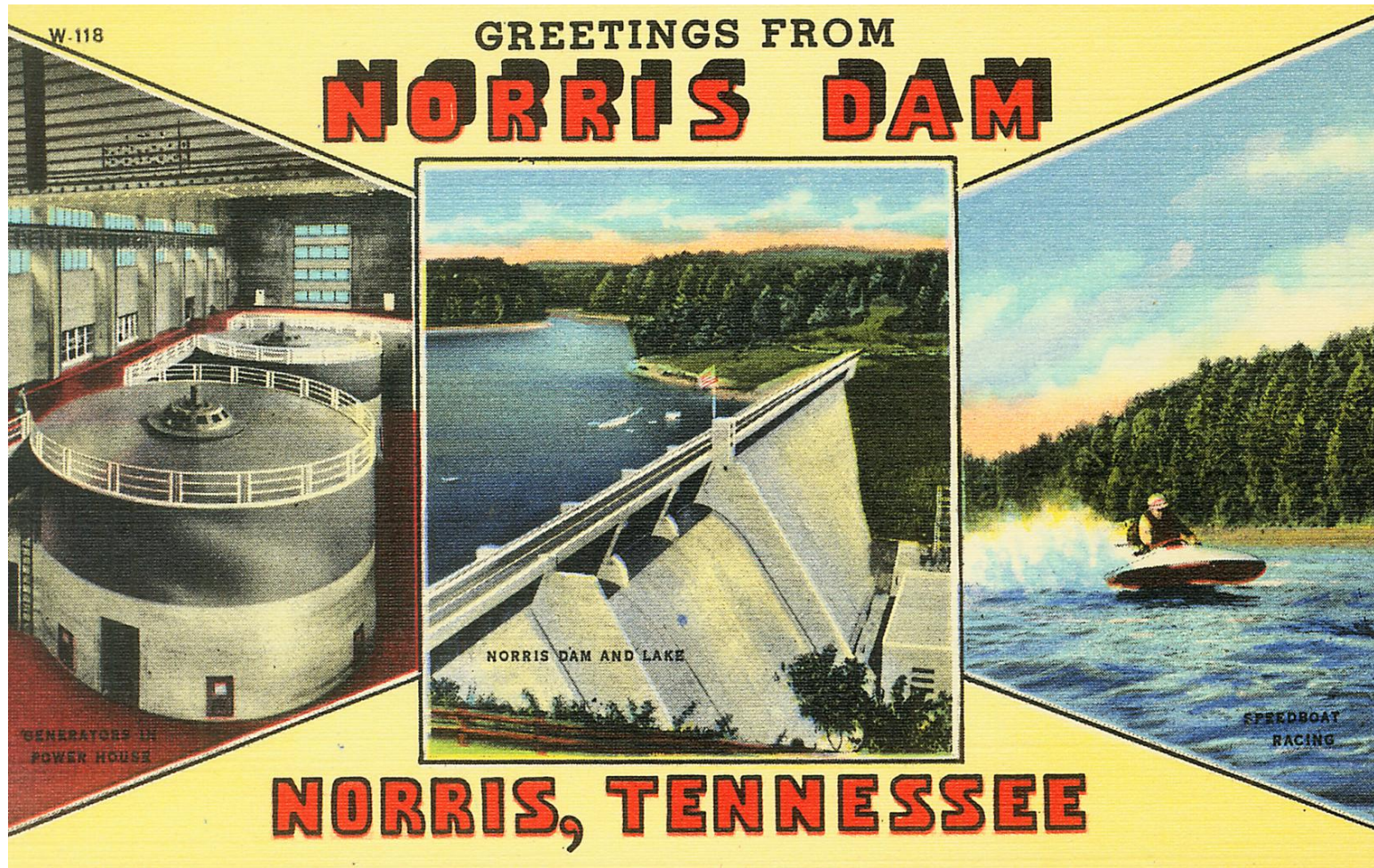
~2000 MW capacity Boulder/Hoover Dam





# Dams Water Energy...

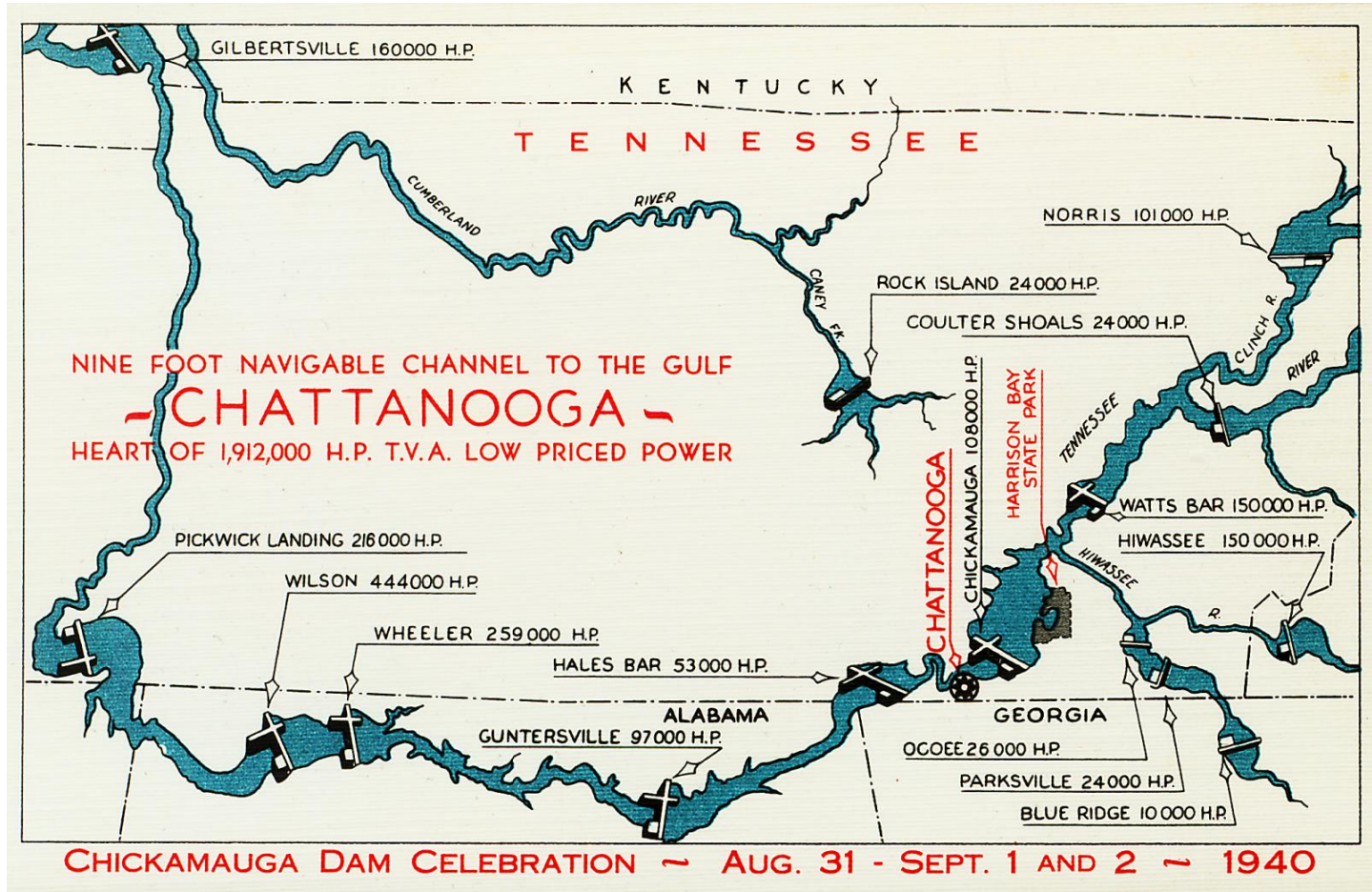
## TVA – Norris Dam 1933-36





# Dams Water Energy...

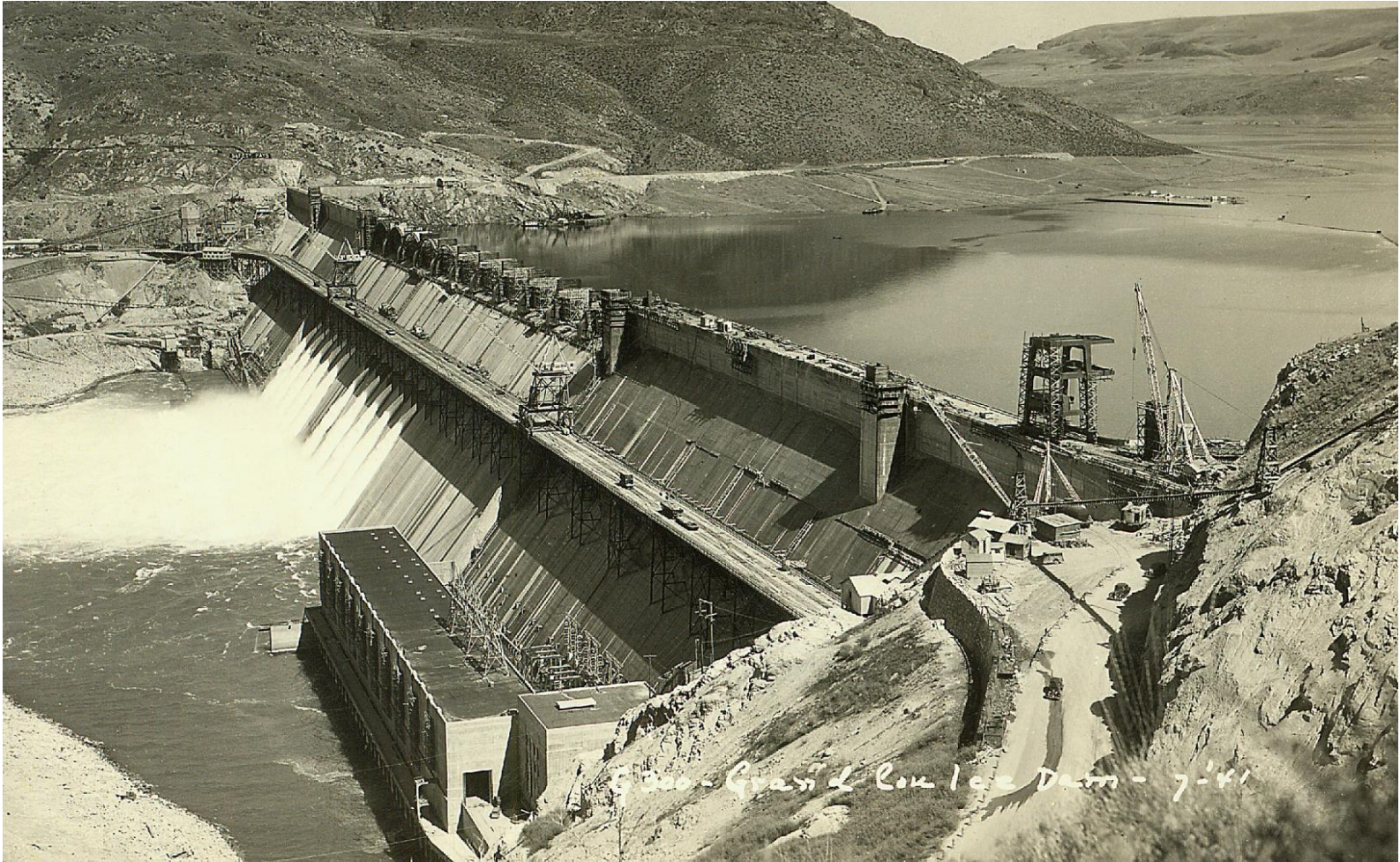
## TVA River Basin Development





# Dams Water Energy...

## Grand Coulee Dam - 1933-42



Grand Coulee Dam - 7-41



# Dams Water Energy...

## Grand Coulee Dam – American Icon

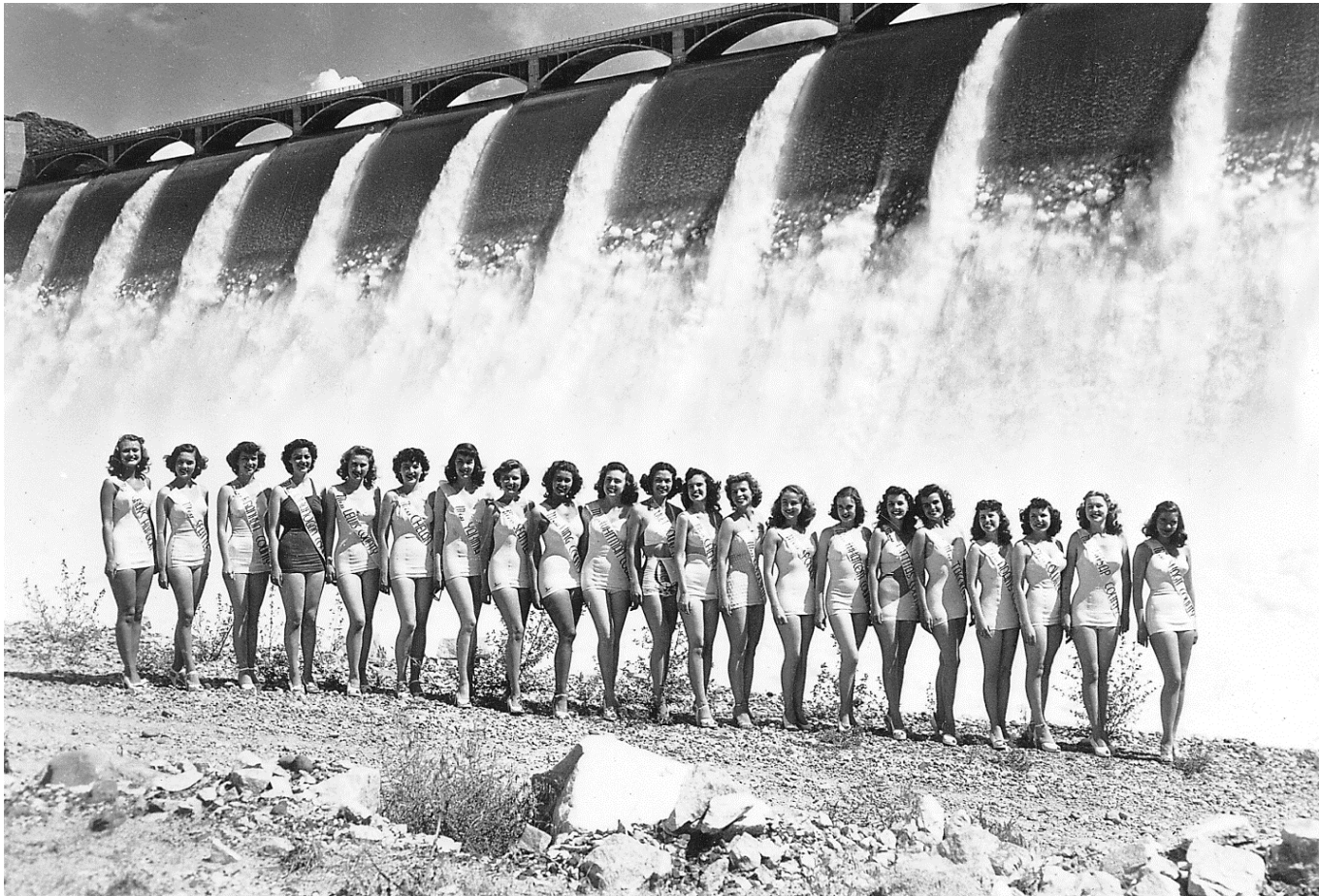




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# Dams Water Energy...

## Grand Coulee Dam – American Icon!





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Dams Water Energy...

# **Dams and Sustainability:**

**Scenic Values**

**Fish**

**Cultural Values**

**Ecological Values**

**A Counter Narrative...**

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# Dam Opposition

## **Hetch Hetchy – Yosemite Natl. Park Beautiful Valley or Ideal Reservoir Site?**



Hetch Hetchy Valley, Tuolumne County, California.

Pub. by Manuel Azevedo, Tuolumne, California.

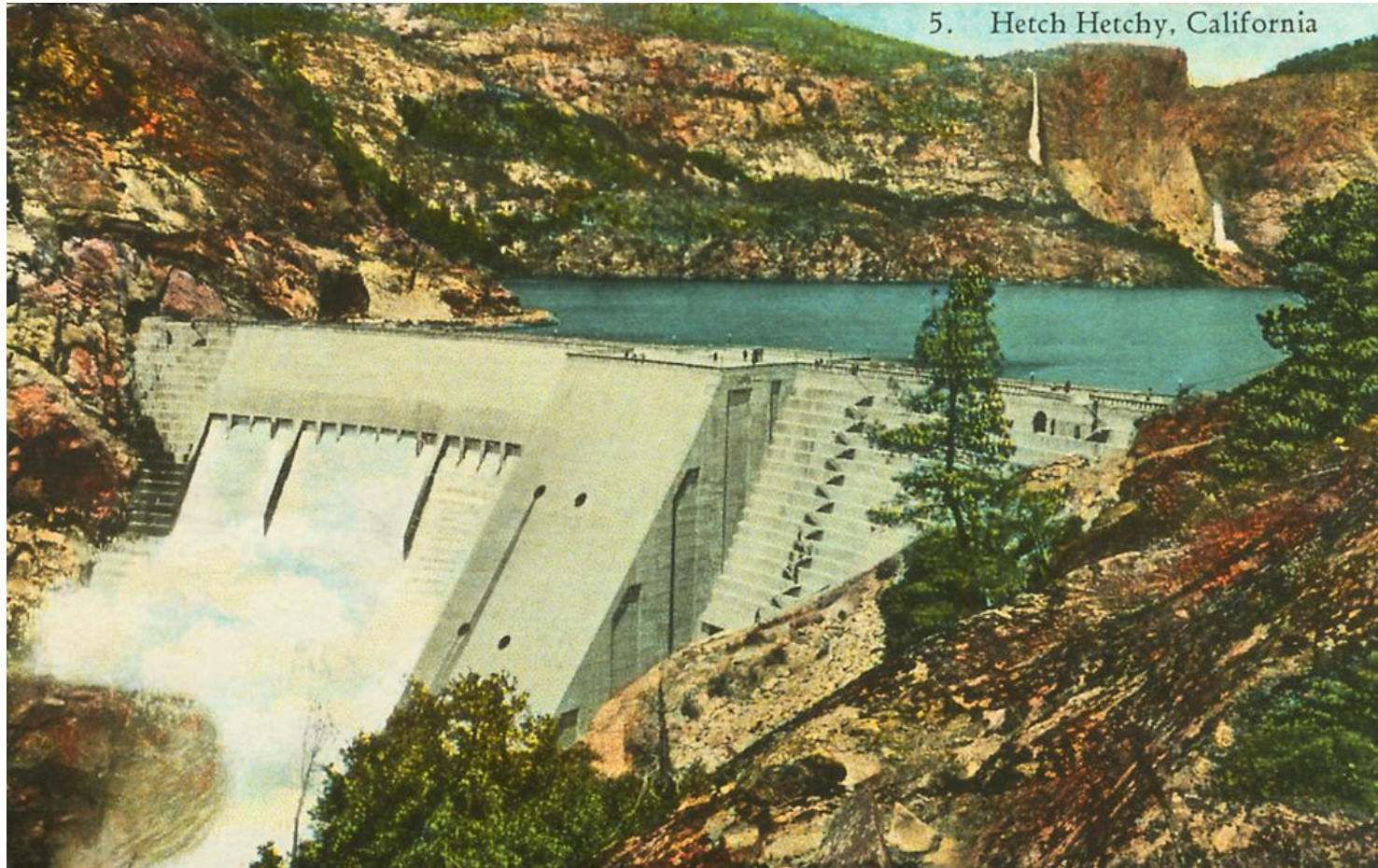
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# Dam Opposition

## Hetch Hetchy Dam 1923



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# Dam Opposition...

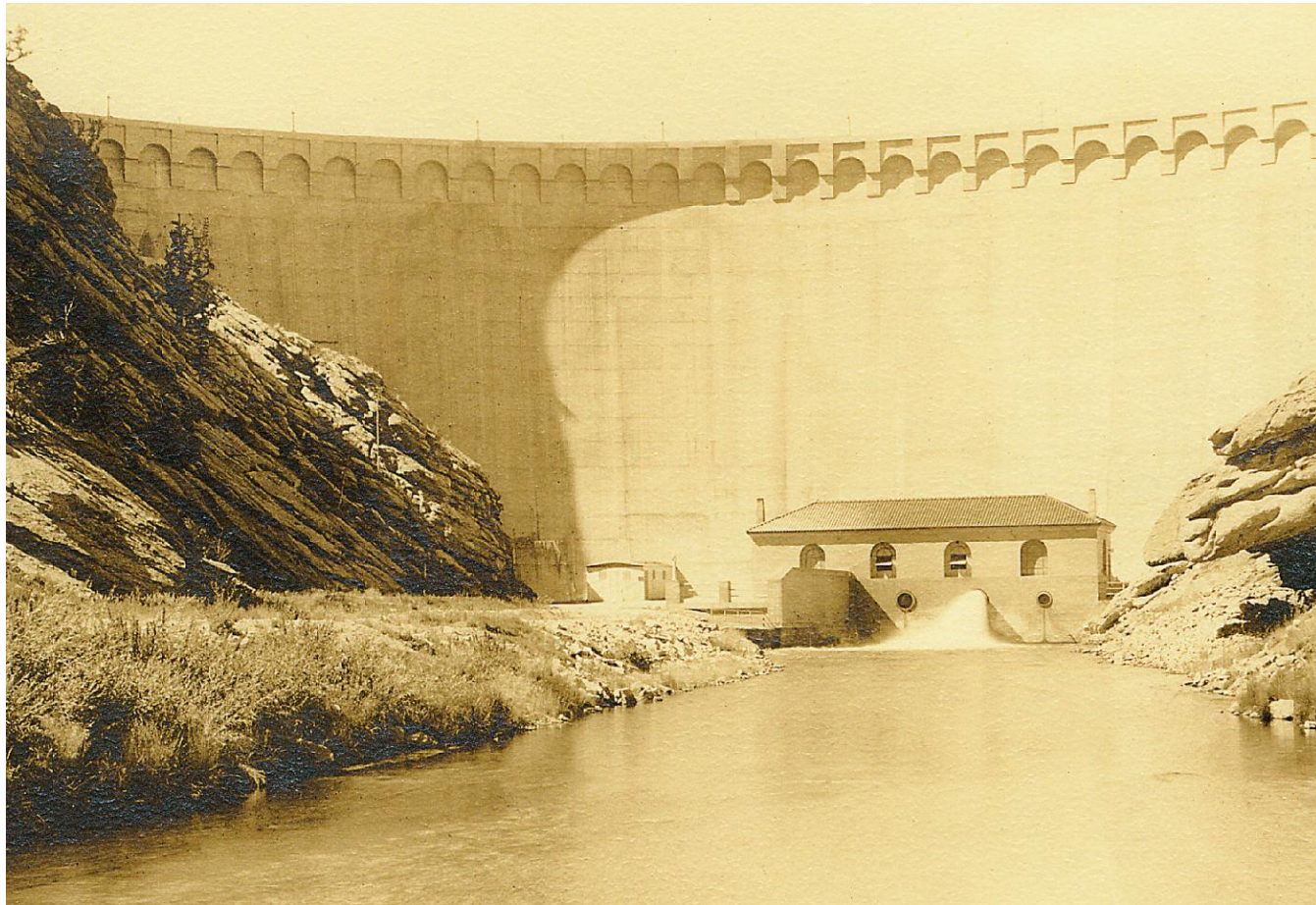
## Hetch Hetchy and Hydroelectric Power





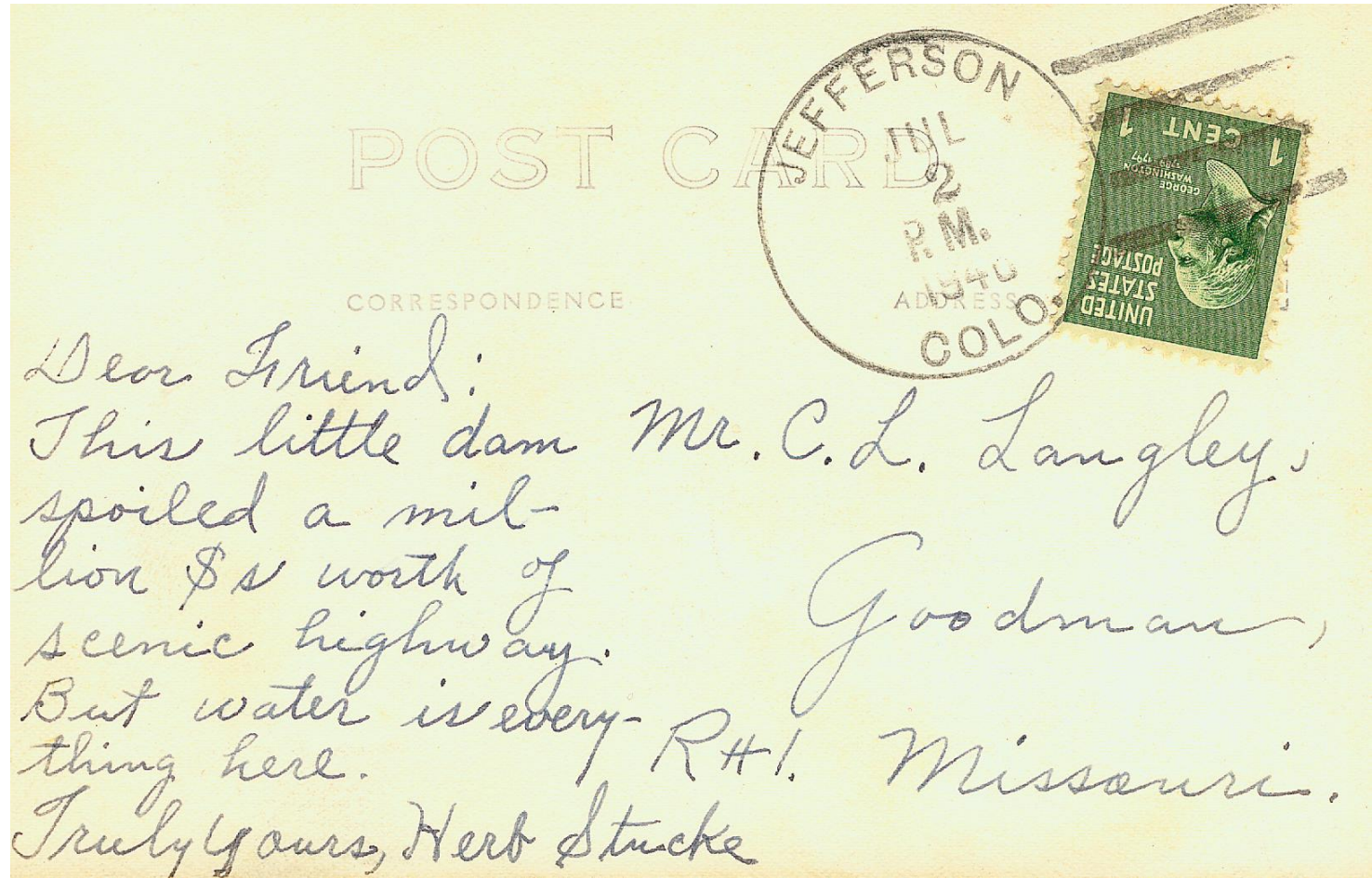
# Dam Opposition...

## **Eleven Mile Dam - Denver Water Supply**



# Dam Opposition...

## Eleven Mile Dam - Denver Water Supply





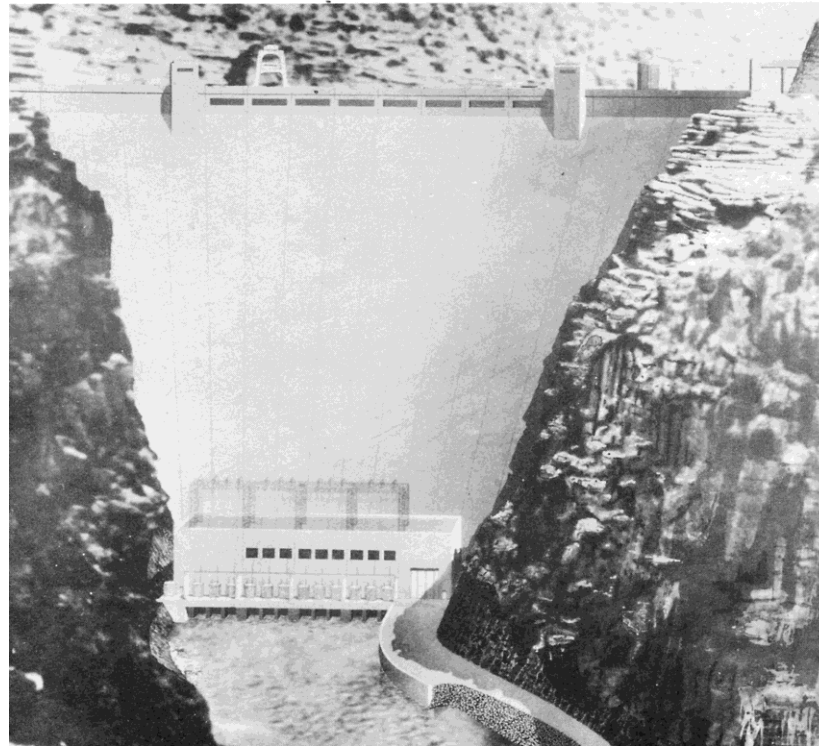
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# Dam Opposition...

## 1940s: A Dam in Dinosaur Natl. Monument?

### *Echo Park Dam*

... Man and Nature Cooperate



# Dam Opposition...

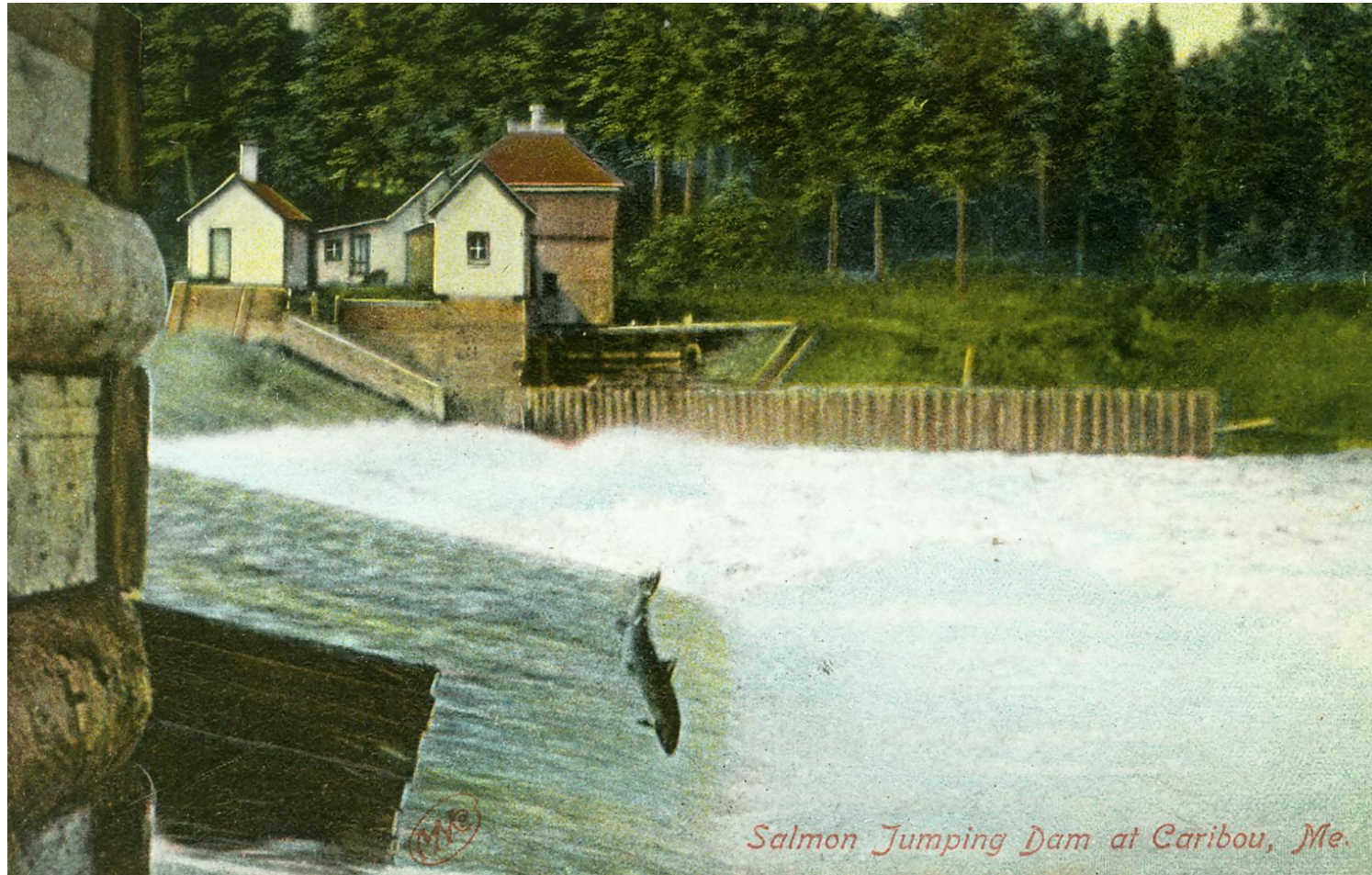
## Echo Park Saved - 1956





# Dams and Fish...

## The effect of dams on spawning fish





# Dams and Fish...

## Lowell: Fish vs. Power

SURDAM & WHITE,

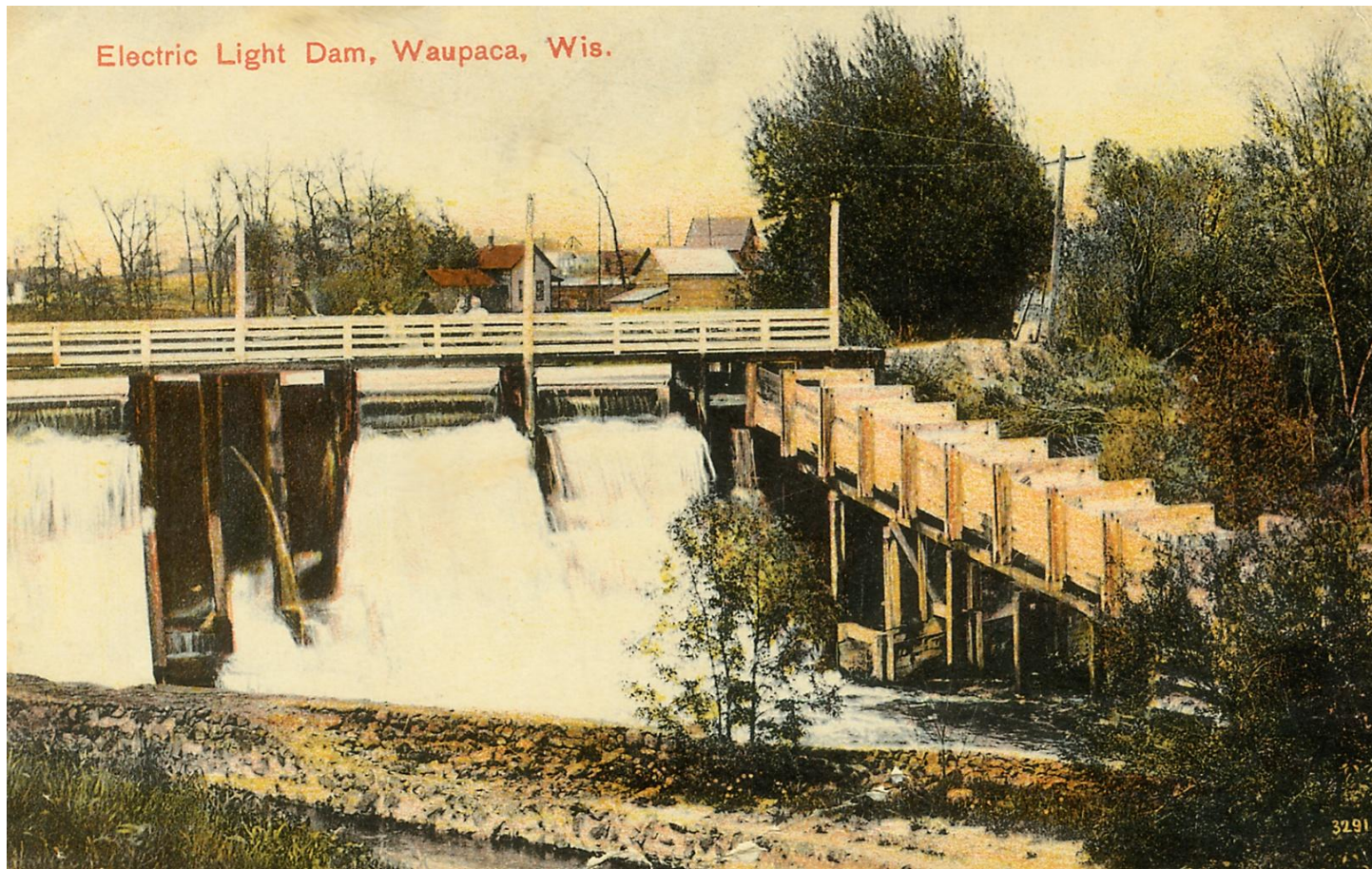


305 BROADWAY, NEW YORK.



# Dams and Fish...

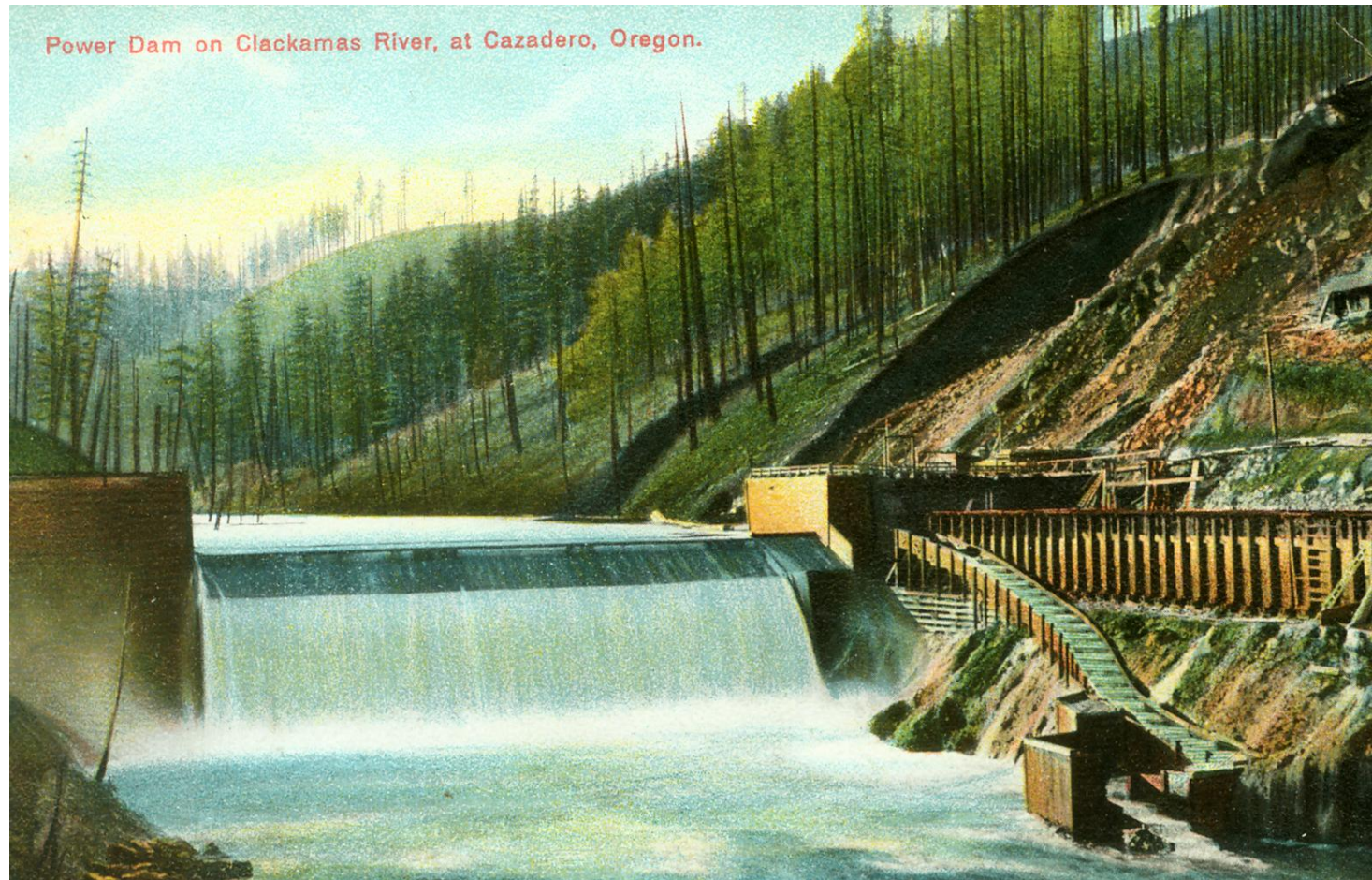
## Fish Ladder - Wisconsin





# Dams and Fish...

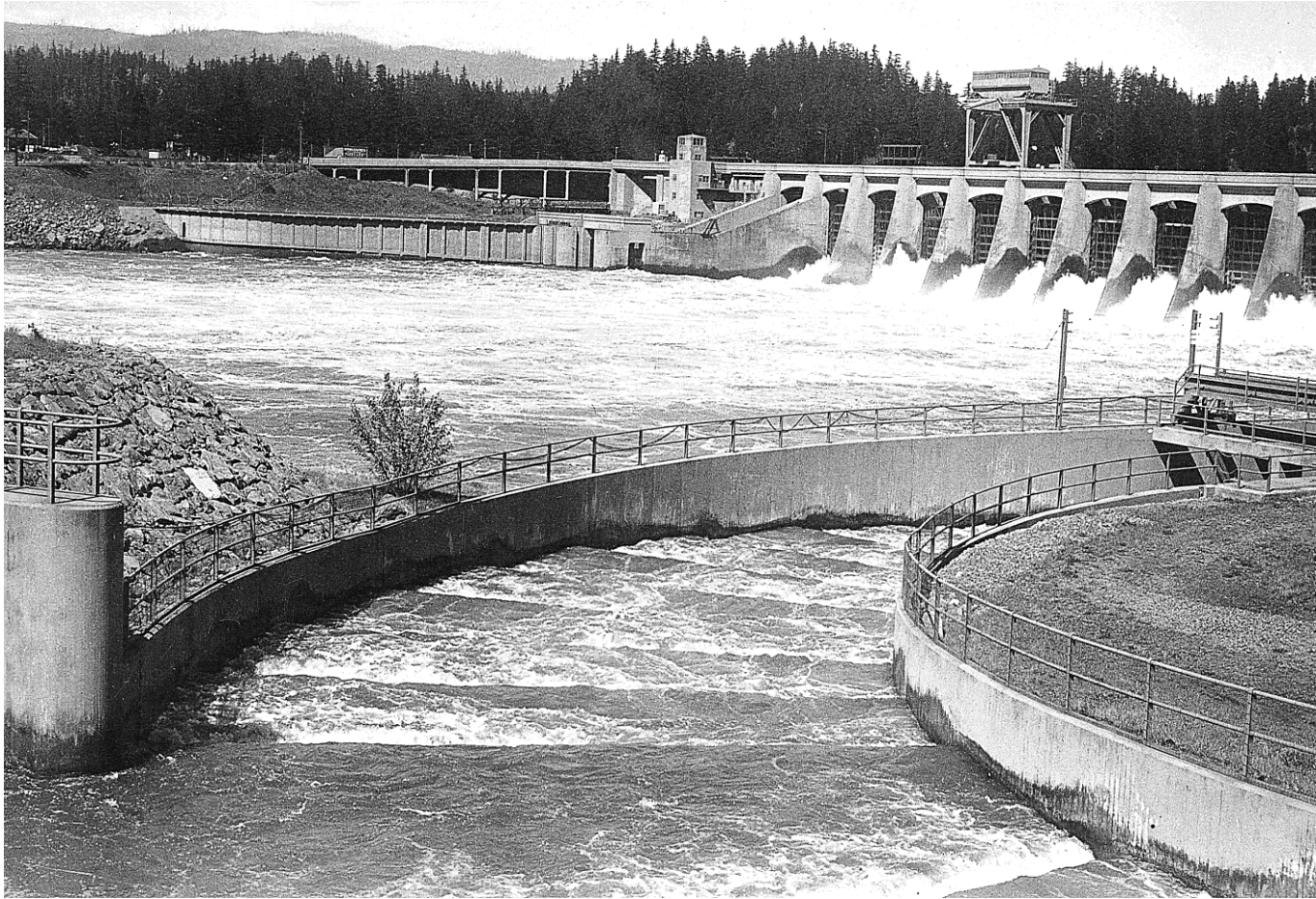
## Fish Ladder – Pacific Northwest





# Dams and Fish...

## Bonneville Dam Fishladders





# Dams and Fish...

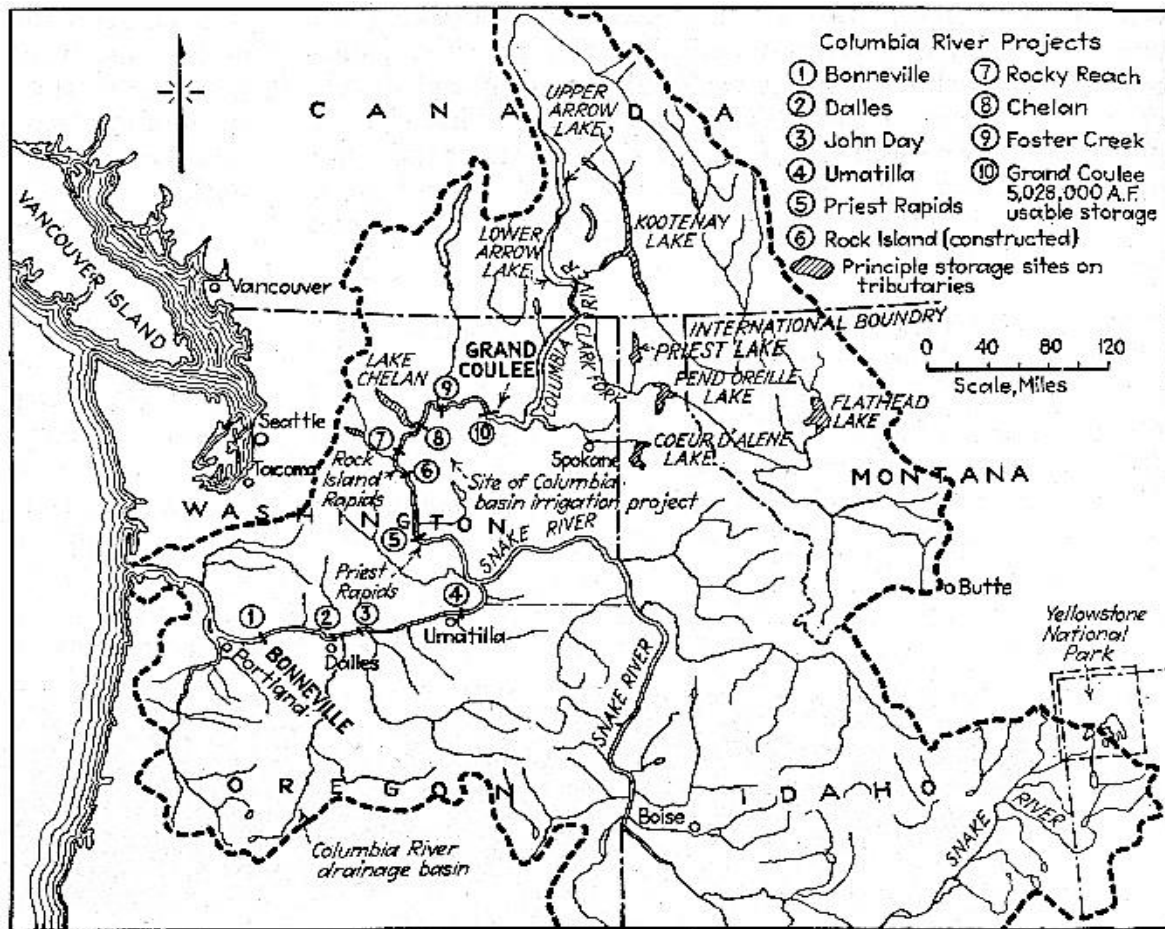
## Bonneville Dam fishladders





# Dams and Fish...

## Columbia River: Filling in the Staircase...



# Dams and Fish...

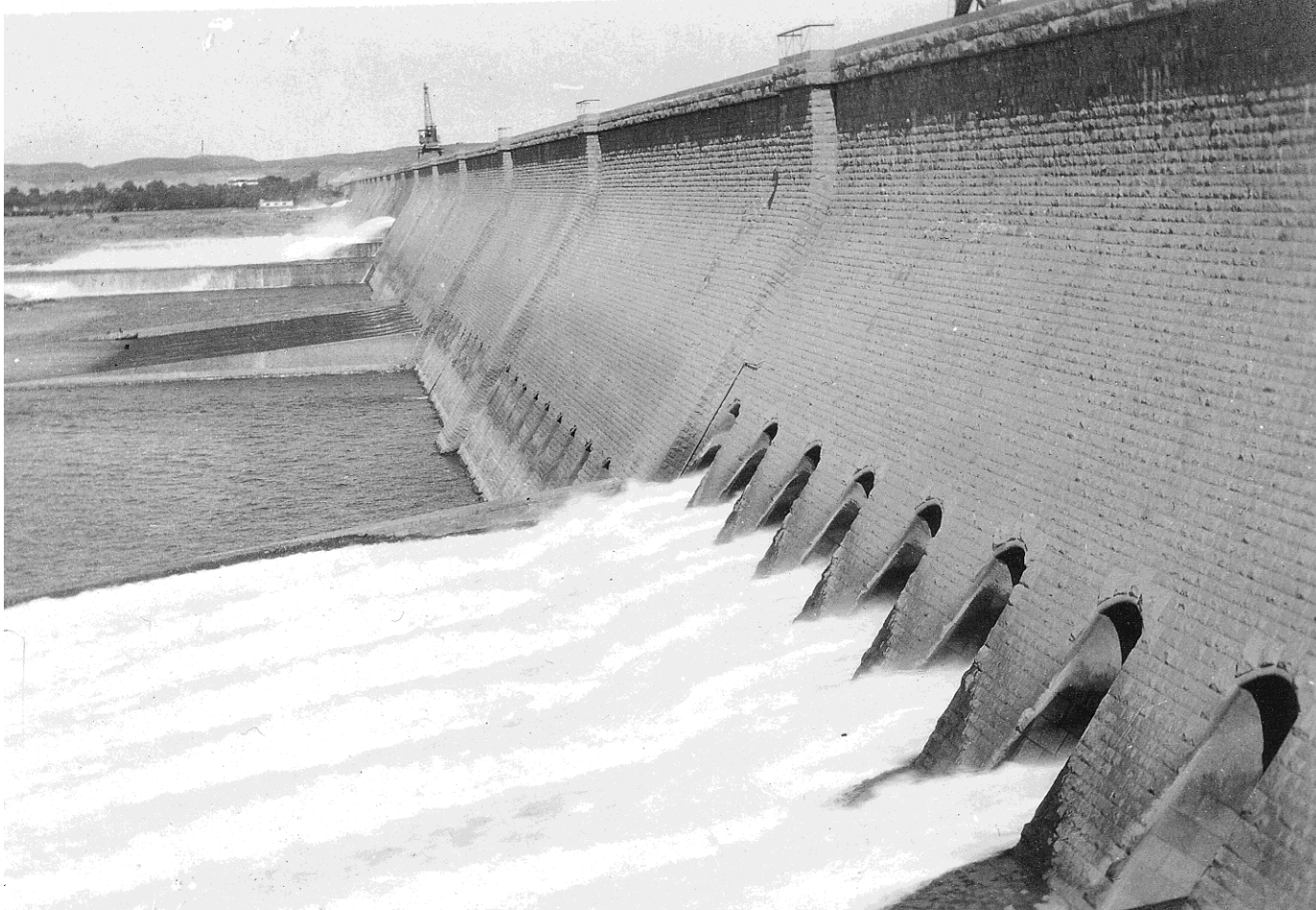
**(Literally) Diminishing returns...**





# Dams and Culture...

## **The Aswan Dam 1908**



# Dams and Culture...

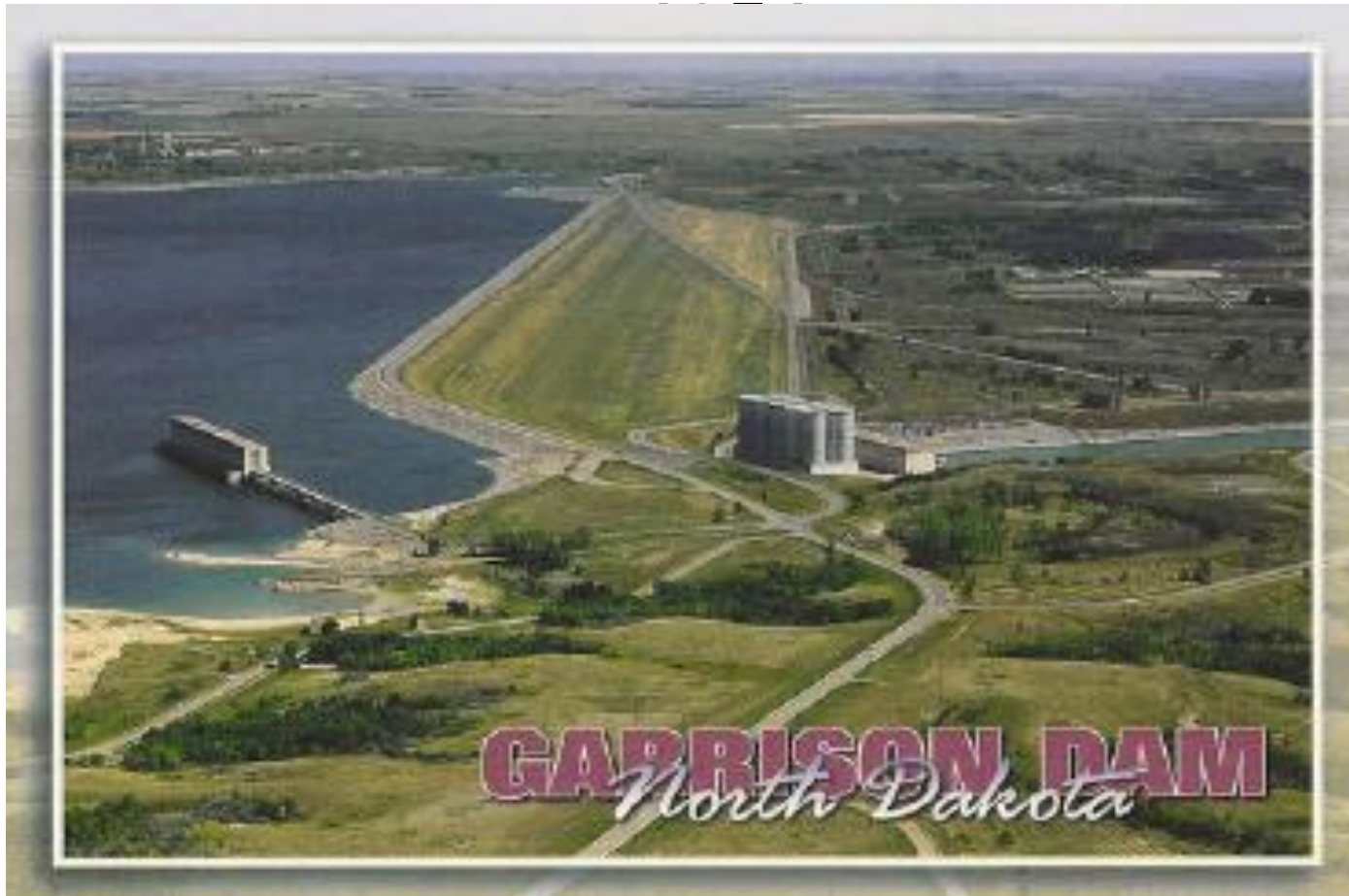
## **Inundation of the Upper Nile basin**





# Dams and Culture...

## Garrison Dam across the Missouri River



---

# Dams and Culture...

## Garrison Dam floods the Three Affiliated Tribes





# Dams and Culture...

**“Not for Man, but for Some Men...”**



---

# Dams and Culture...

## **Columbia River: Celilo Falls**





# Dams and Culture...

## **Dalles Dam Drowns Celilo Falls 1957**



# Dam Opposition...

## **“Grand Canyon Dams” - 1963-68**





---

# Dam Opposition...

## **Operational Issues – Glen Canyon Dam**



# Dam Opposition...

**1980s - Glen Canyon Dam and River “Surge”**





---

# Dam Opposition...

## **Humpback Chub & Grand Canyon Ecology**



---

The Dam Removal Movement

# **Dams and Ecology**

Cultural Sustainability

&

Environmental Sustainability

# **The Dam Removal Movement**

---



# The Dam Removal Movement

## 1990s - An Era of Cheap Energy



---

# The Dam Removal Movement

## **Small Hydropower Loses \$\$\$ Value**

**In a world of 1,000+ MW power plants,  
why worry about 3 MW facilities?**





# The Dam Removal Movement

## Edwards Dam – Kennebec River, Maine





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# The Dam Removal Movement

## Edwards Dam – Removed 1998





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# The Dam Removal Movement

## FERC Approved – In Stream Use



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# The Dam Removal Movement

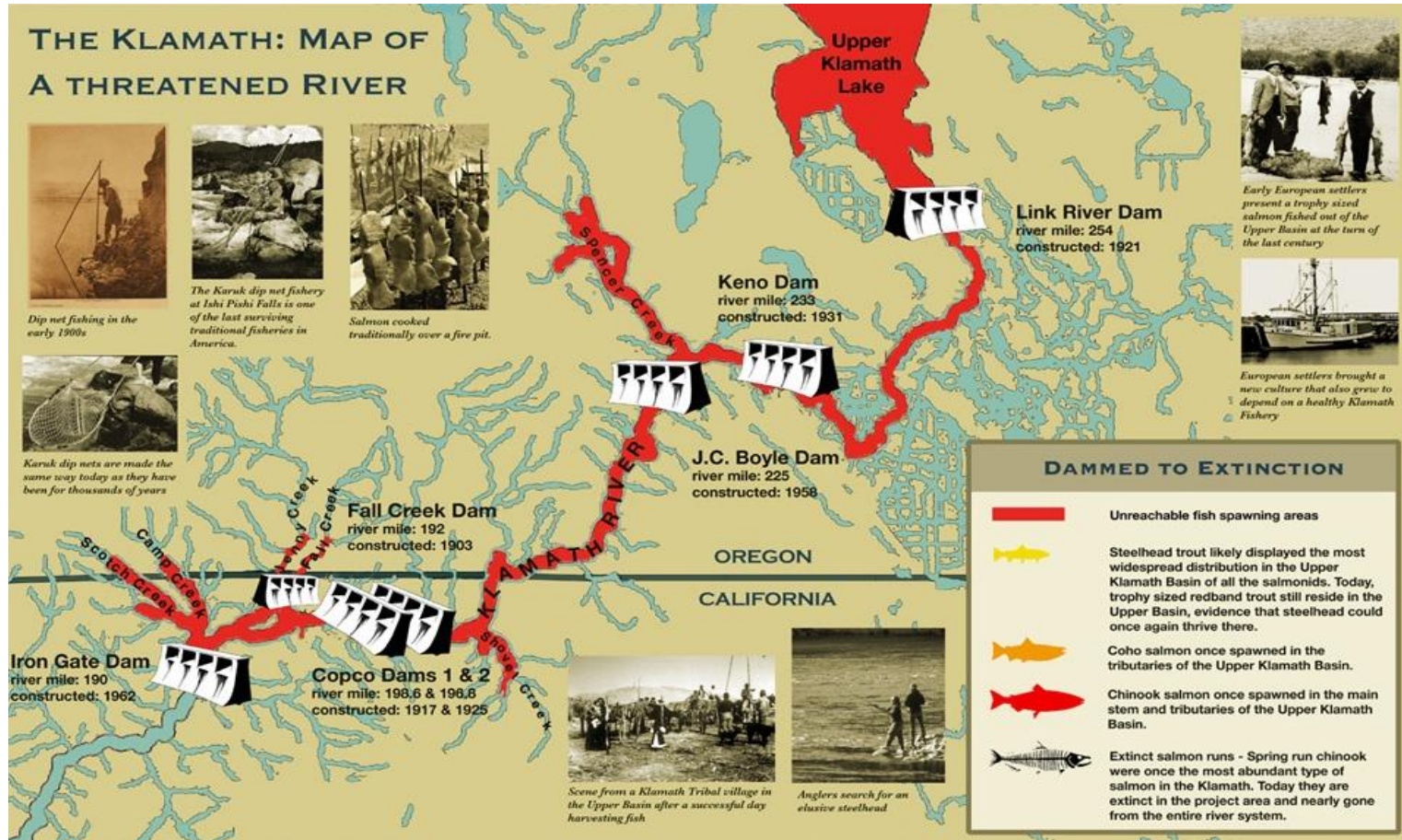
Raising the Stakes: Marmot Dam - Avg. 13MW





# Dam Removal Today...

## Copco's Klamath Hydropower Dams



---

# Dam Removal Today...

## The Klamath River

263 miles long – Avg. discharge 17,000 cfs





---

# Dam Removal Today...

## Copco Dam #1 (1918)



---

# Dam Removal Today...

## **The Power Capacity of the COPCO Dams**

**JC Boyle Dam: ~80 MW**

**Copco 1 Dam: ~20 MW**

**Copco 2 Dam: ~20 MW**

**Irongate Dam: ~17 MW**

**TOTAL: ~137 Megawatts**

---



---

# Dam Removal Today...

**Power Supply Capacity of California:  
~53,000 MW**

**Available Capacity: ~47,000 MW (give or take)**

**137 MW seems minuscule in this light**

**But regional power demand is also large  
When demand surges and blackouts loom**

**137 MW is far from insignificant**

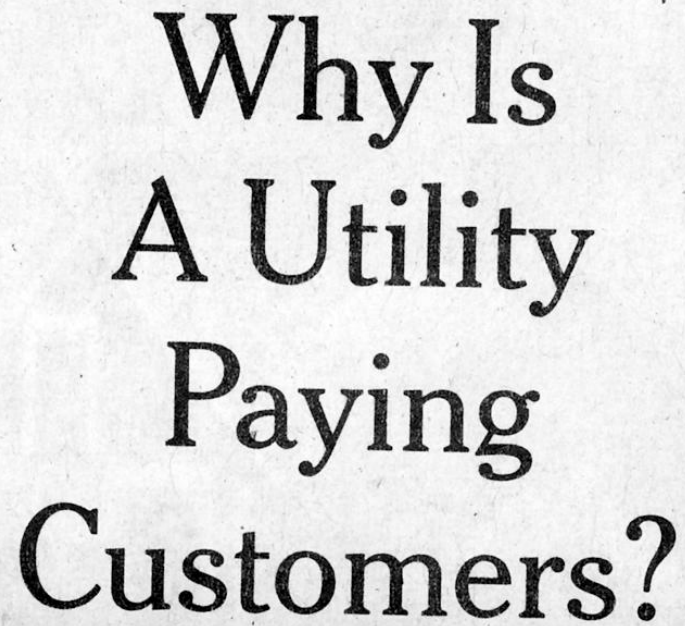
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# Power Grid Realities...

## **A Context: Idaho Power Company's Program to Meet Peak Load**

***NYTimes Business section 1/24/2010***



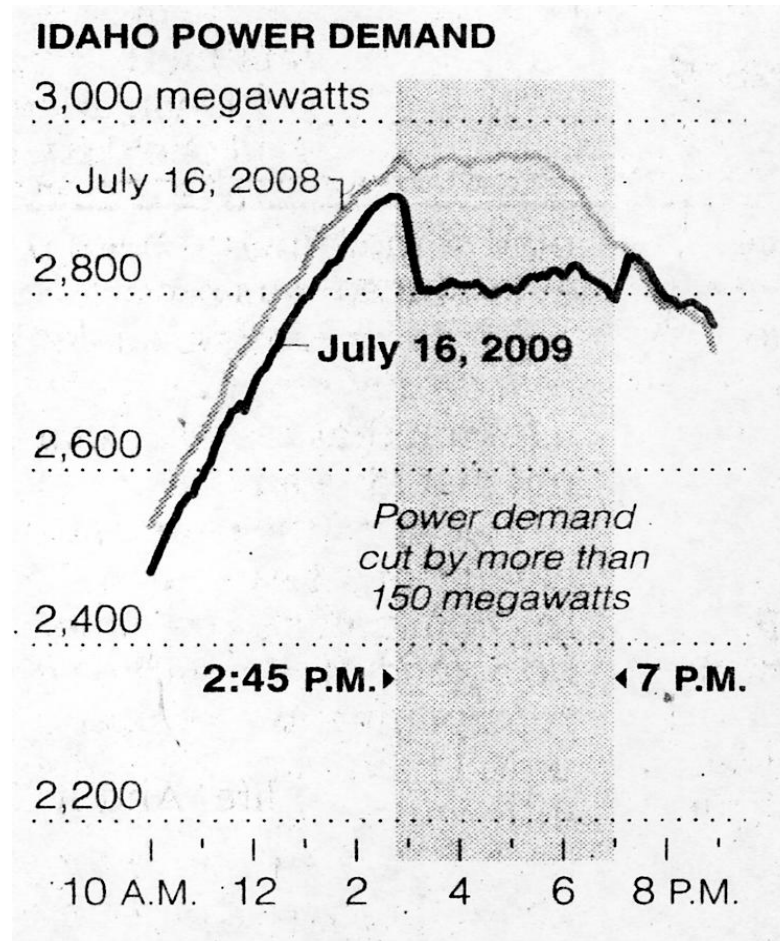
Why Is  
A Utility  
Paying  
Customers?

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# Power Grid Realities...

## Paying to Meet Peak Load



# Dams Water Energy...

## Questions and Comments





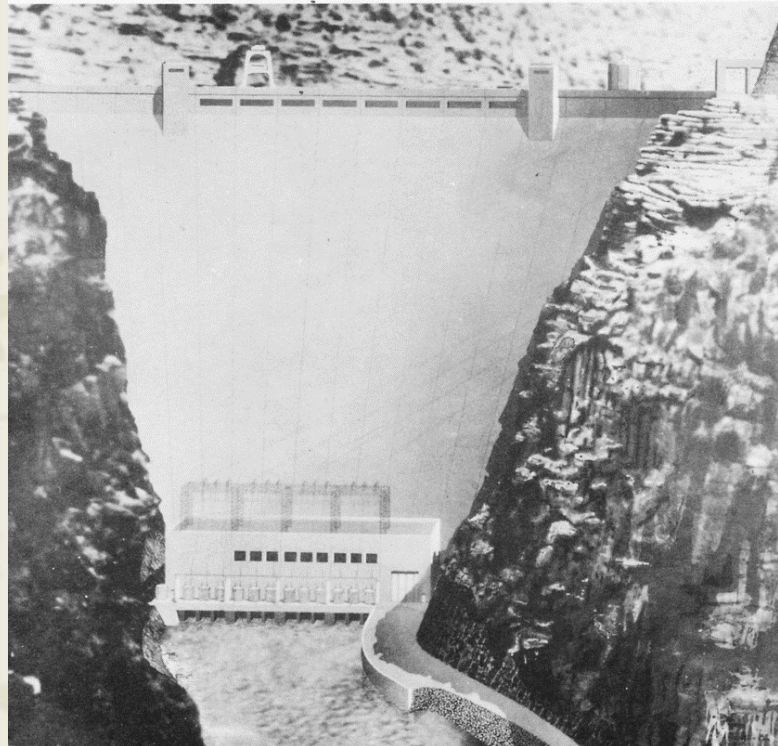






## *Echo Park Dam*

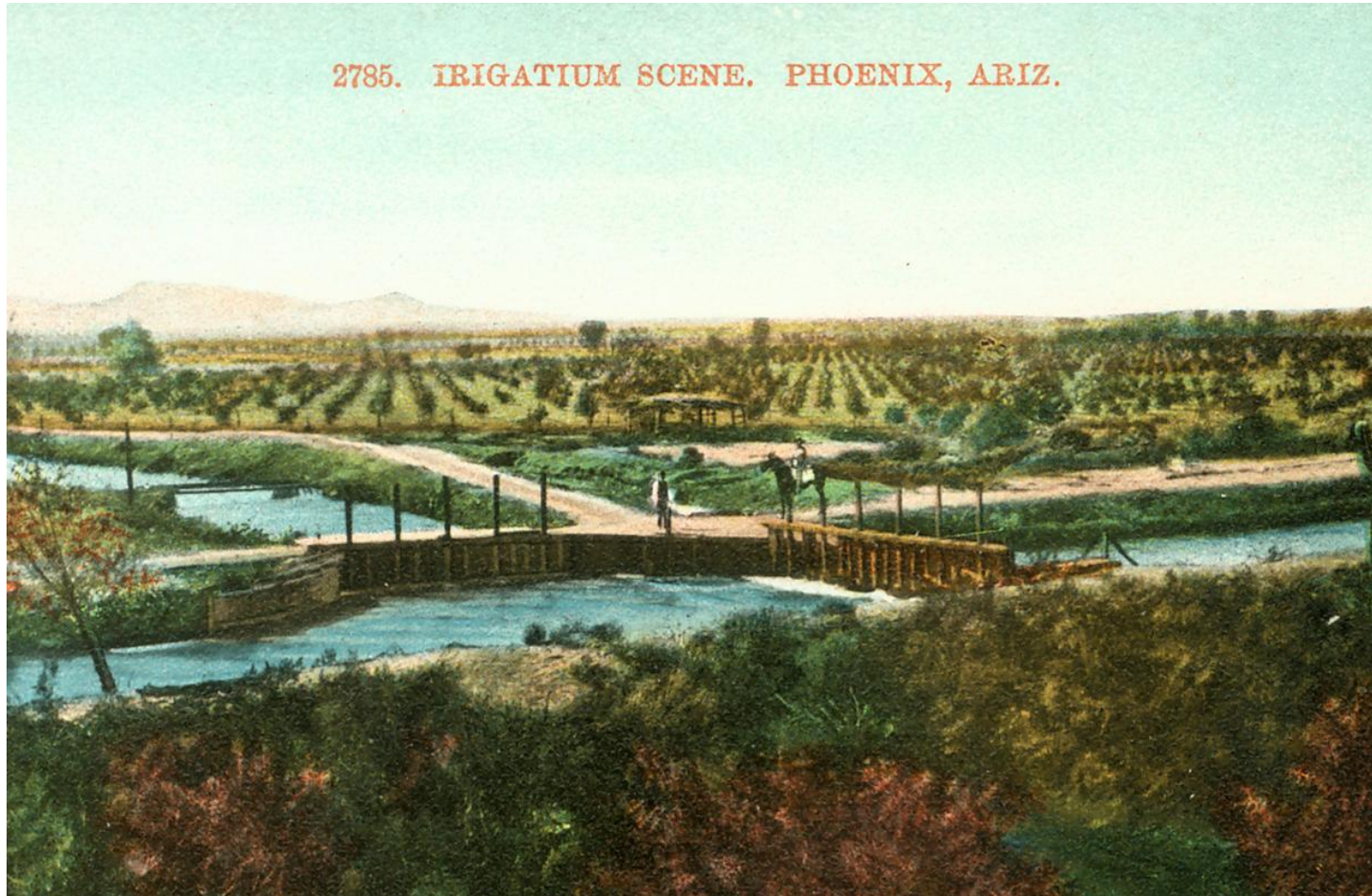
... Man and Nature Cooperate



**Anti-Dam Reaction – Echo Park, Dinosaur Natl. Mon.  
1948-1956**

# Dam (History) and the Environment...

## Irrigation: Making the Desert Bloom





---

# Dams and the Environment...

**Britain's Lake District controversy 1870s**  
**Lake Thirlmere as municipal reservoir**



# Dams and Fish...

The effect of dams on spawning fish





---

# Dams and Culture...

## The Swift River Valley: Western Mass



# Dams and Culture...

## Boston's Quabbin Reservoir/Dam 1940





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# Dams and Culture...

## The Quabbin Reservoir



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# Dams and Hydroelectricity...

## **SJEC's 2.5 MW Powerhouse 1896**





---

# The Dam Removal Movement

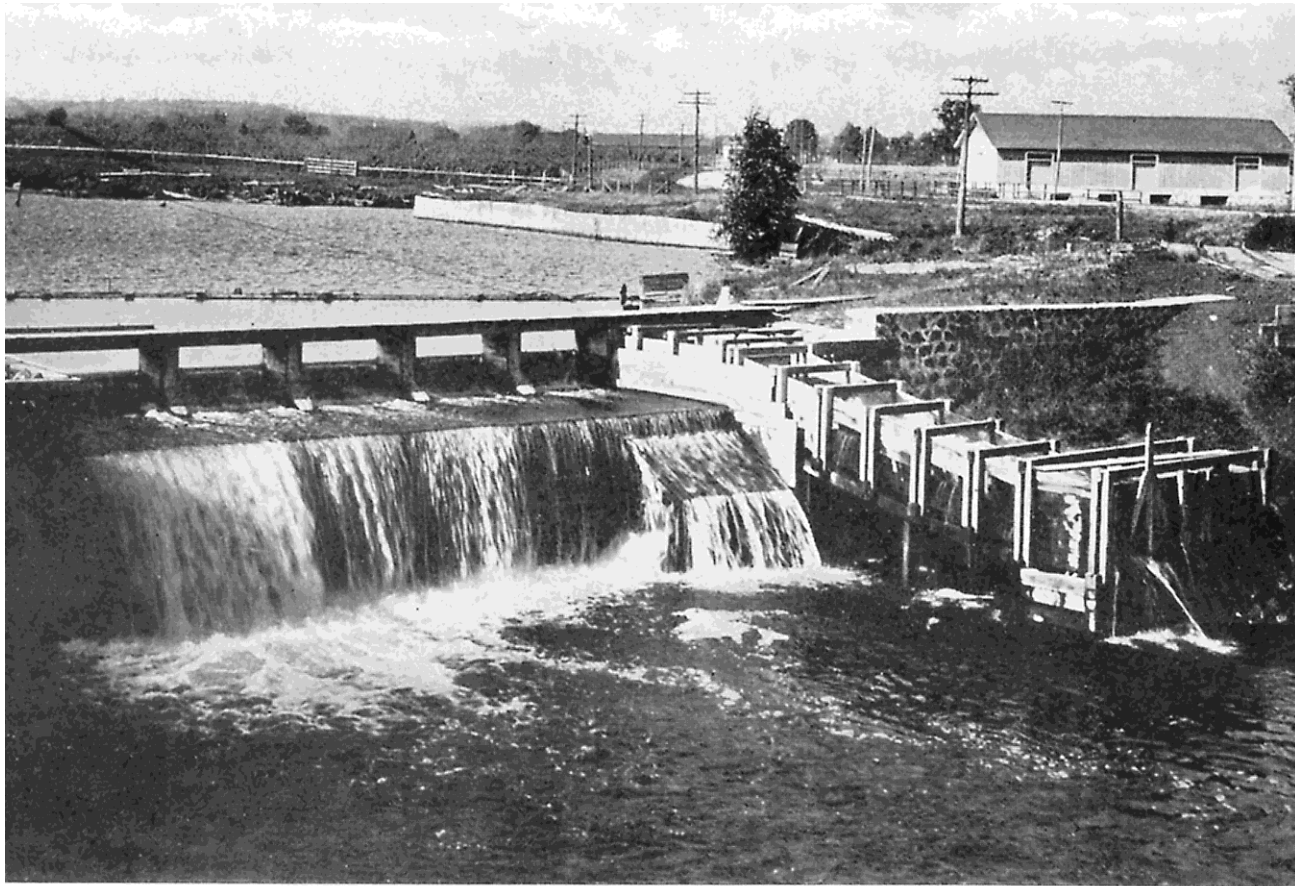
Milltown Dam, Montana: 1.5 MW 1908



---

# Dams and Fish...

## Dams and fish ladders – Wisconsin



Dam and Fish Way, Weyauwega, Wis.

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# The Dam Removal Movement

Glen Canyon Dam mitigation – 1992...



# The Klamath River Watershed

## The Klamath River

Along the California/Oregon borderland





---

# The Dam Removal Movement

## Grand Canyon's Humpback Chub



# The Klamath and COPCO

Copco 1 designed by Hermann Schussler  
engineer for SF's Crystal Springs Dam (1888)





---

# The Klamath and COPCO

## J. C. Boyle Dam (1958)



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# The Dam Removal Movement

Large Initiatives/Hopes: Lower Snake River





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# The Dam Removal Movement

## Large Initiatives/Hopes: Hetch Hetchy



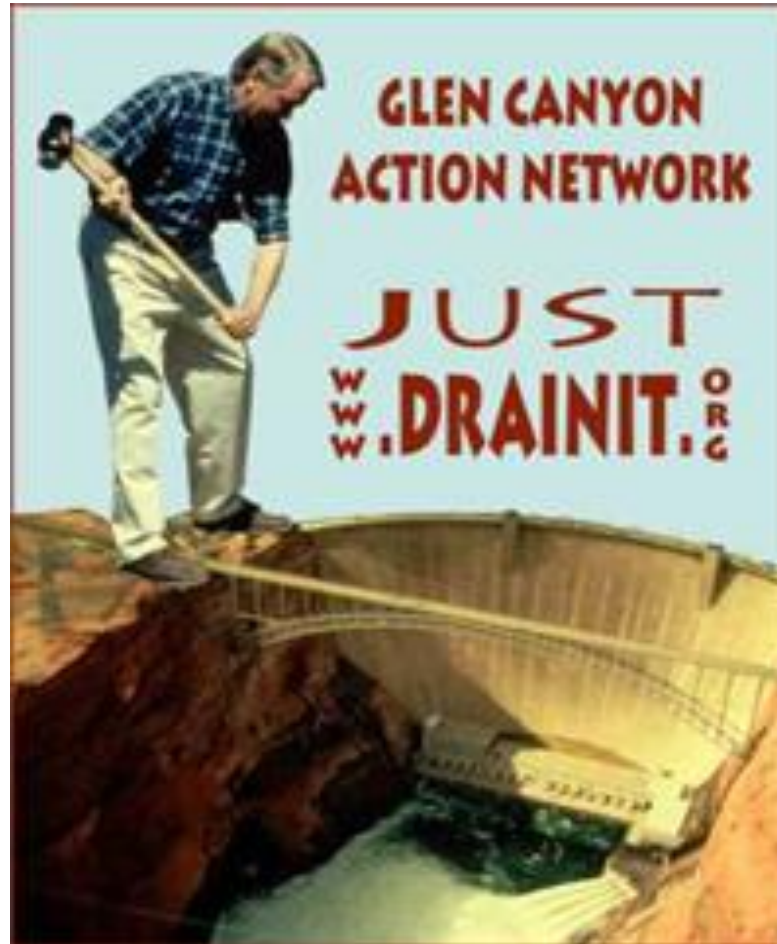
**RESTORE HETCH HETCHY**

YOSEMITE NATIONAL PARK

---

# The Dam Removal Movement

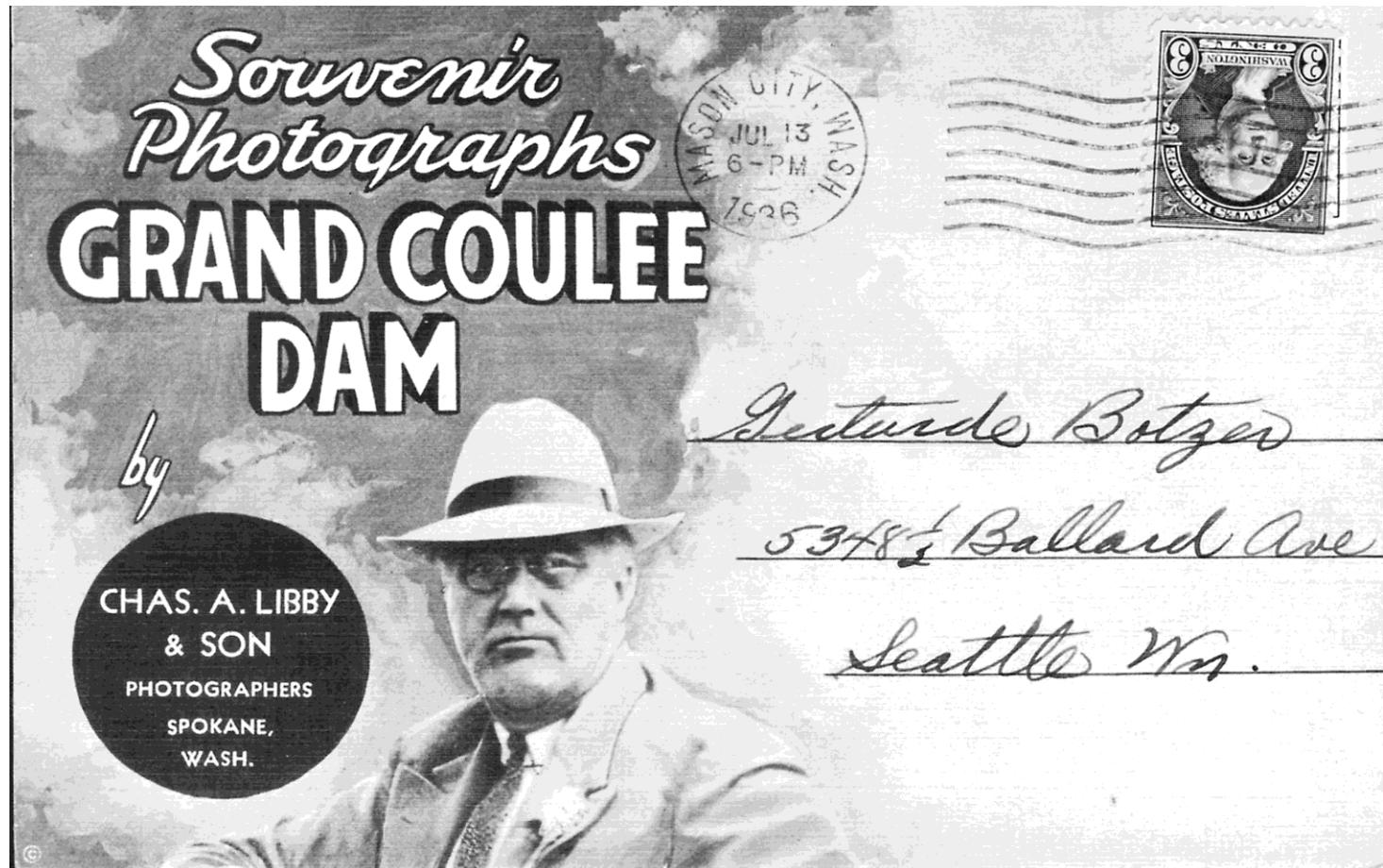
## Large Initiatives/Hopes: Glen Canyon





# Dams and Hydroelectricity...

## FDR and “New Deal” Dams: Grand Coulee



# Dams and Hydroelectricity...

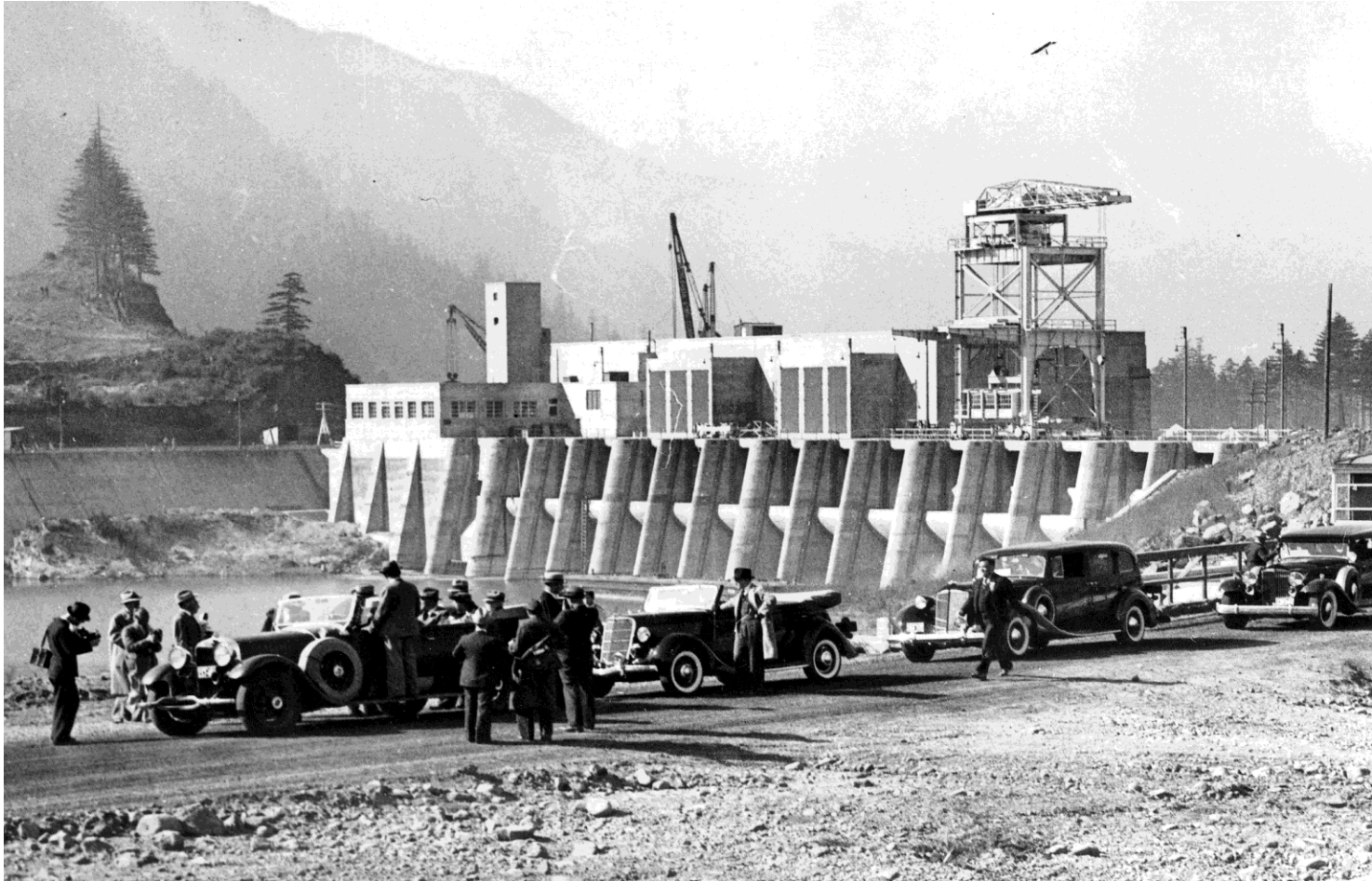
## FDR's "New Deal" Dams: Grand Coulee 1937





# Dams and Hydroelectricity...

## FDR's "New Deal" Dams: Bonneville 1937



# Dams and Hydroelectricity...

FDR and “Boulder Dam” 1935





---

# The Dam Removal Movement

Glen Canyon Dam surge mitigation – 1992



---

# Dams and Hydroelectricity...

**“Go-Go” with the Army Corps: Pine Flat 1954**







2013  
Rock Mountain  
Energy Summit

# Pastoral & Monumental

25th Annual Energy Summit Conference  
Presented by the Colorado Oil & Gas Association  
August 5-8, 2013



**Anti-Dam Reaction – Glen Canyon Dam, 1957-64**

---

# The Klamath and COPCO

## Irongate Dam (1962)





# The Klamath and COPCO

## J. C. Boyle Dam and Penstock (1958)



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# The Klamath and COPCO

## Copco Dam # 2 (1925)





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# Dam Removal along the Klamath...

## **The Klamath River**



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# The Dam Removal Movement

## Edwards Dam Removal 1998





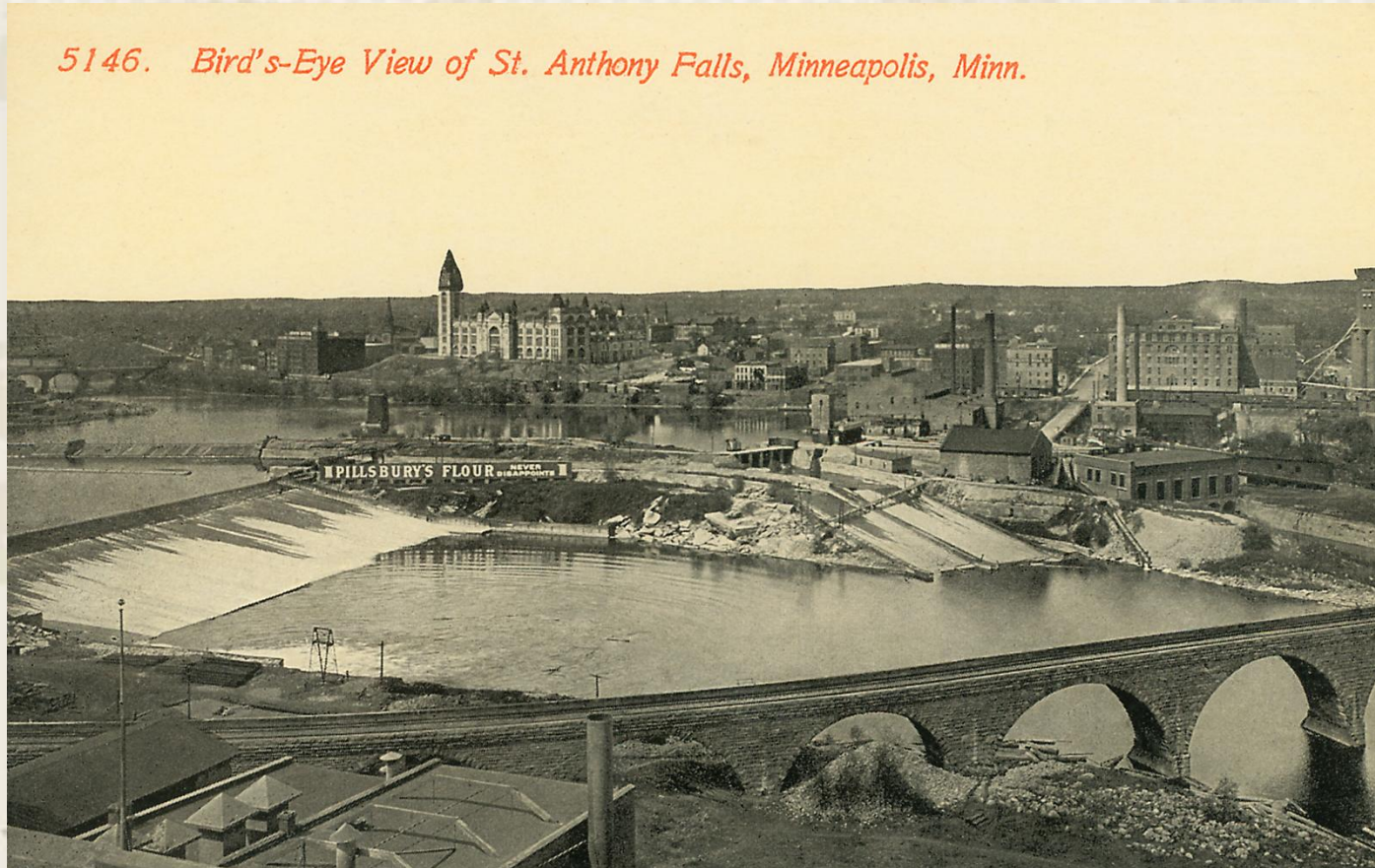
# Dams and the Environment...

## Mill Dam Heritage: Britain





*5146. Bird's-Eye View of St. Anthony Falls, Minneapolis, Minn.*

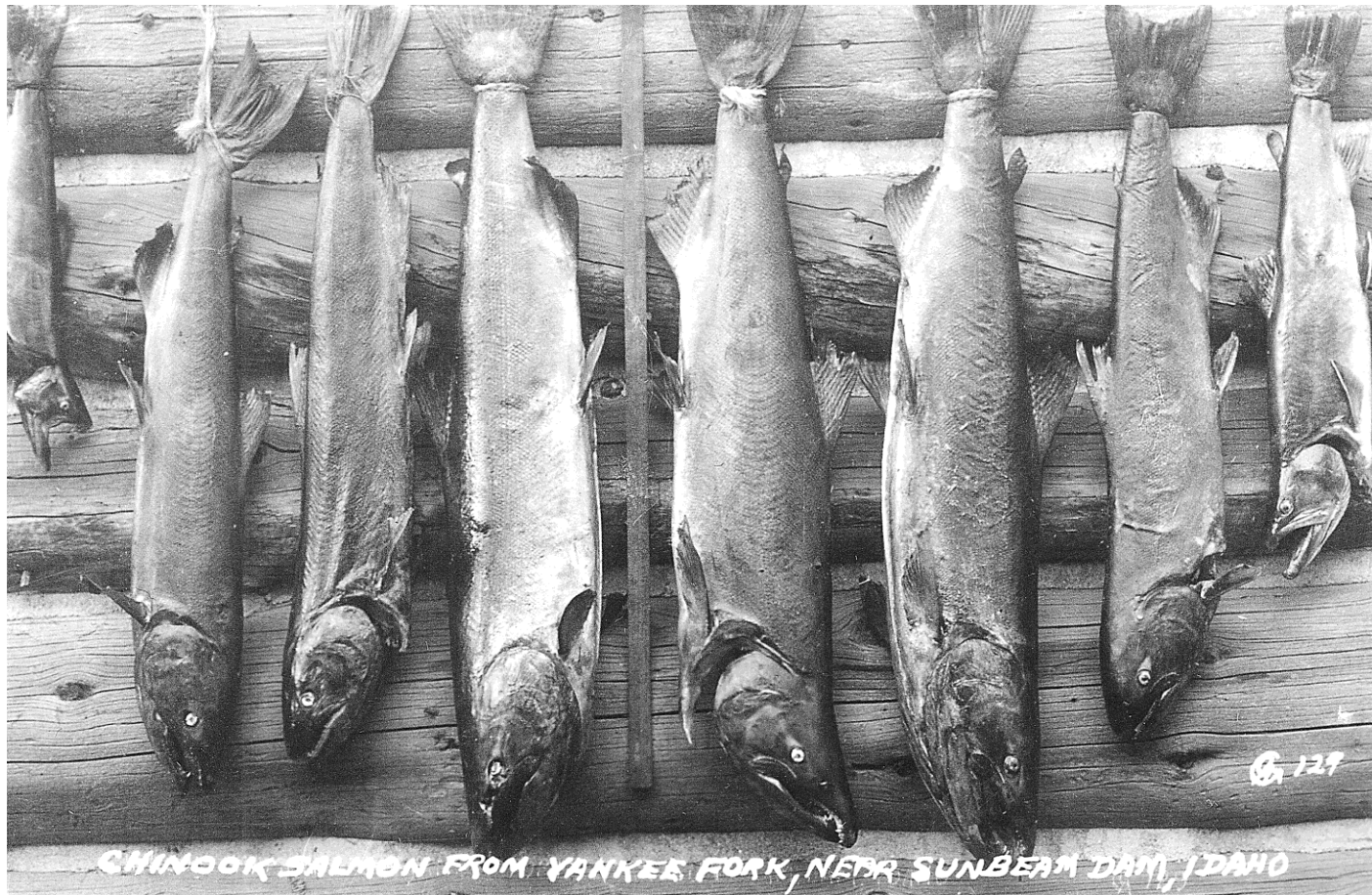


**Mississippi River Water Power – Minneapolis/St. Paul**



# The Dam Removal Movement

Sunbeam Dam, Idaho – Good Fishing...





# Dams and Hydroelectricity...

## 30 MW Big Creek No. 1 - 1913

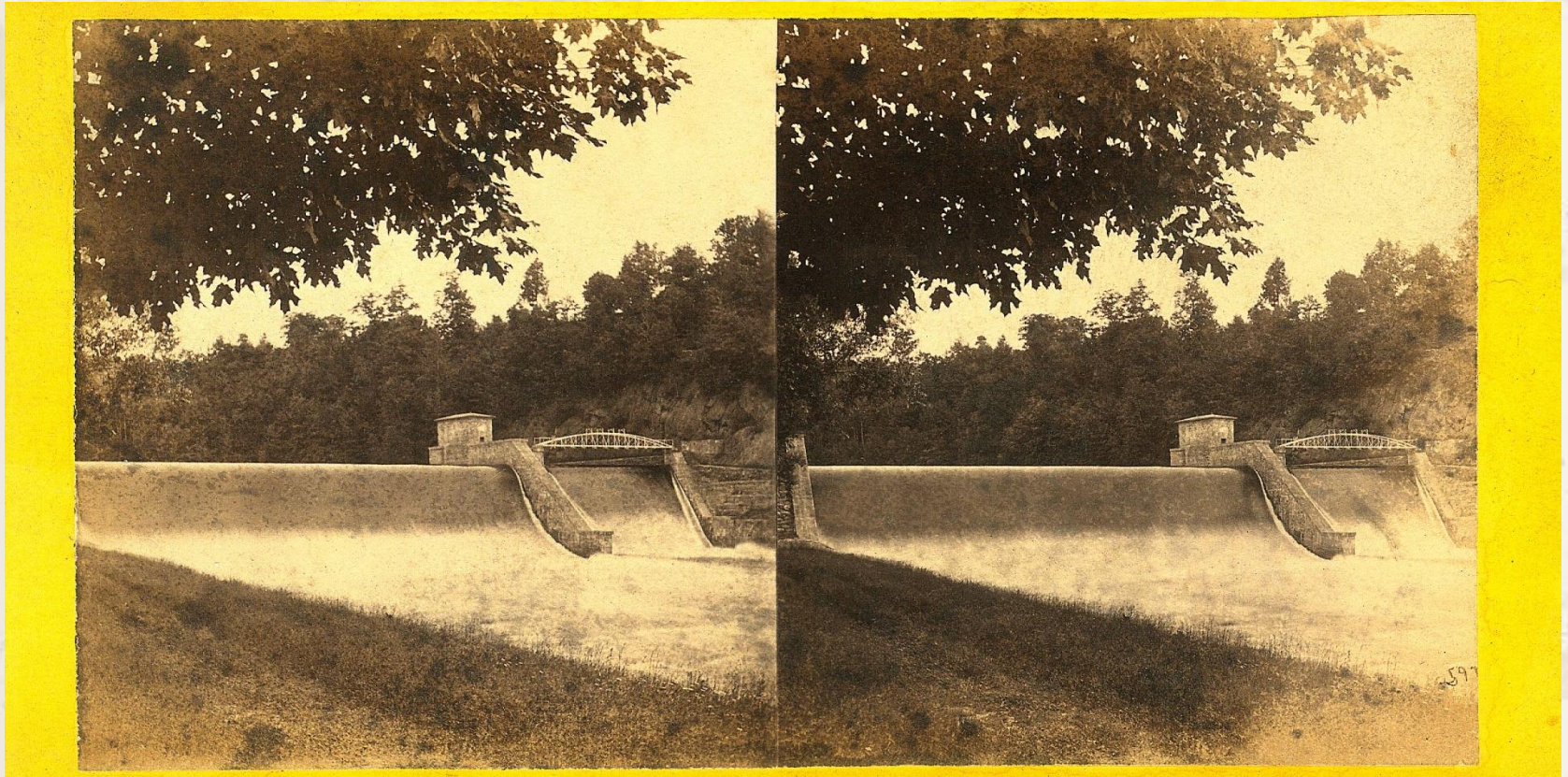




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# Dams Water Energy...

**D**



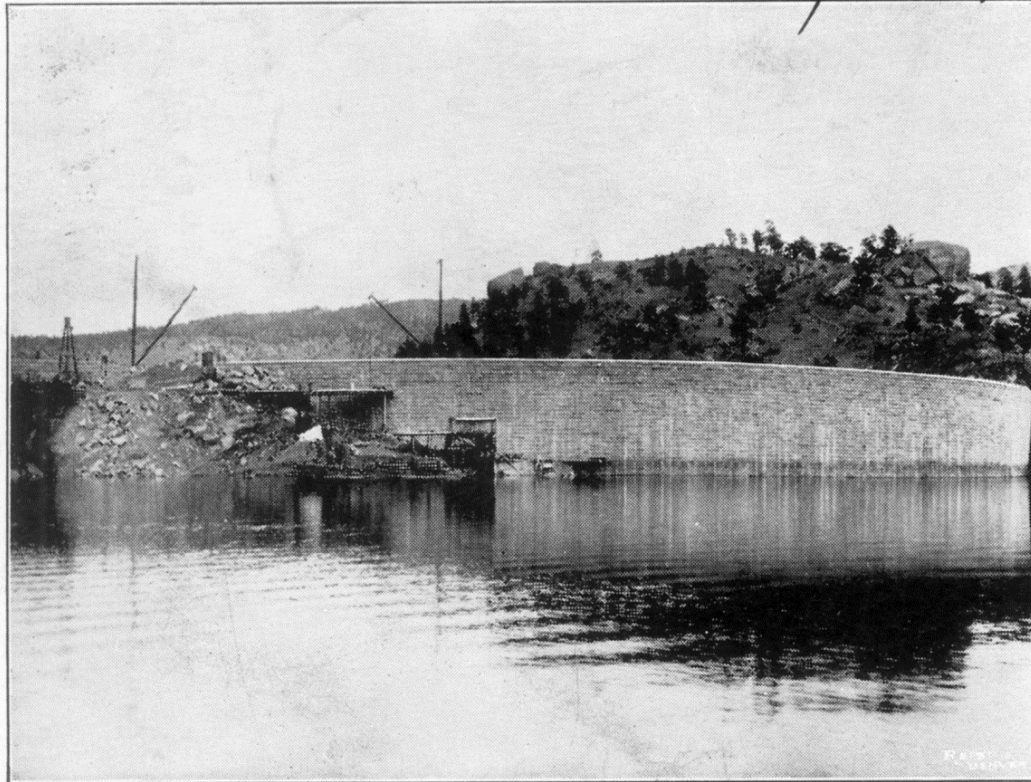
**Monumental Storage Dams – NYC's Croton  
Dam 1842**





**Monumental Dam – SF's San Mateo/Spring Valley Dam, 1886**





Aug 2-07. This, now  
completed, is  
where Denver  
gets its water  
supply.  
A friend and  
I are spending  
a week near  
by - at Buffalo  
Park. Mabel.

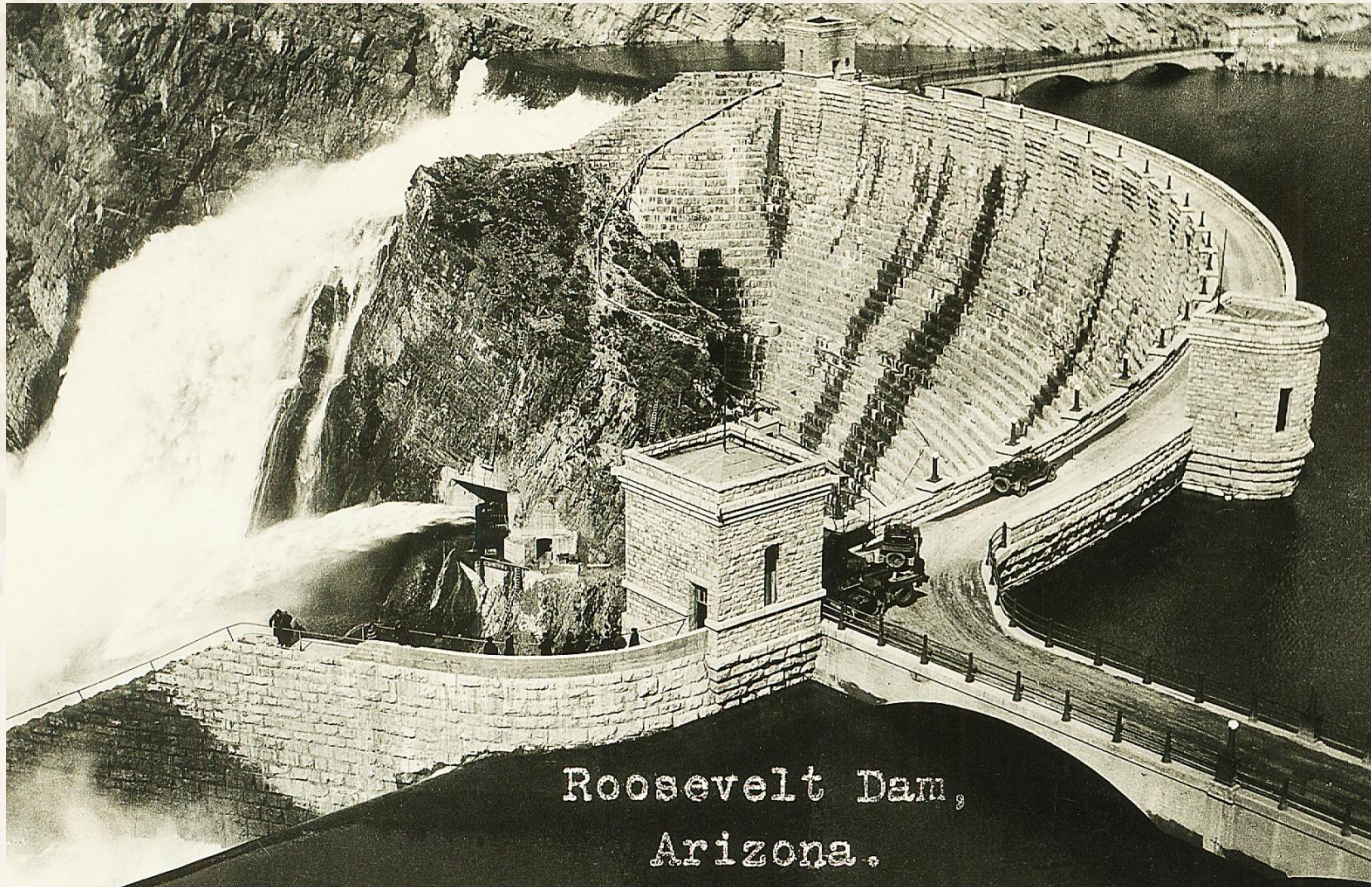
Highest in the World

Cheesman Dam.

217 Feet High

**Monumental Dam – Denver's Cheesman Dam,  
1904**





**Monumental Dam – U.S. Reclamation Service, Roosevelt Dam, 1911**





# Pastoral & Monumental



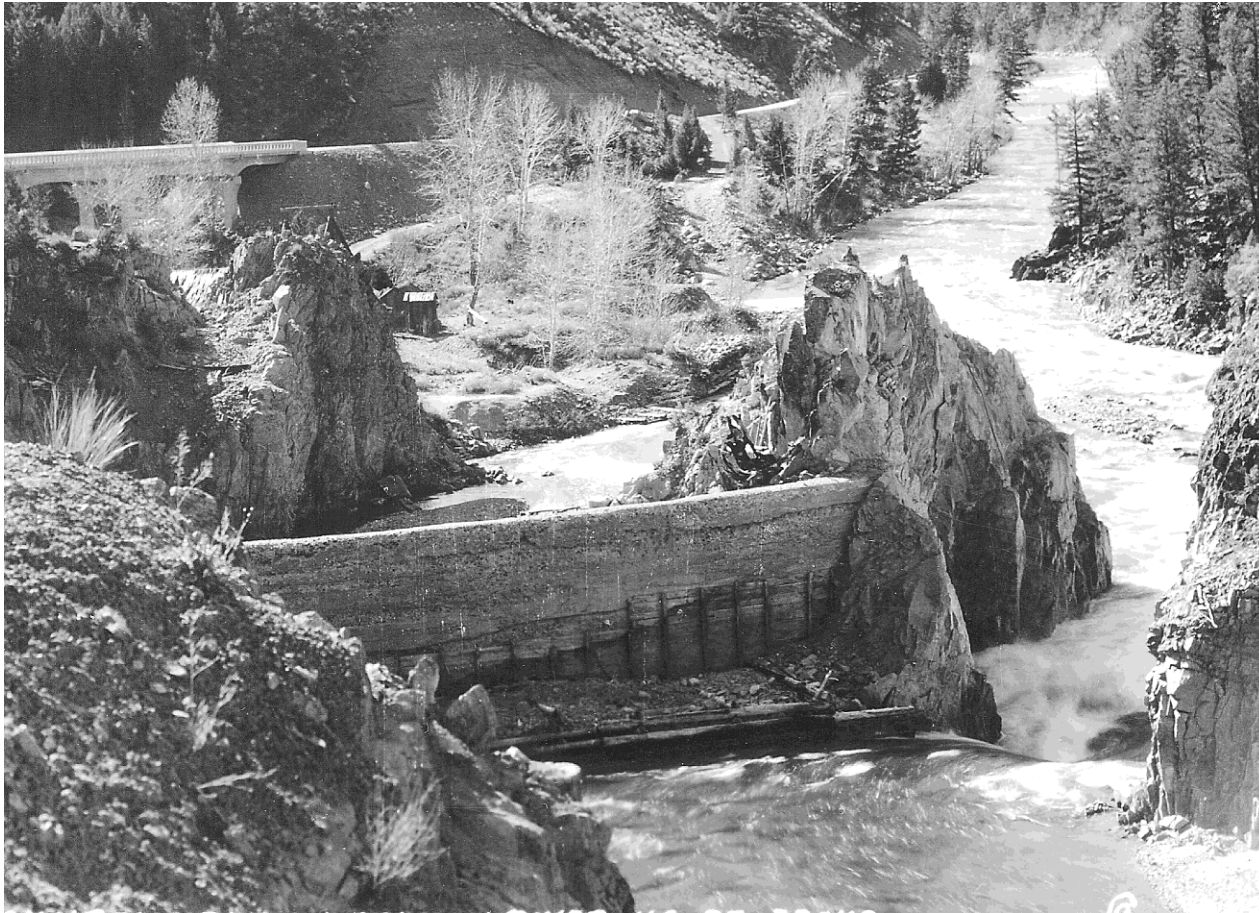
**Monumental Dam – U.S. Reclamation Service, Elephant Butte**



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# The Dam Removal Movement

Sunbeam Dam, Idaho – Breached 1934



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# Dams and the Environment...

## **NYC Municipal Supply: New Croton Dam 1907**





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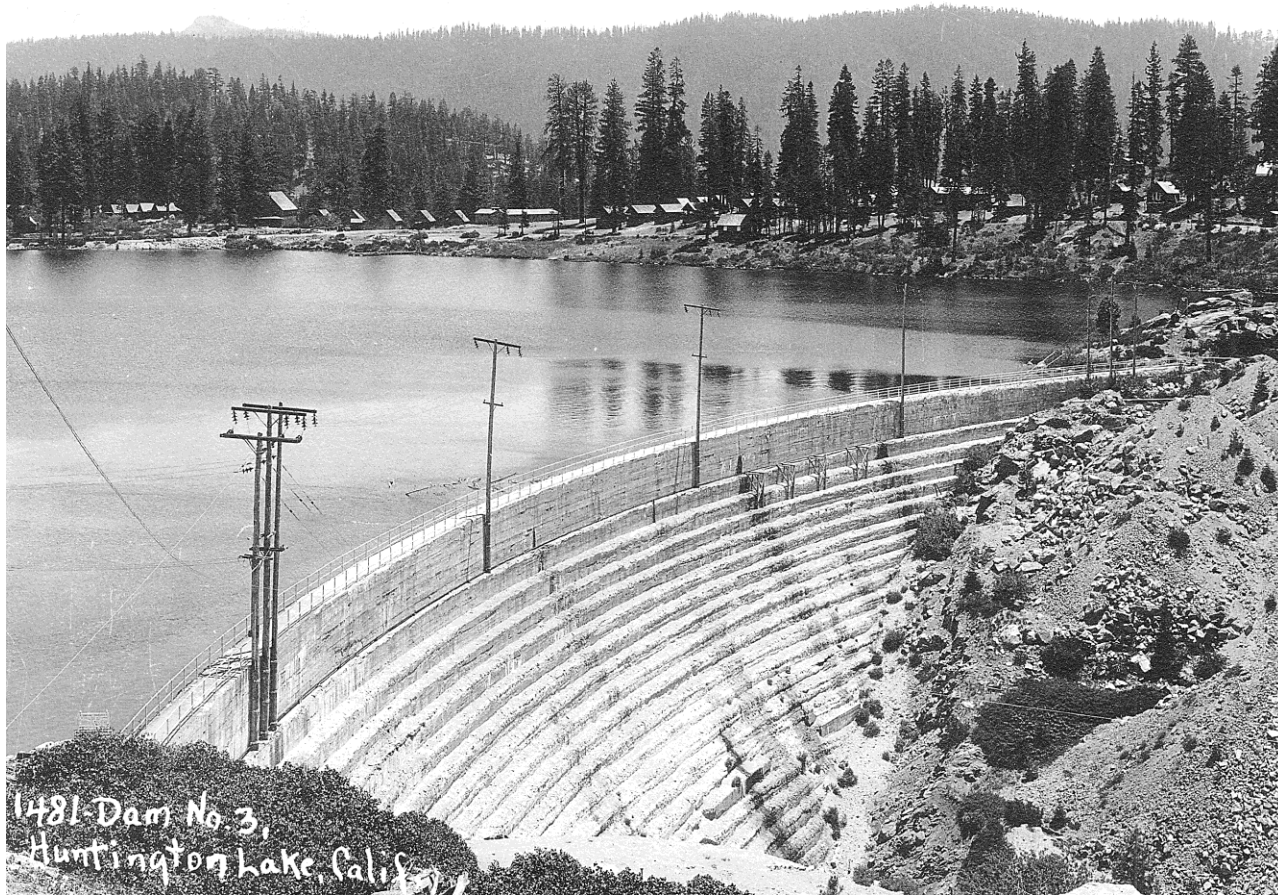
# Dams and Hydroelectricity...

## **Hoover Dam, Colorado River (1931-35)**



# Dams and Hydroelectricity...

## Sierra Nevada's Big Creek System 1913...





# Dams and Fish...

No Returns...



---

# The Dam Removal Movement

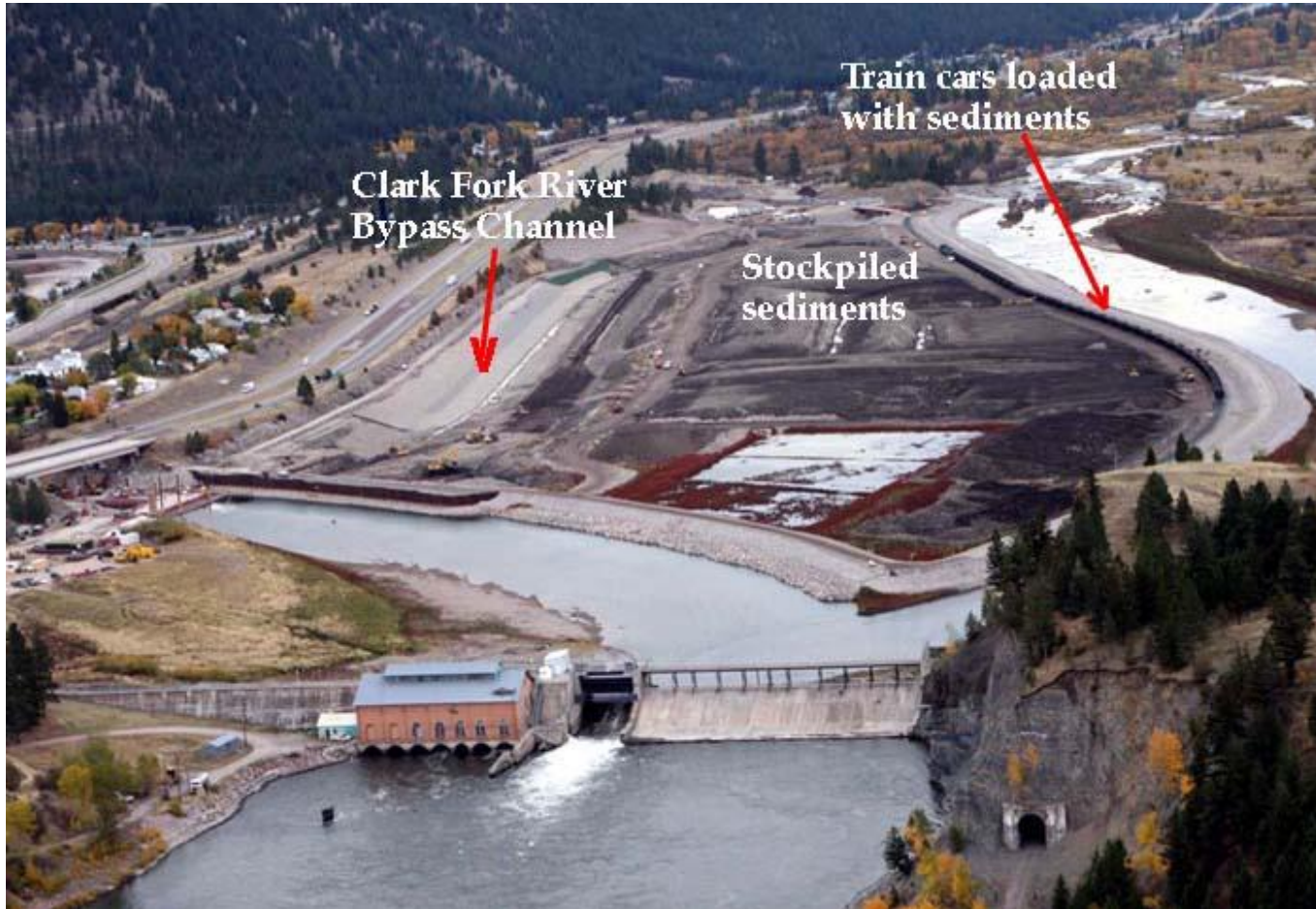
## “Orphan” Dam Removals





# The Dam Removal Movement

## Milltown Dam: Mine Waste/Superfund Site





# Dams and the Environment...

## Rural Mill Dams: America





# Dams Water Energy...

## **TVA's Fontana Dam 1944**



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# Dams Water Energy...

## **Shasta Dam, Northern California 1945**

