Sediment Sustainability, Tuttle Creek Lake, and Water Injection Dredging

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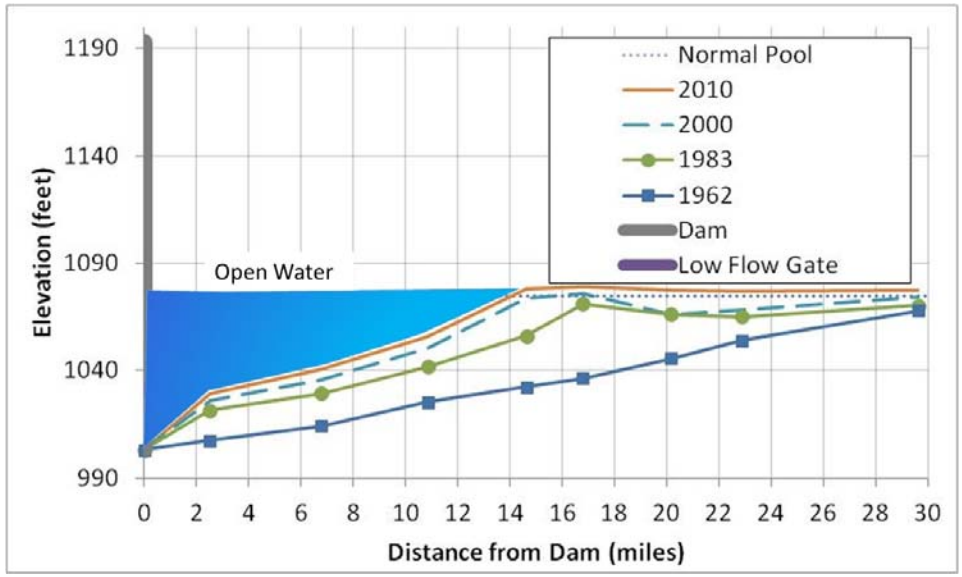
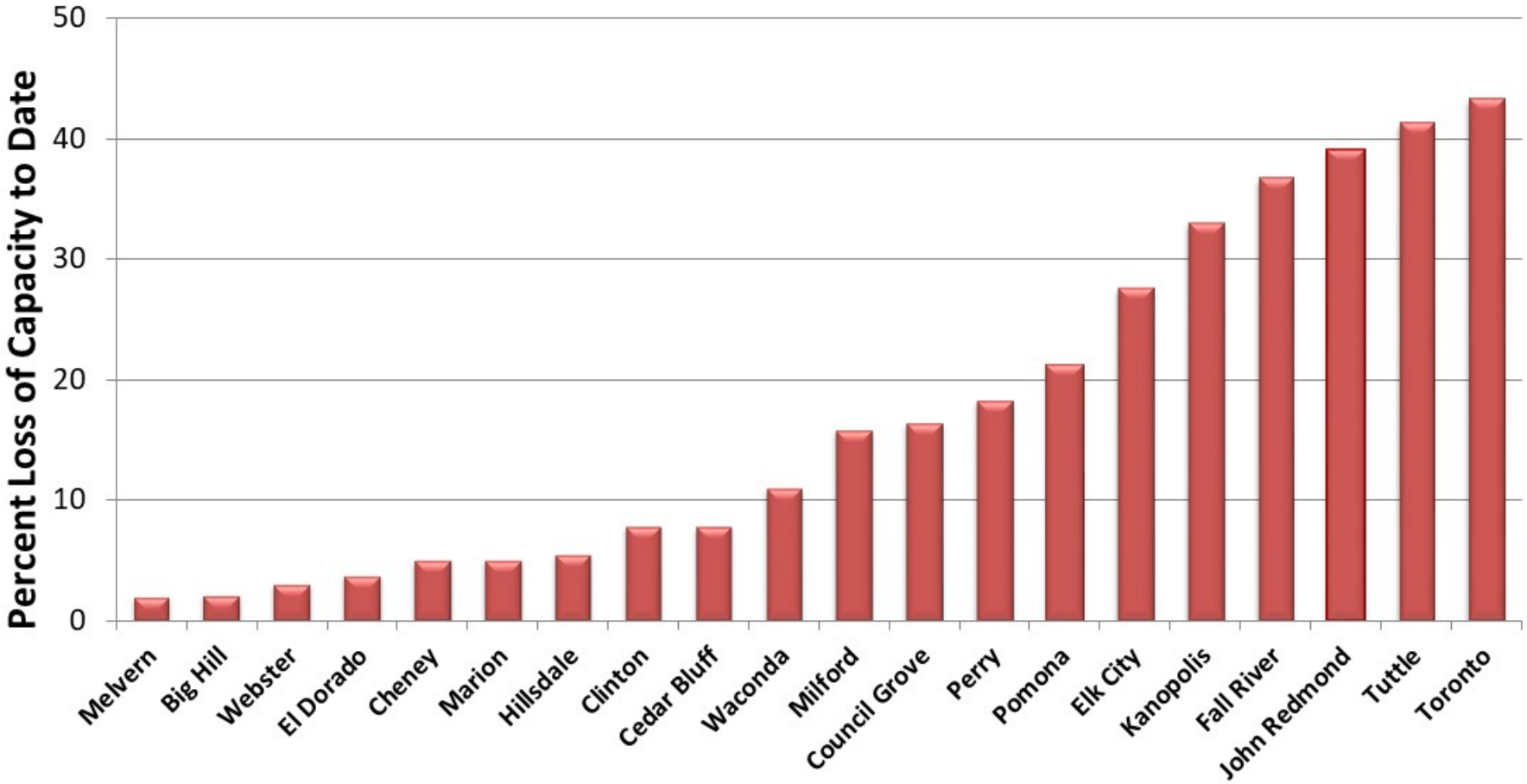


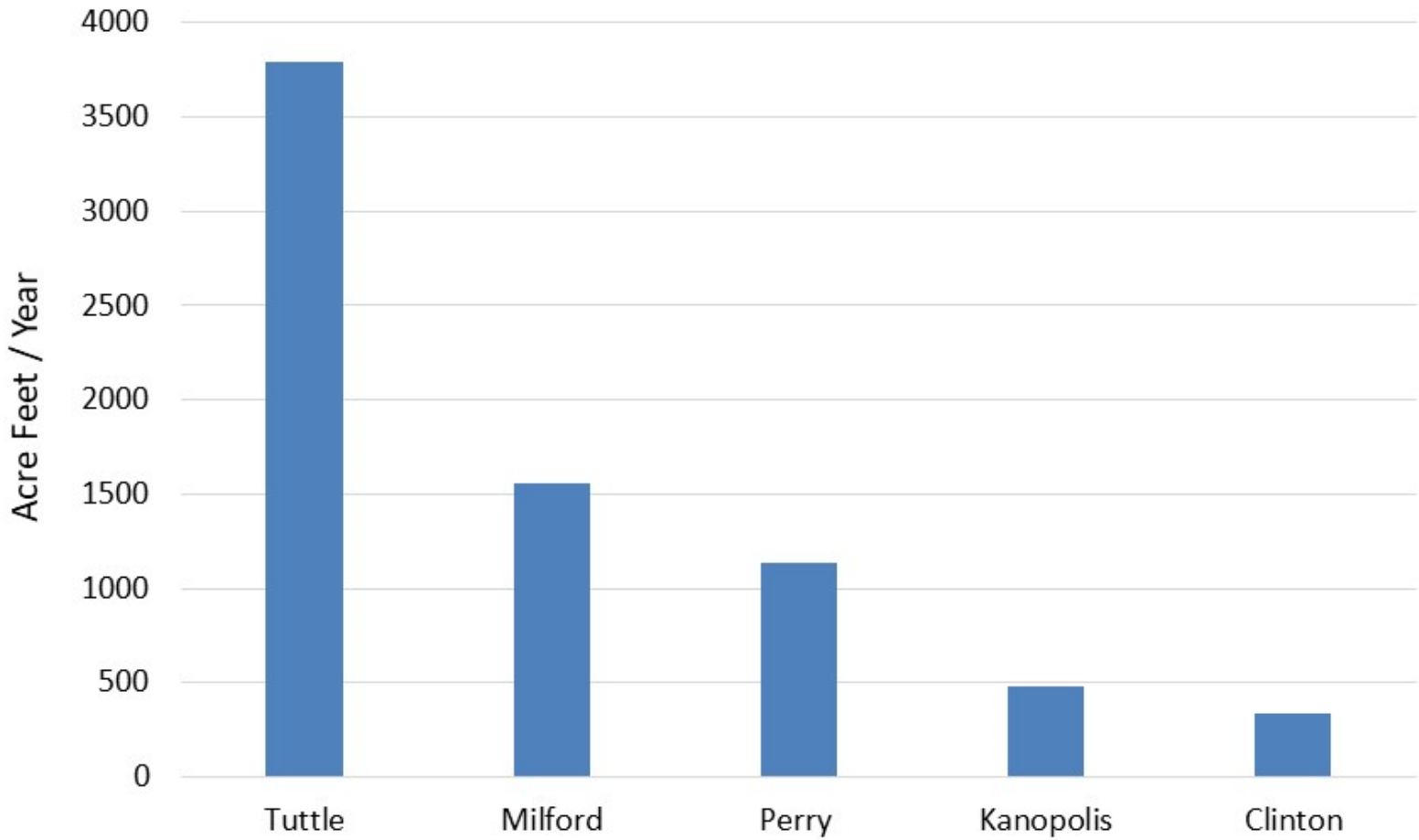
Outline

- Kansas River Basin
- Sediment Sustainability: The long view
- Options
- Turbidity Currents in lakes
- Water Injection Dredging

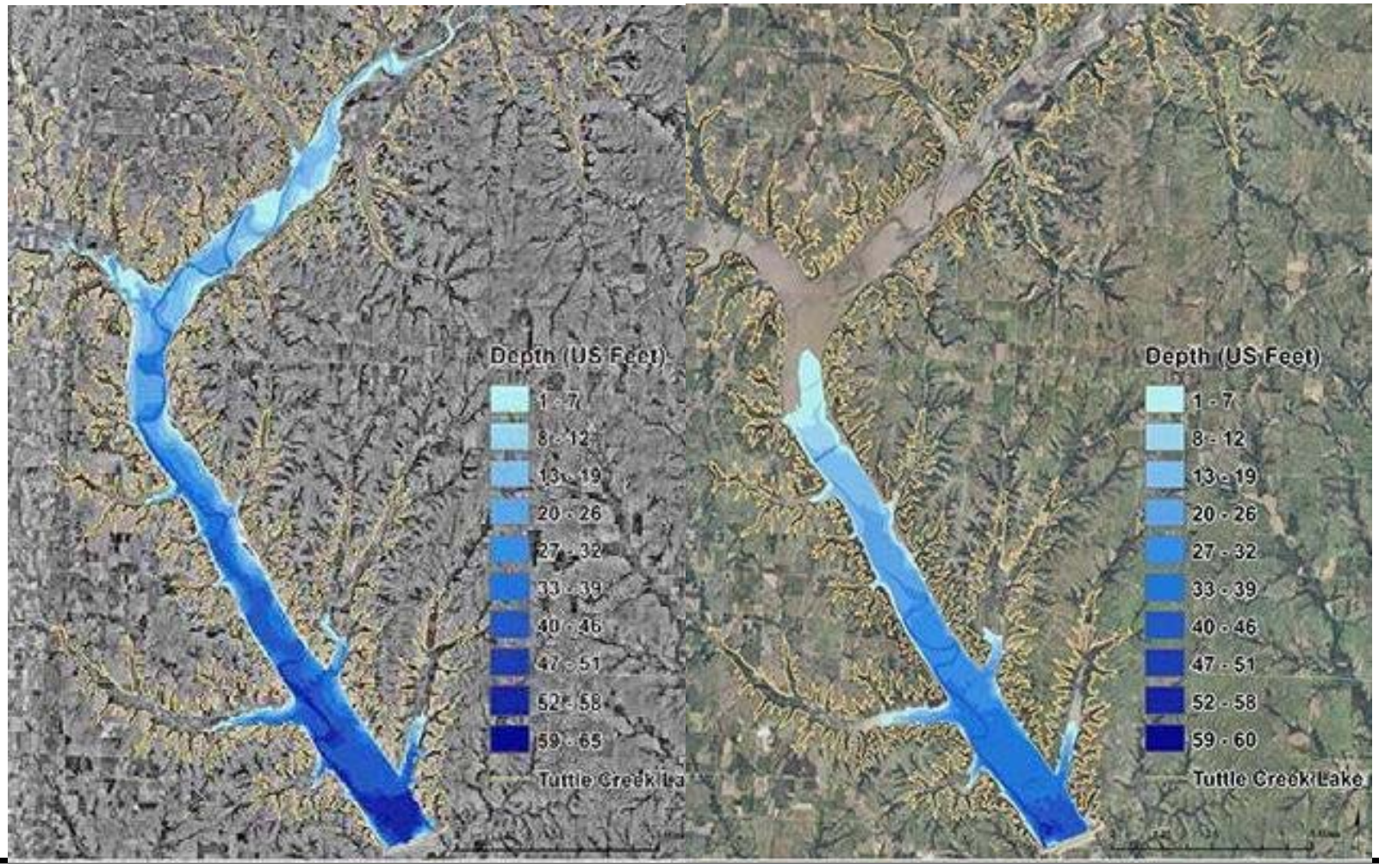
Kansas Reservoirs Loss of Capacity

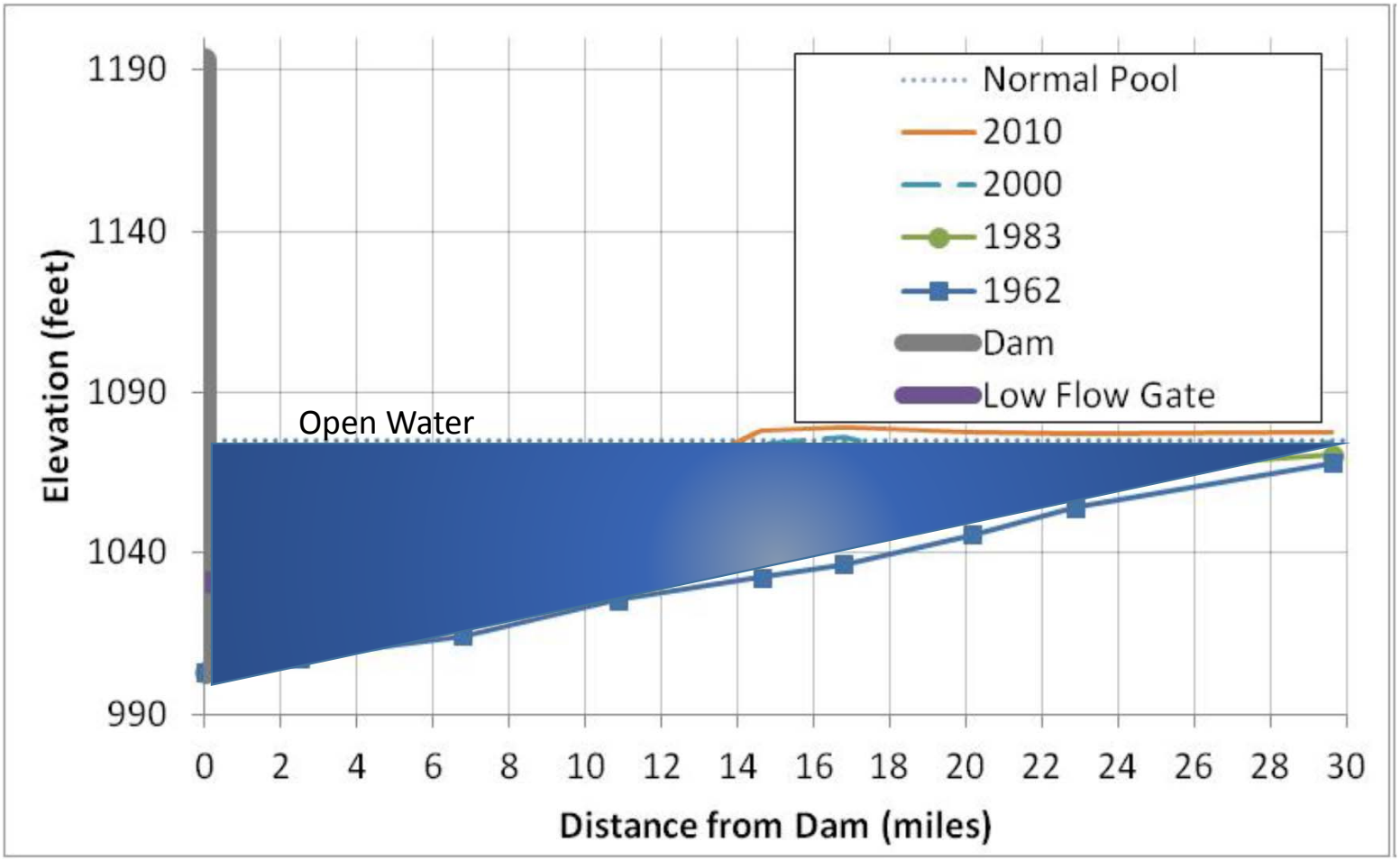


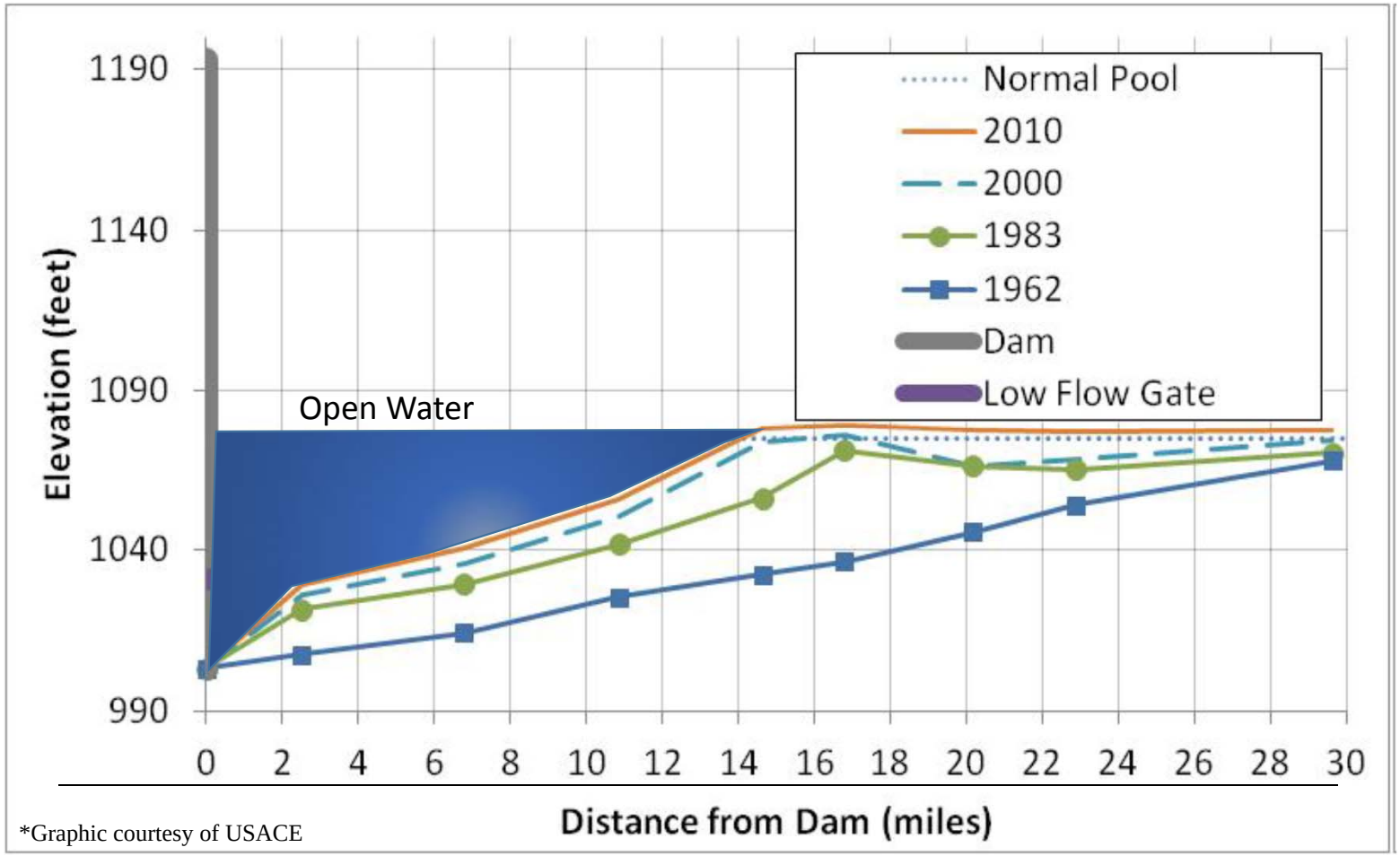
Sediment Accumulation in the Multipurpose Pool



Tuttle Creek Lake: 1962 to 2010




Normal Pool
2010
2000
1983
1962
Dam
Low Flow Gate
Open Water
Elevation (feet)
1190
1140
1090
1040
990
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Distance from Dam (miles)



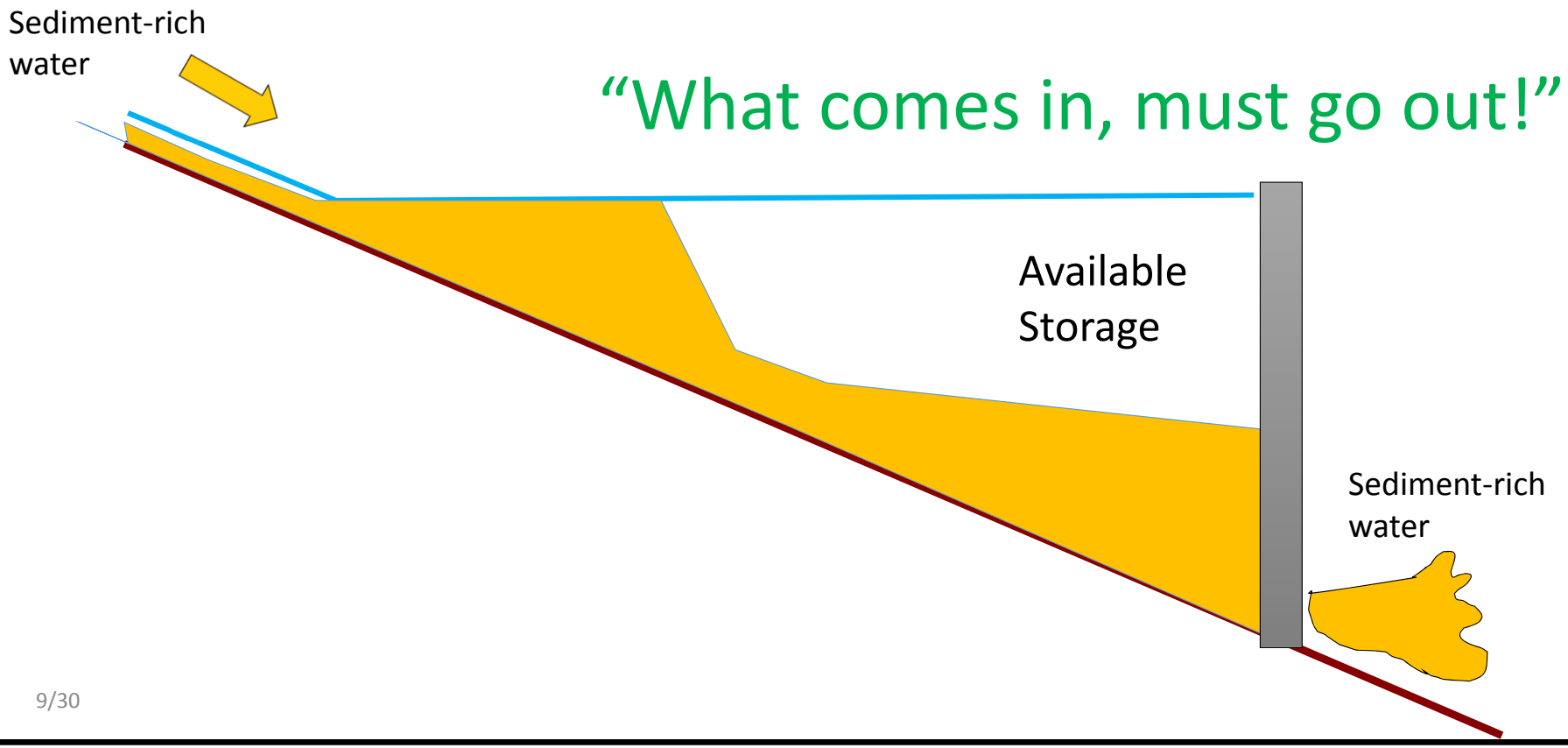
*Graphic courtesy of USACE

Tuttle Creek Lake

At the same annual rate of sedimentation:

- **Multi-purpose pool will be 88% full in 50 years**
- **Total storage (multi-purpose + flood control) will be 21% full**

Reservoir Sediment Sustainability

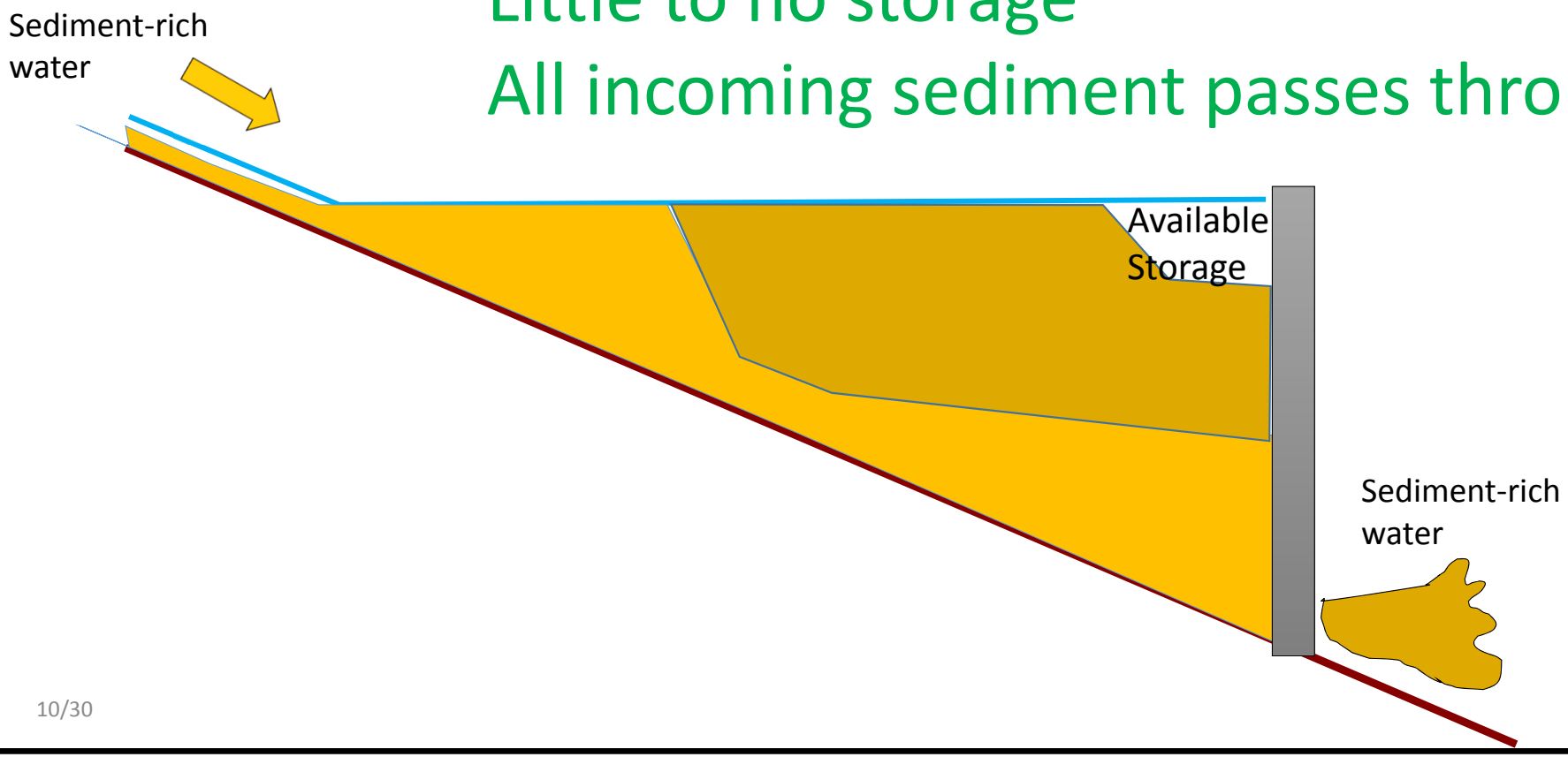


"What comes in, must go out!"

Without Reservoir Sustainability

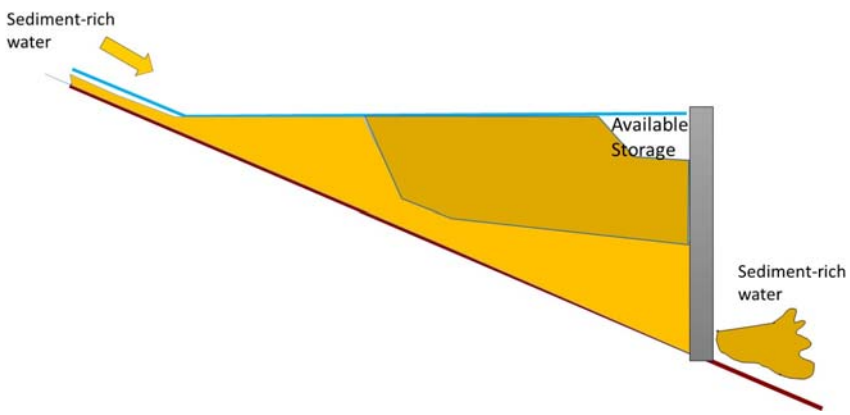
Little to no storage

All incoming sediment passes through



The Decision

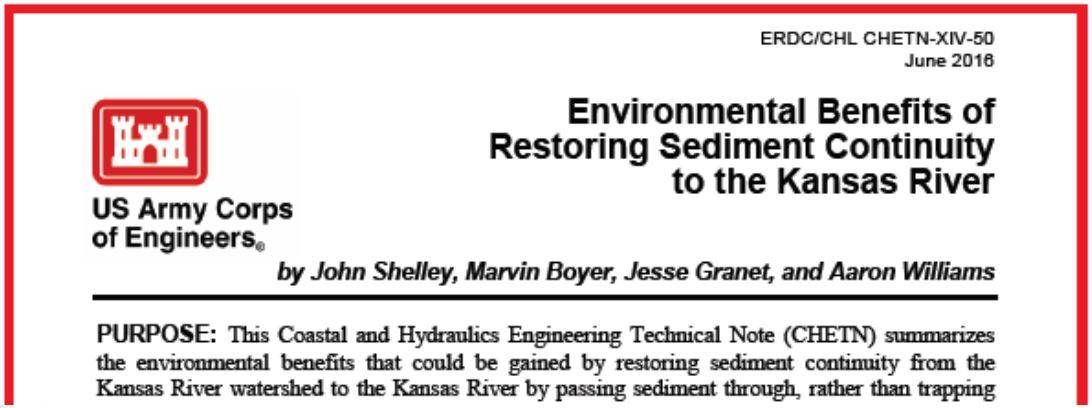
OR



Either way, outgoing sediment = incoming sediment
The difference is whether or not we have a reservoir when we reach a sediment equilibrium.

Environmental Impacts: Kansas River

- Pre-dam Sediment Load: 44 million tons per year
- Post-dam Sediment Load:13 million tons per year
- A 70% reduction in sediment transport



ERDC/CHL CHETN-XIV-50
June 2016

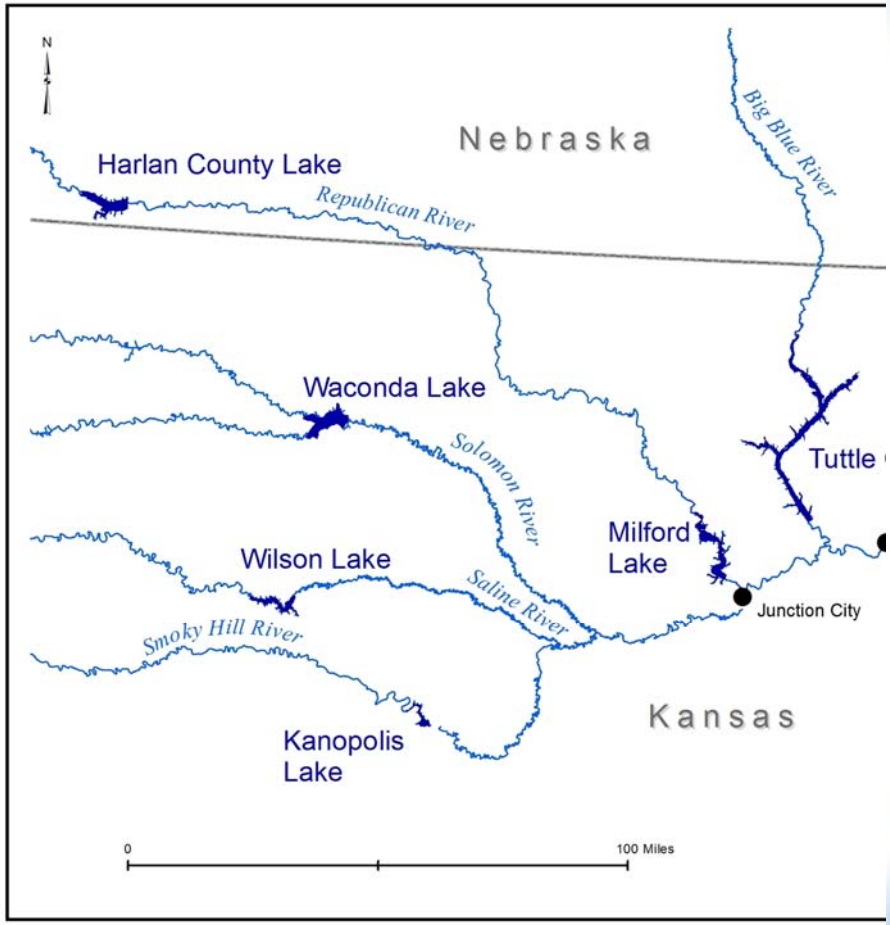
US Army Corps of Engineers®

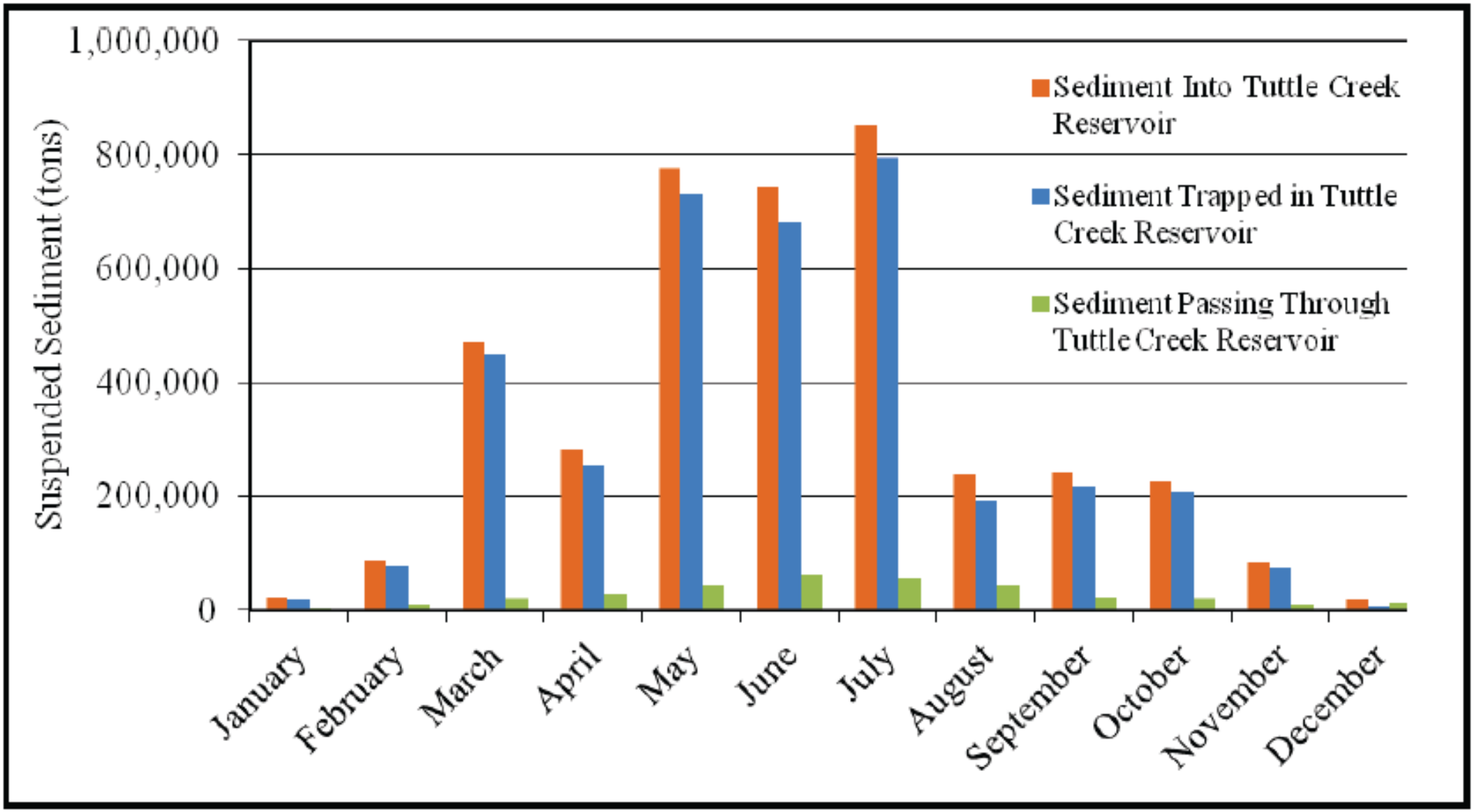
Environmental Benefits of Restoring Sediment Continuity to the Kansas River

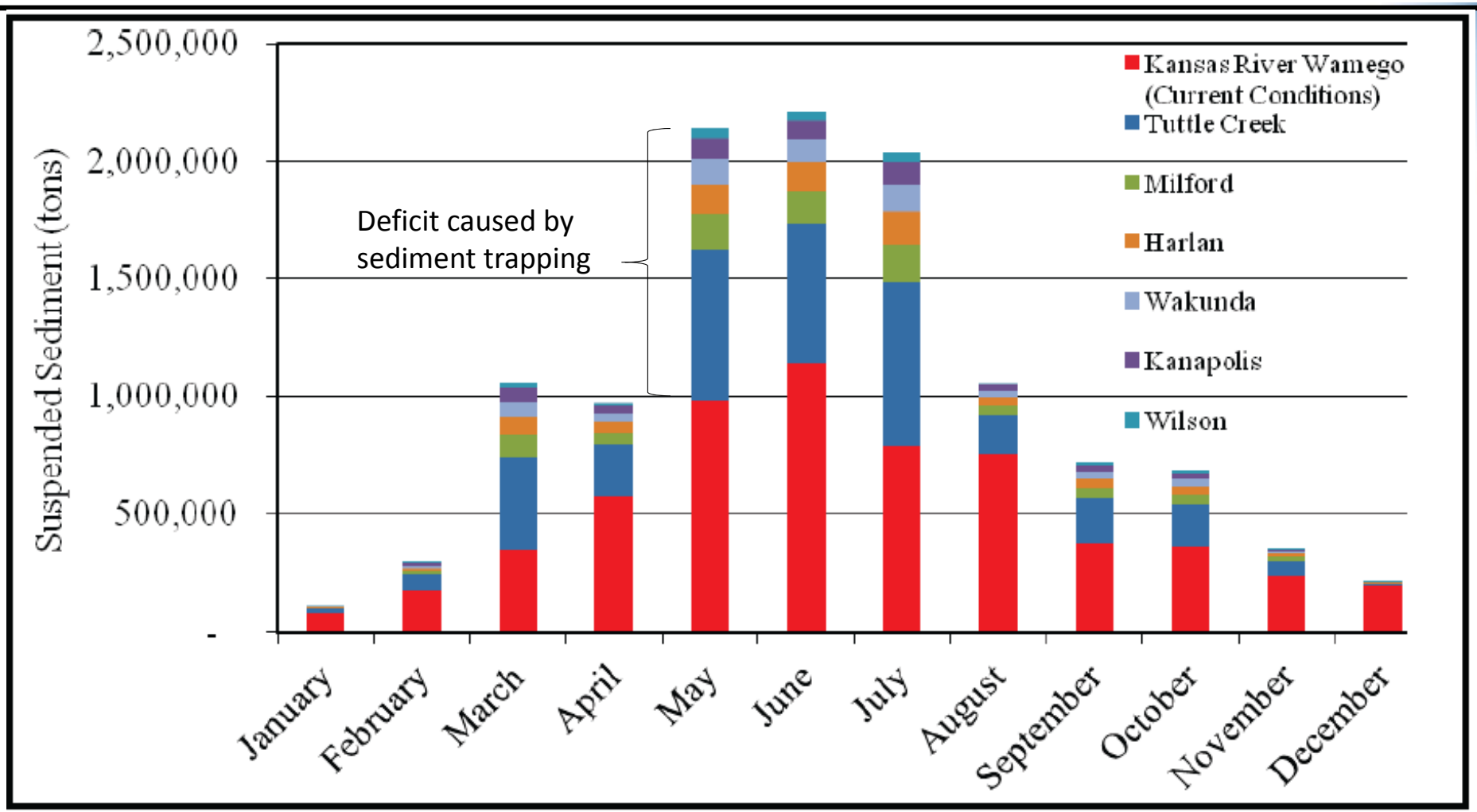
by John Shelley, Marvin Boyer, Jesse Granet, and Aaron Williams

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) summarizes the environmental benefits that could be gained by restoring sediment continuity from the Kansas River watershed to the Kansas River by passing sediment through, rather than trapping

http://www.dtic.mil/dtic/tr/fulltext/u2/1011945.pdf



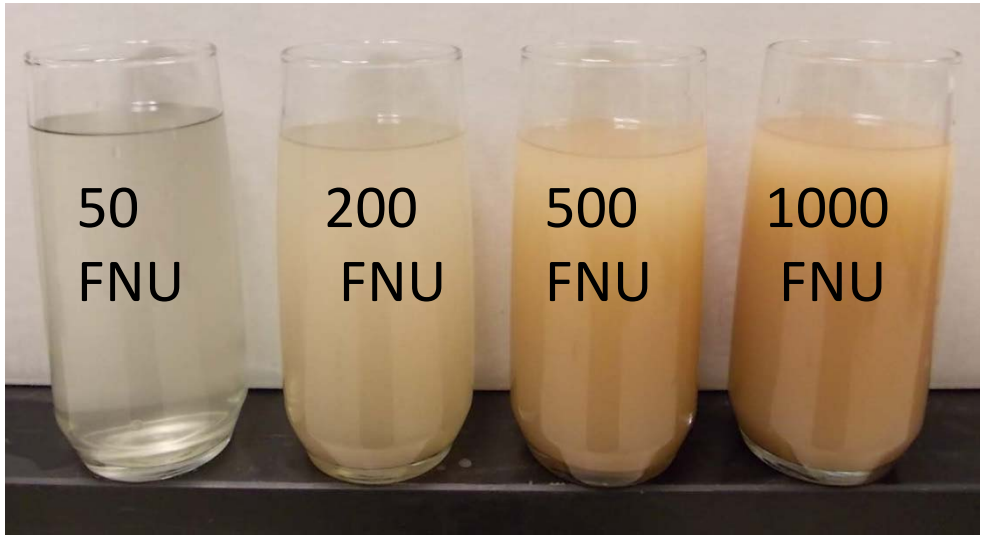

1,000,000
800,000
600,000
400,000
200,000
0
Suspended Sediment (tons)
Sediment Into Tuttle Creek Reservoir
Sediment Trapped in Tuttle Creek Reservoir
Sediment Passing Through Tuttle Creek Reservoir
January
February
March
April
May
June
July
August
September
October
November
December



*This graph uses the long-term sediment trapping rate calculated from repeat bathymetric transects for total volume and assumes the same temporal distribution as Tuttle Creek Lake.

Environmental Impacts: Lack of Turbidity

- Humpback Chub numbers have decreased substantially and they are now federally protected
- One primary reason is that the Colorado River used to be usually over 1000 FNU, but after construction of Glen Canyon Dam now is usually below 50 FNU. The small chub become easy prey for trout species in clear water.

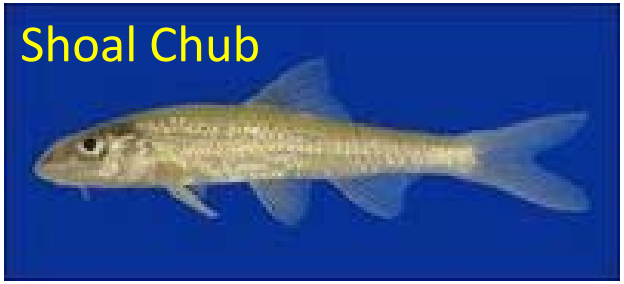


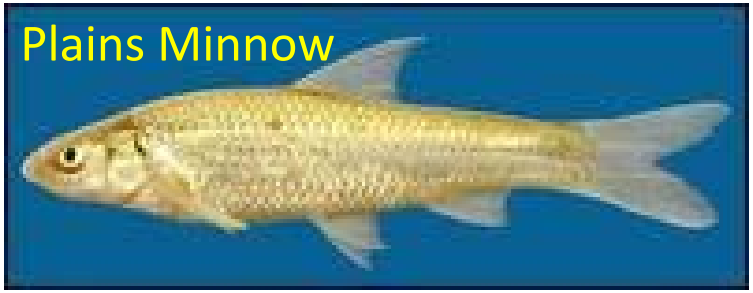
David Ward and Rylan Morton Starner, USGS, Grand Canyon Monitoring and Research Station

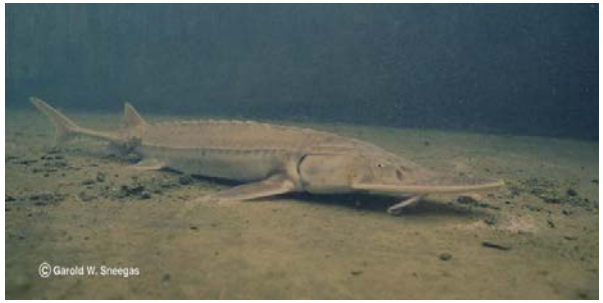
Brown trout
mean TL = 261 mm

Humpback chub
mean TL = 56 mm

Decline in Turbidity-Dependent Species in the Kansas River







Other impacted species showing significant decline or complete extirpation:
Silver Chub, Flathead Chub, River Shiner, Carmine Shiner, Sturgeon Chub

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The Good News

Reservoirs are operated sustainably around the world through a variety of methods.

But not every method is effective, acceptable, or optimal for every situation.

Dredging Discharge from Millsite Dam near Ferron, Utah

Traditional Dredging with disposal into a CDF

3,600 ac-ft/year into Tuttle's multi-purpose pool

At $6.7/yd^3 = $39 M/year +++

Cost increases as available disposal sites are filled
Does not address the sediment deficit downstream

Reservoir Sediment Management Strategies

- Water-injection Dredging
- Sediment yield reduction
- Sediment traps
- Sediment bypass
- Sediment pass-through (routing, sluicing)
- Drawdown flushing
- Hydrosuction
- Inlet extension
- Density current venting
- Dredging with land disposal
- Dredging with downstream recharge
- Pressure flushing
- Sediment focusing
- Reallocation
- New reservoirs/dam raises

The Ideal Solution

- Restore sediment continuity to:
  - Sustain reservoir storage at current levels
  - Pass sediment downstream at concentrations similar to upstream of the dam (i.e. higher concentration during high flows, no extra sediment during low flows)
- Economically sustainable

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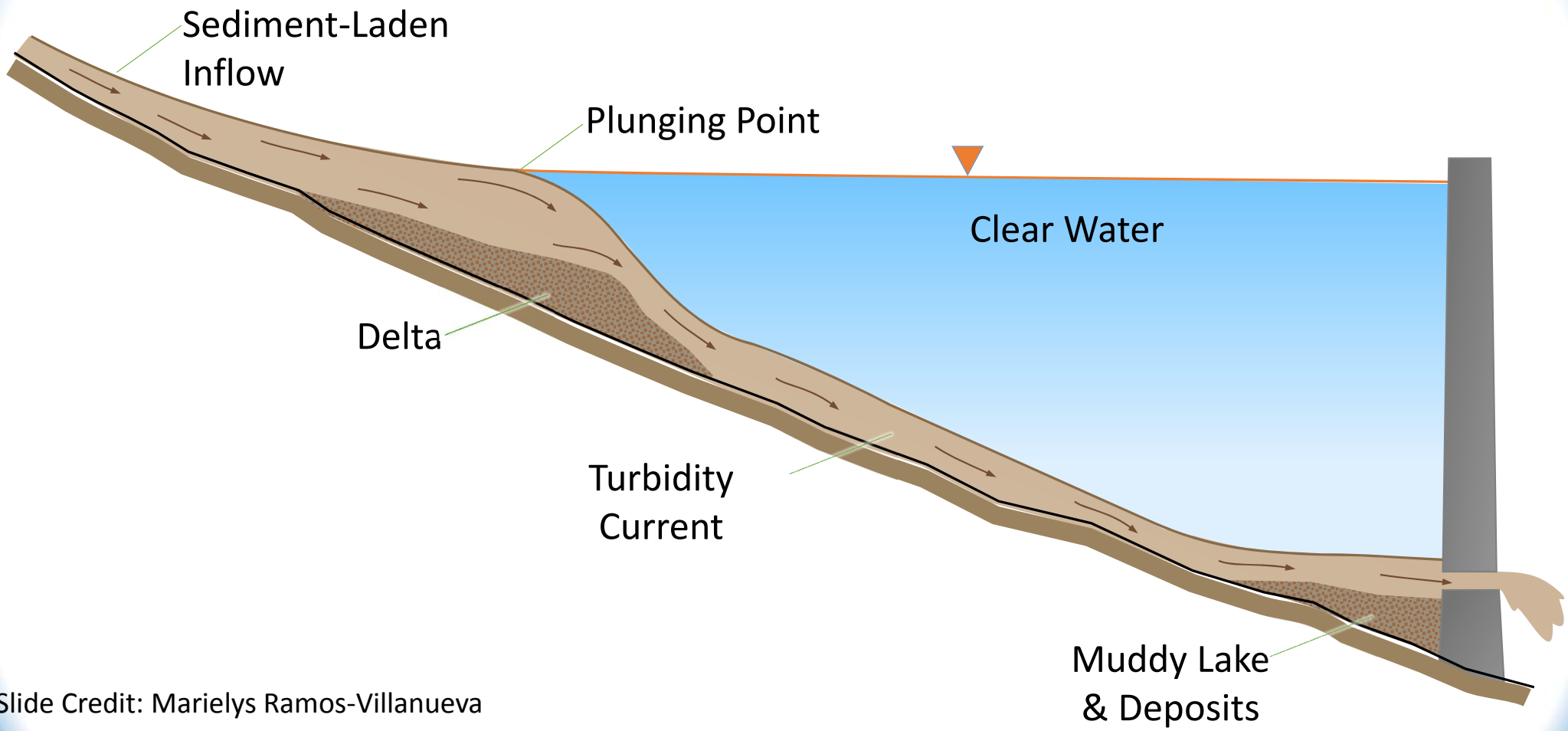
TURBIDITY CURRENT VENTING

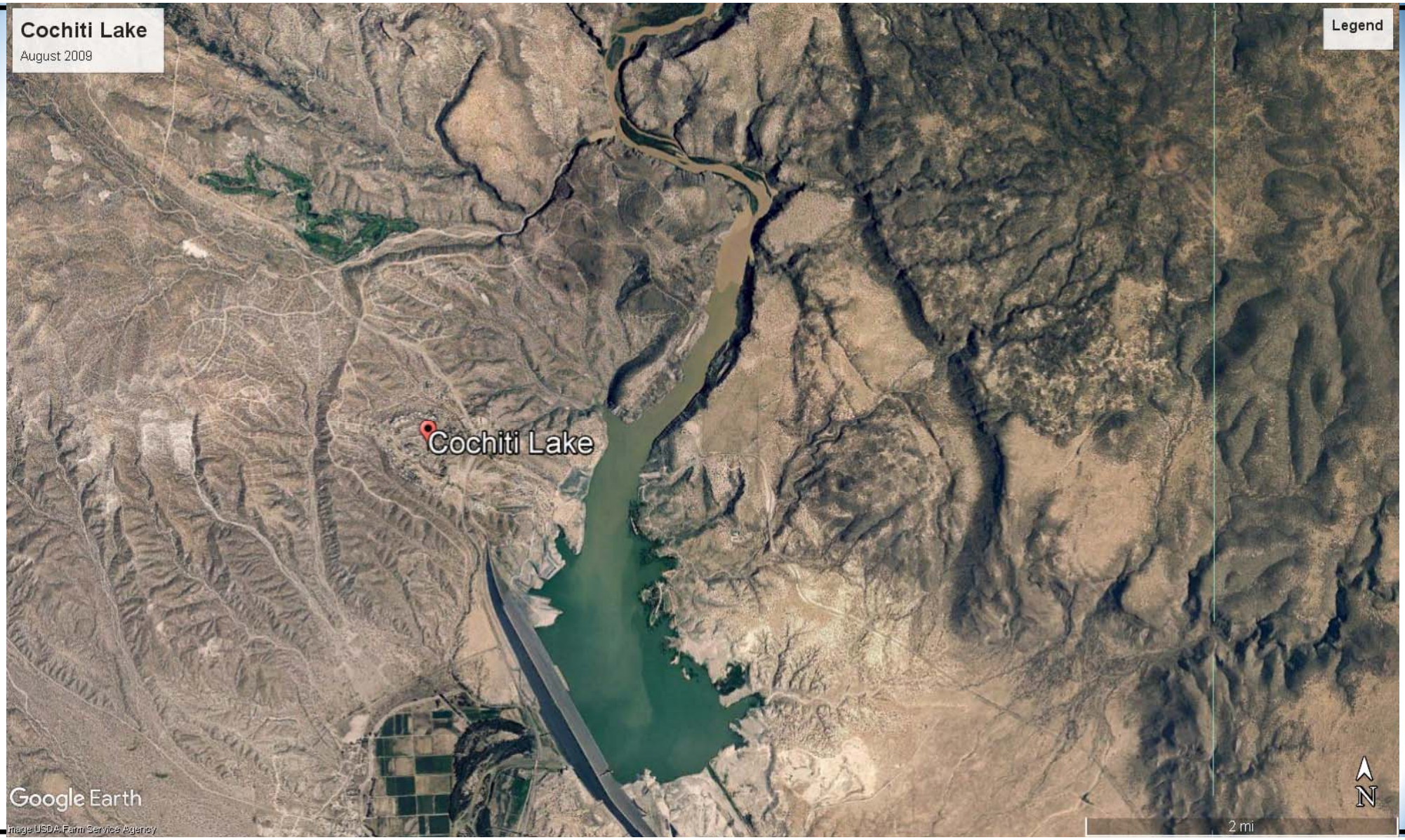


Slide Credit: Marielys Ramos-Villanueva

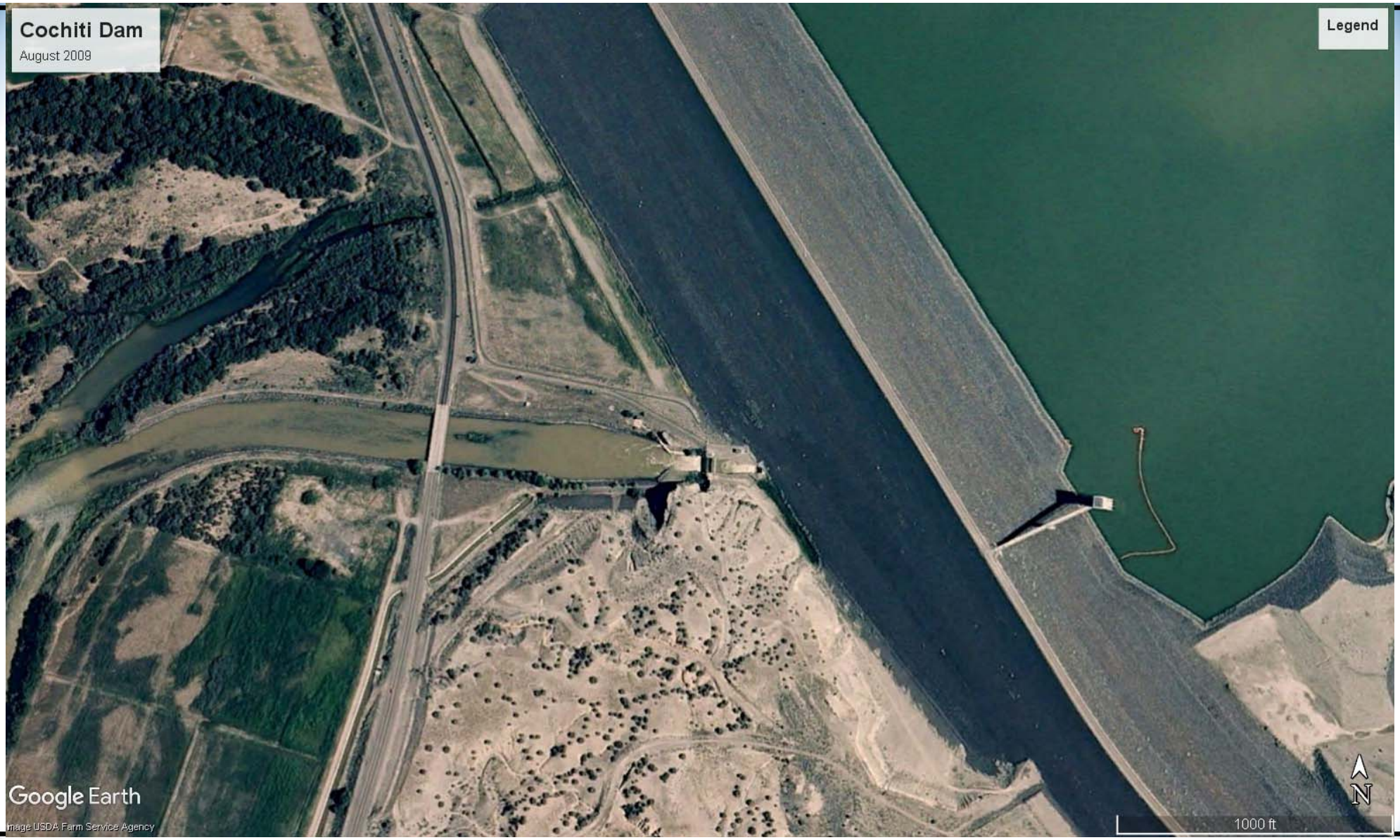
Photo Source: Greg Morris

Conchas Lake
October, 2017
Legend
Conchas Lake
Google Earth
N
1 mi

Conchas Dam
October, 2017
Legend
Google Earth
500 ft
N


Cochiti Lake
August 2009
Legend
Cochiti Lake
Google Earth
Image USDA Farm Service Agency
2 mi
N

Cochiti Lake
August 2009
Google earth
Image USDA Farm Service Agency
1 mi
N


Cochiti Dam
August 2009
Legend
Google Earth
Image USDA Farm Service Agency
1000 ft
N

Turbidity currents occur naturally at some lakes, which leads to much less sediment trapping.

Next Presentation: Water Injection Dredging

Water injection dredging is the processes of hydraulically creating a turbidity current.

WATCH CREDITS

NEXT EPISODE IN 1