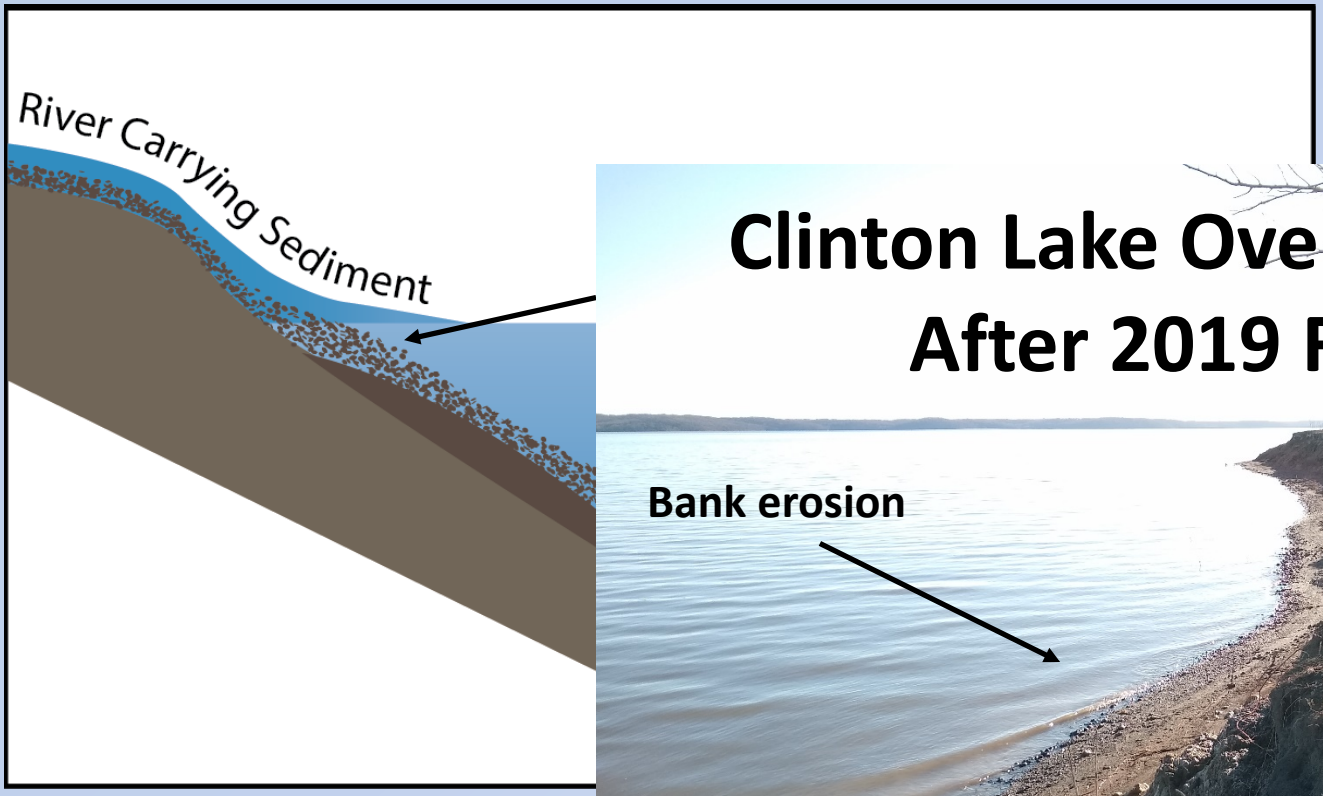
Kansas Reservoir Sedimentation

Chris Shultz

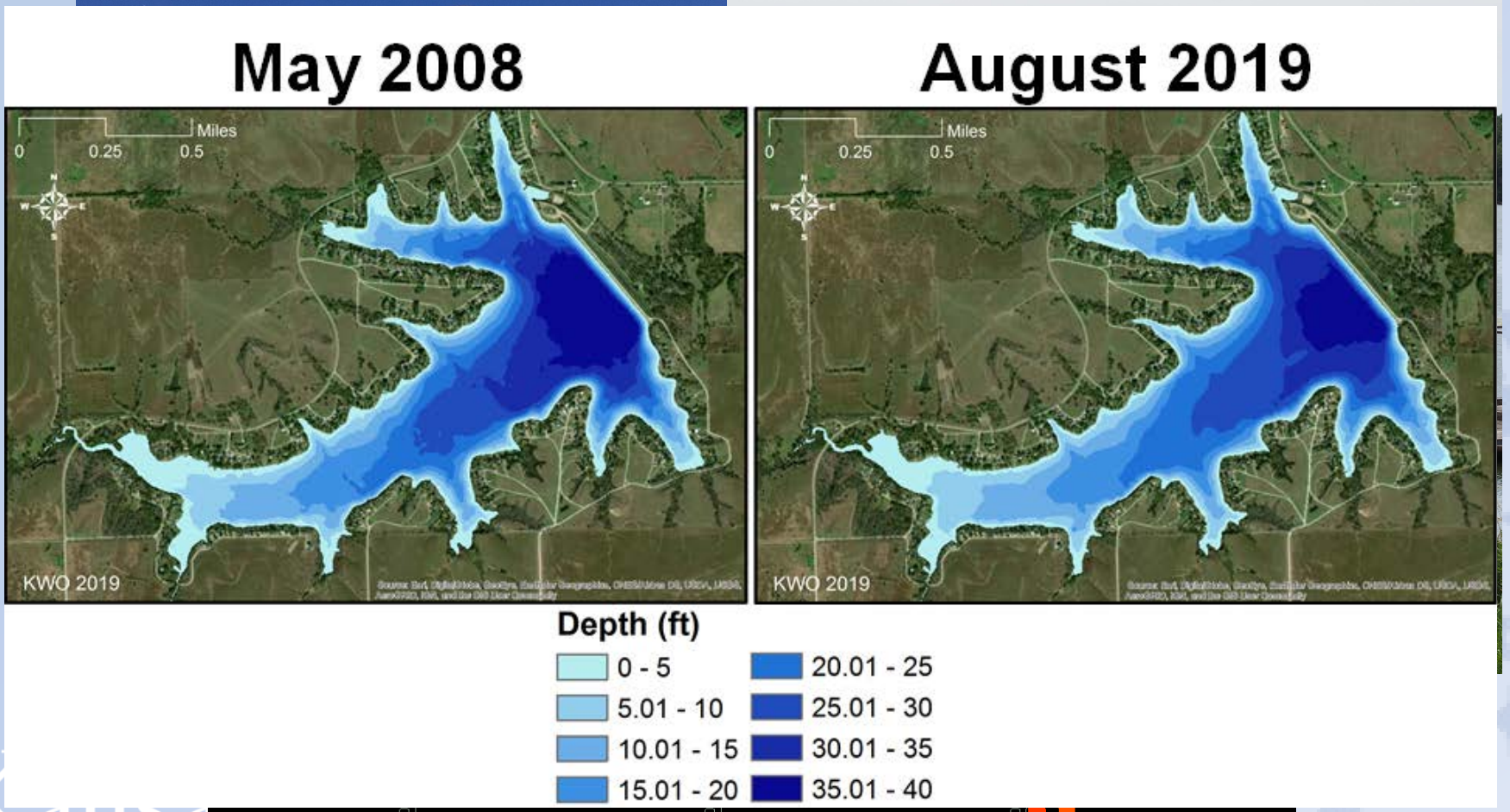
Kansas Water Office

Causes



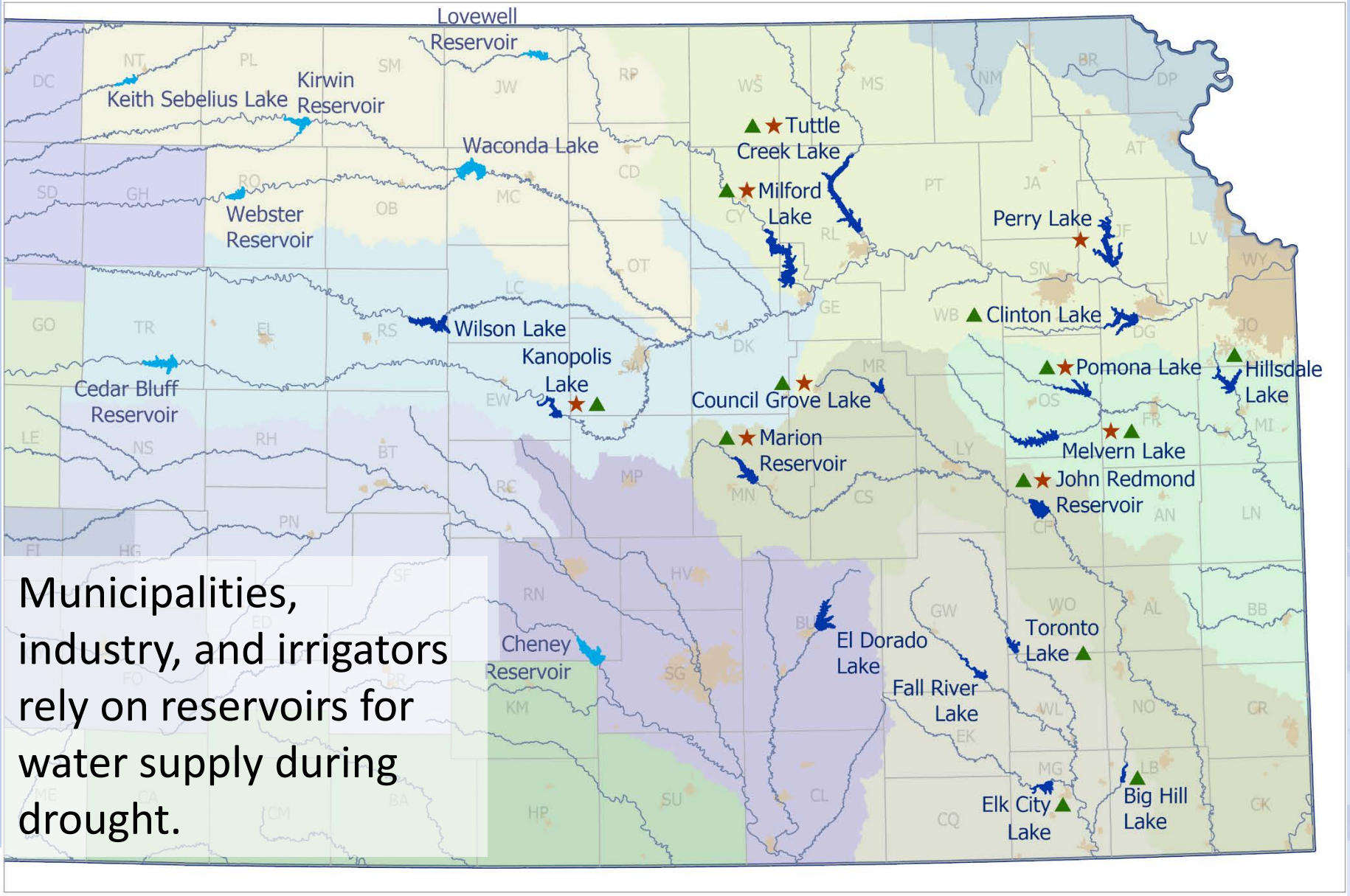
Kansas Water Office

Measurement

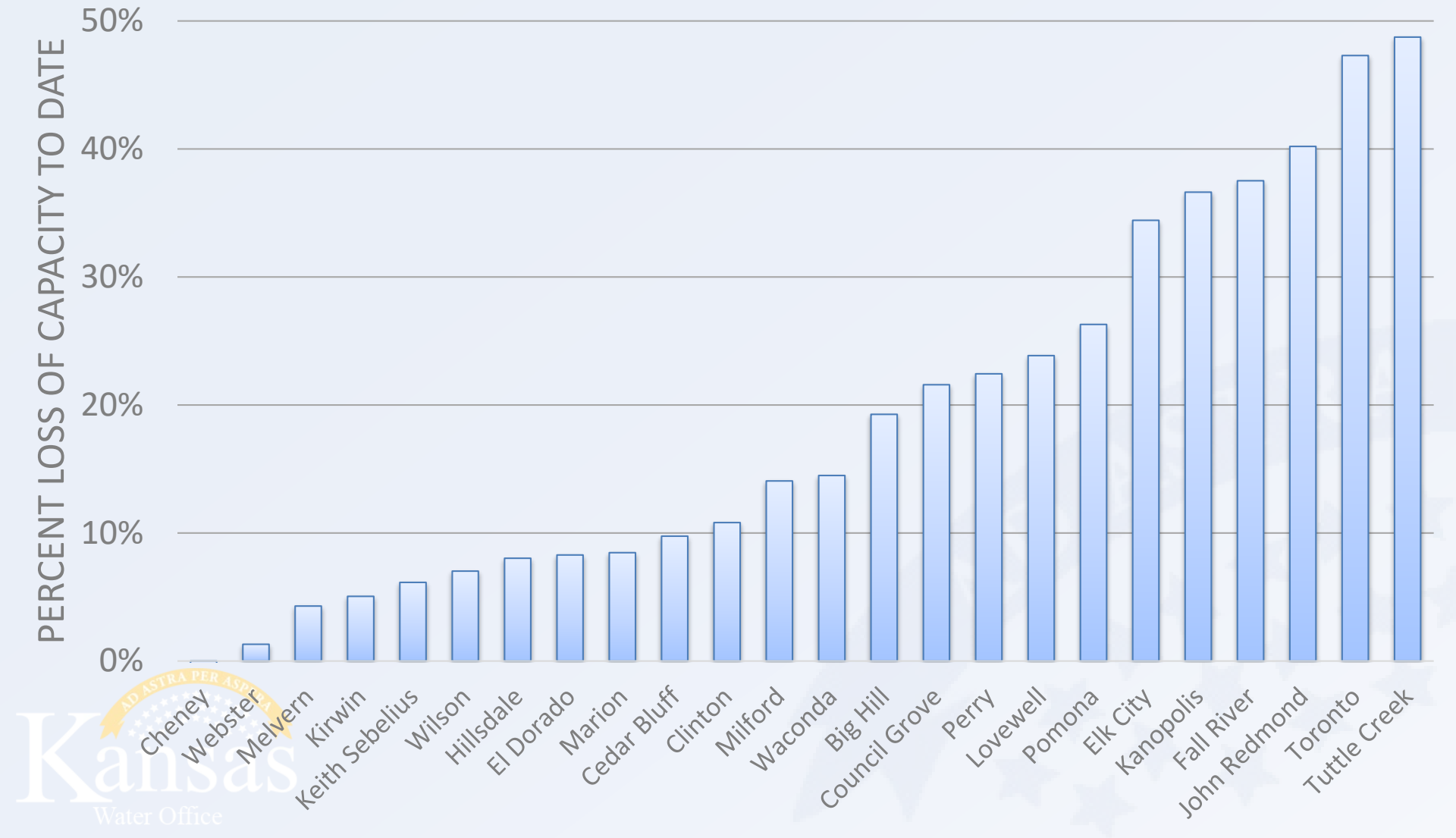


Kansas Water Office

Federal Reservoirs in Kansas

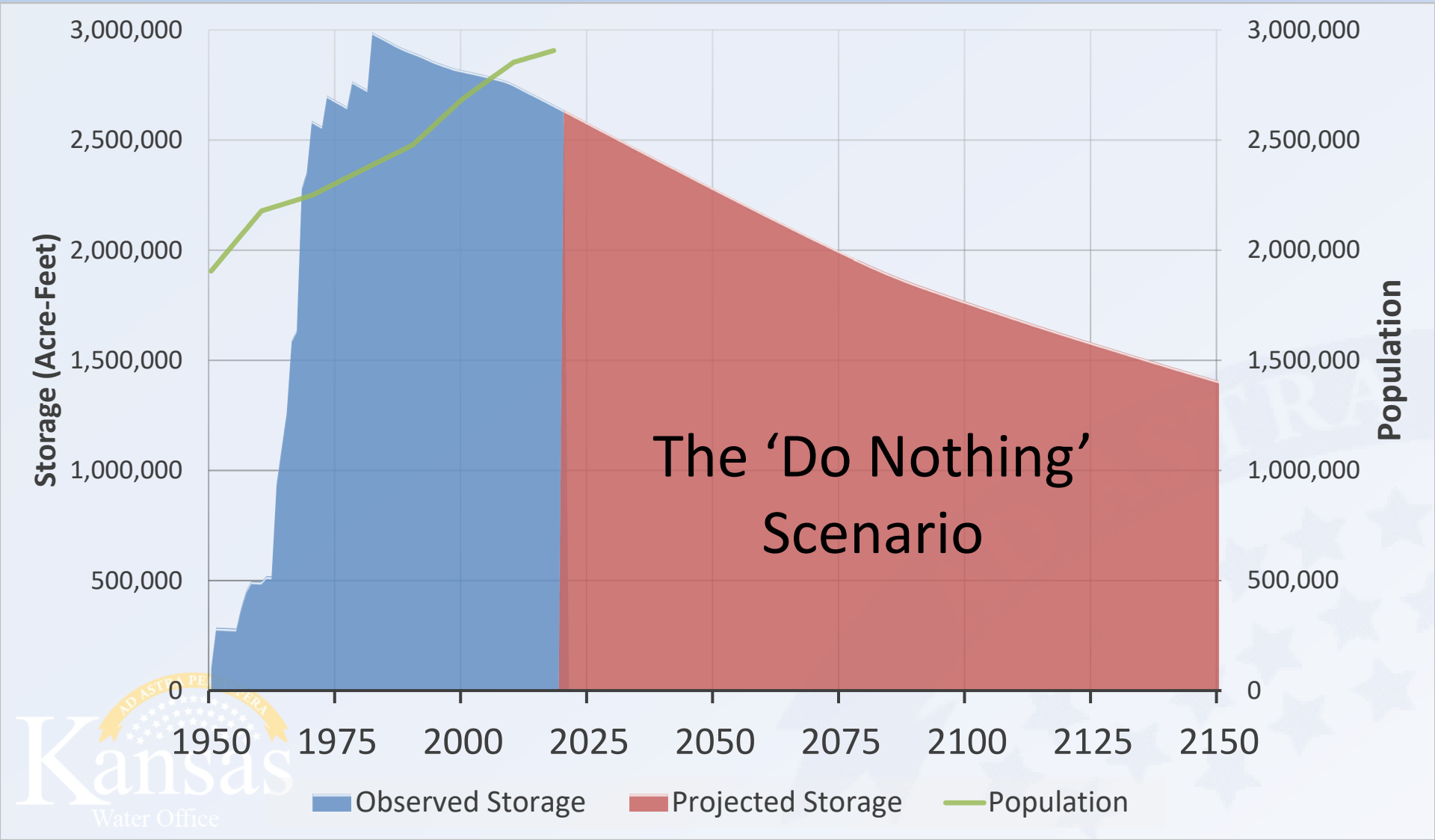


Capacity Lost



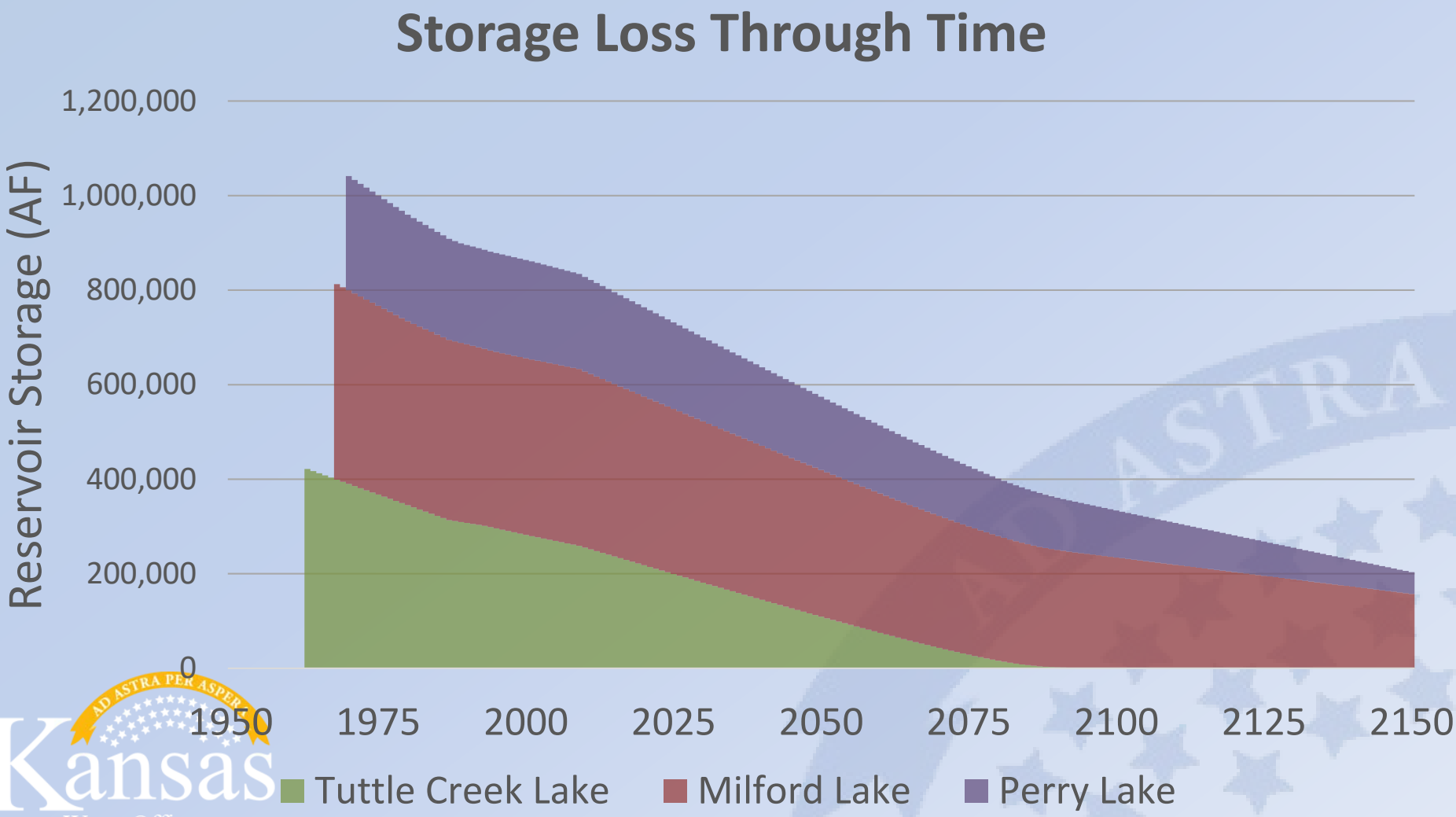
Kansas Water Office

Kansas Federal Reservoir Storage



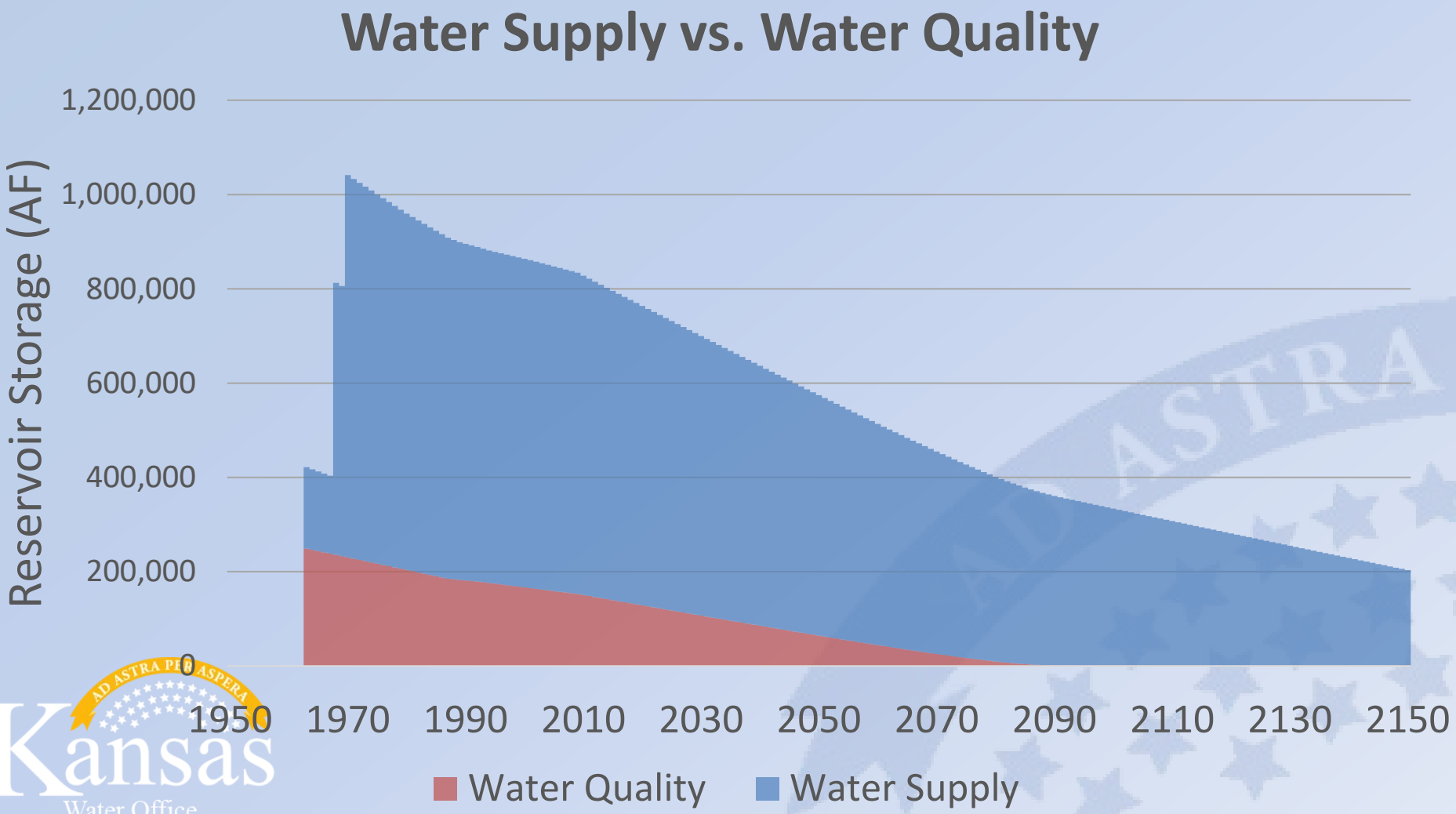
Kansas Water Office

Mainstem Kansas River



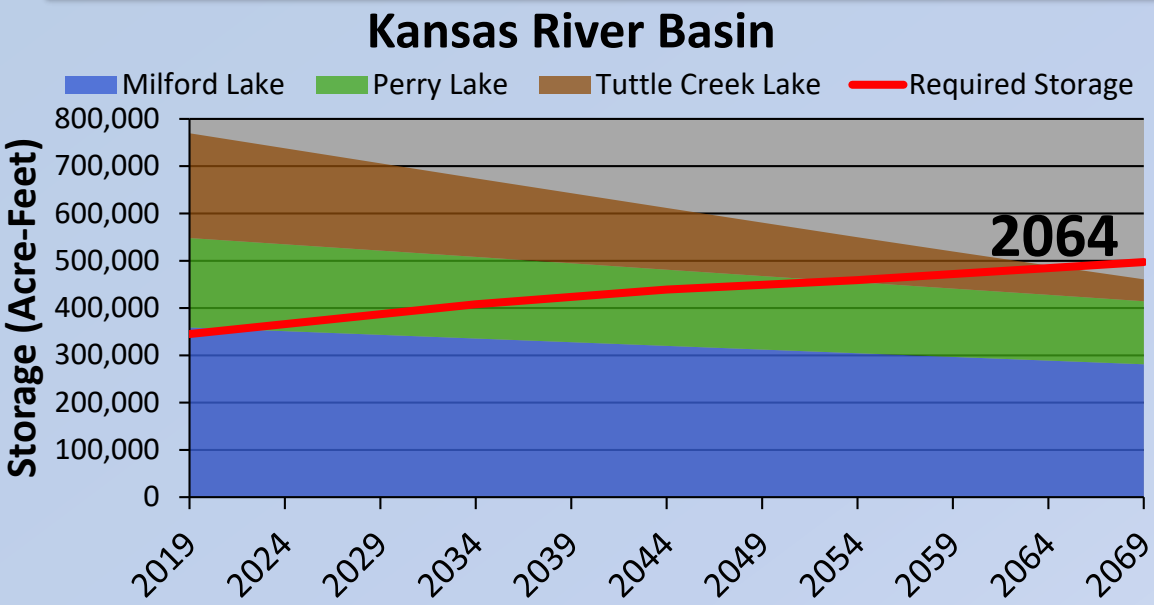
Kansas Water Office

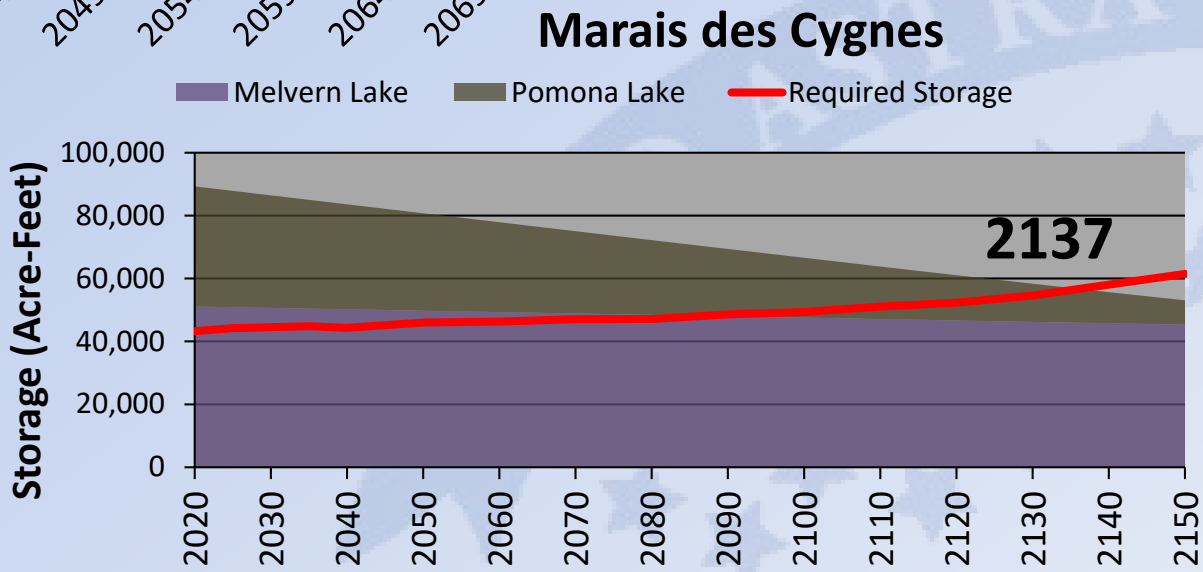
Mainstem Kansas River



Kansas Water Office

Supply/Demand





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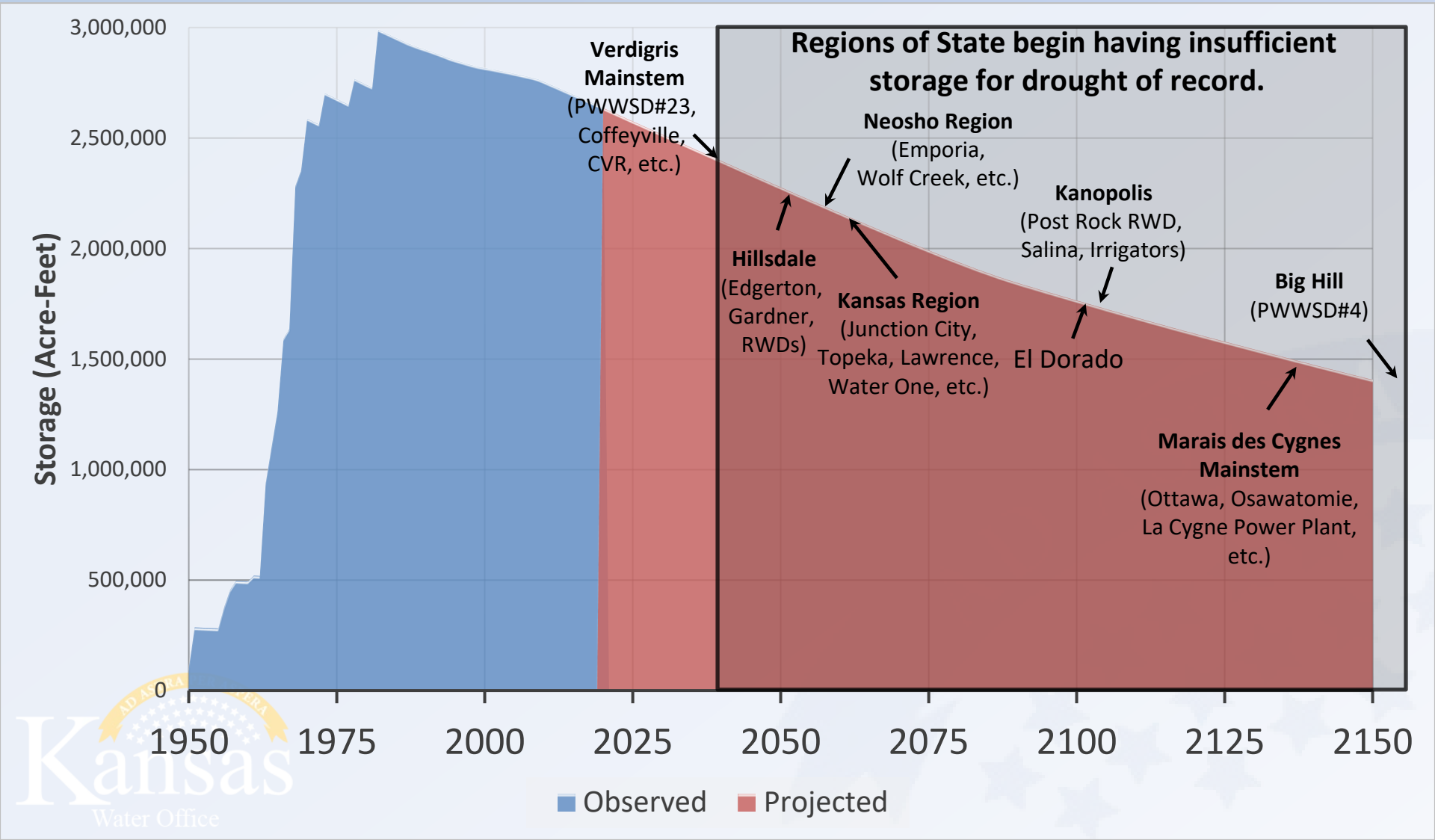
Kansas Federal Reservoir Storage



Kansas Water Office

Questions

Kansas Water Office

RESERVOIR SEDIMENT MANAGEMENT

JOHN SHELLEY, PH.D., P.E.
U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT

Part 1/2

US Army Corps of Engineers

U.S. ARMY

Purpose

To share the good news of reservoir sediment management:

Reservoirs CAN be operated for long-term sustainability by passing the sediment downstream.

Outline

Why we all should care

Examples and Methods

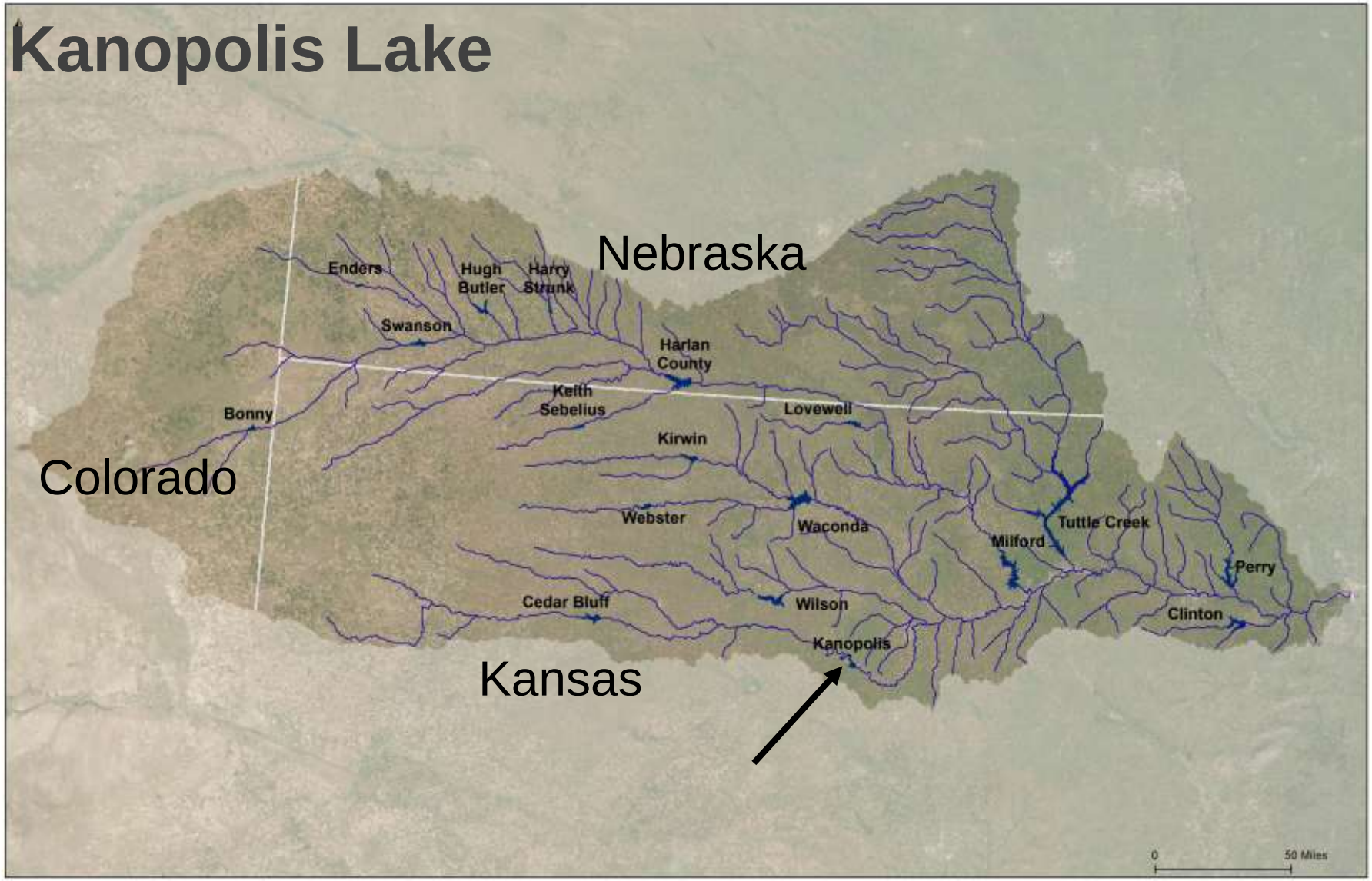
Water Injection Dredging

Why Does the Corps Care About Reservoir Sedimentation?

Acute problems

Chronic problems

Kanopolis Lake



Kanopolis Lake

Multi-purpose pool 43% full of sediment

Pool raise not pursued due to dam safety concerns

Kanopolis Lake

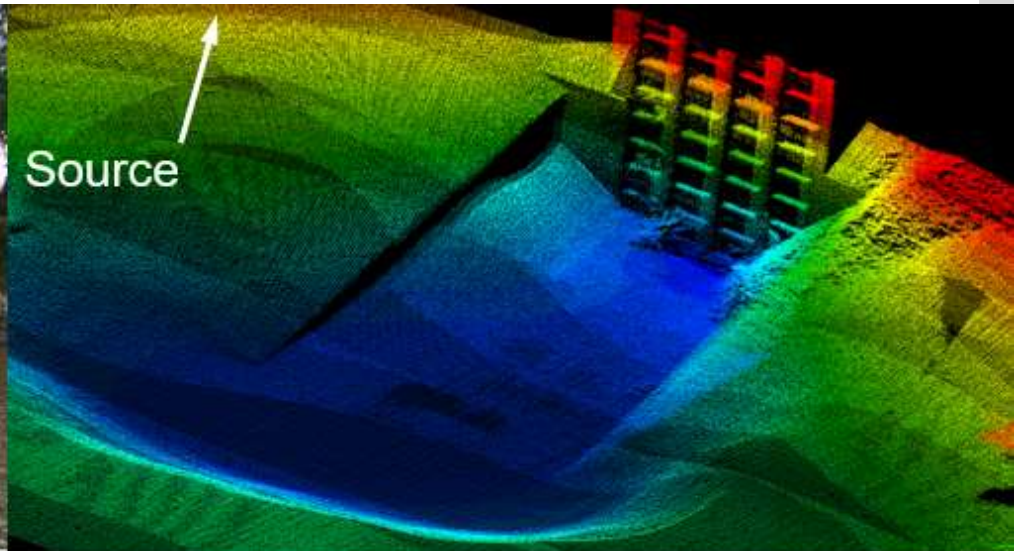
Sedimentation Issues: Acute

Gate operability

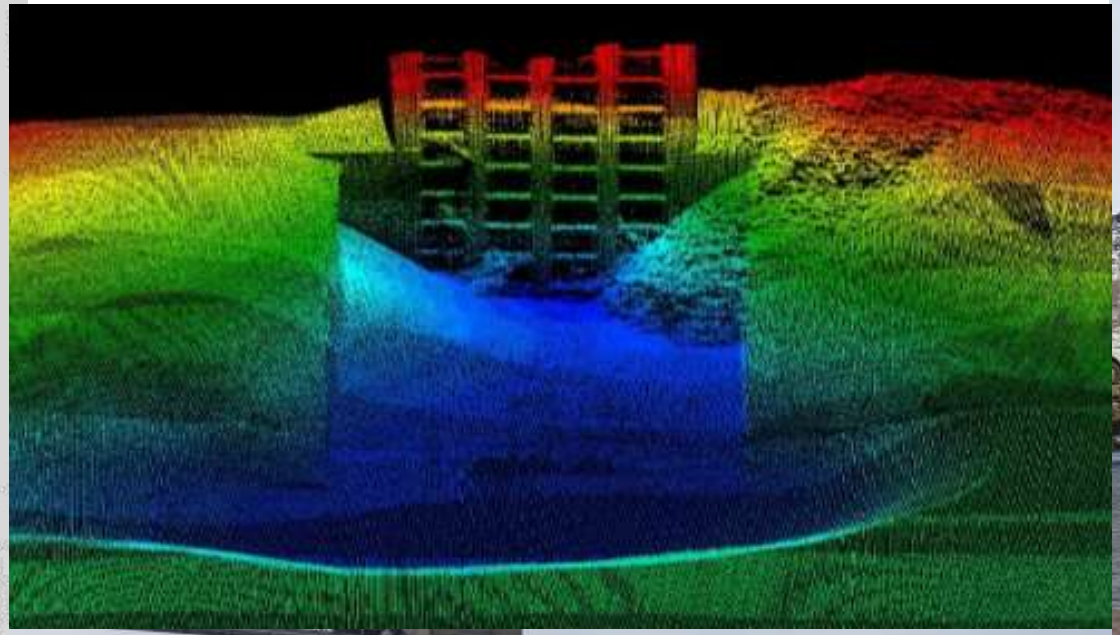
2009- 19’ of sediment in front of left trash rack

Suction dredging using divers within intake tower and approach structure ~ $1,000,000.

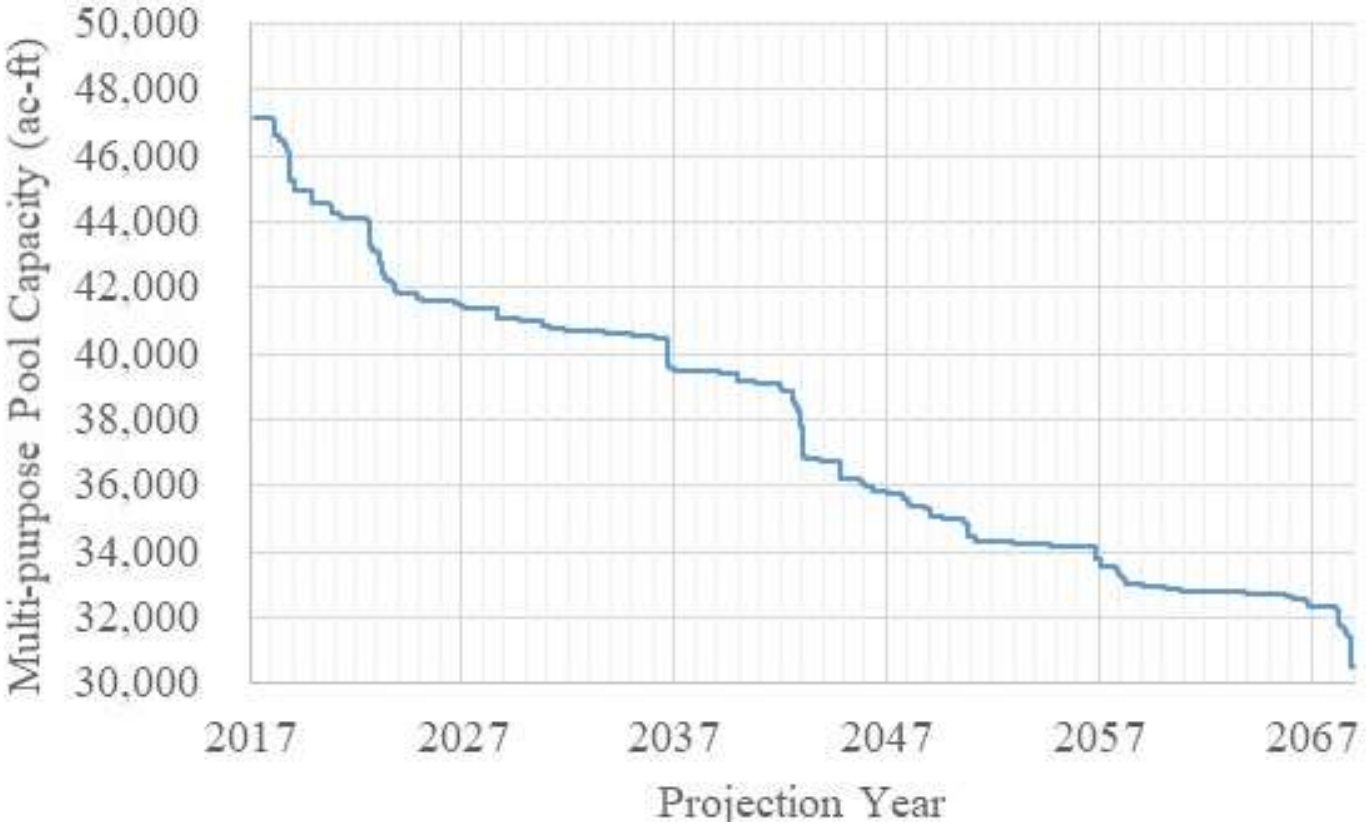
Sediment depths, 2014 = 9’, 2015 = 10’, and 2018 = 14’.



Kanopolis- Feb 2019

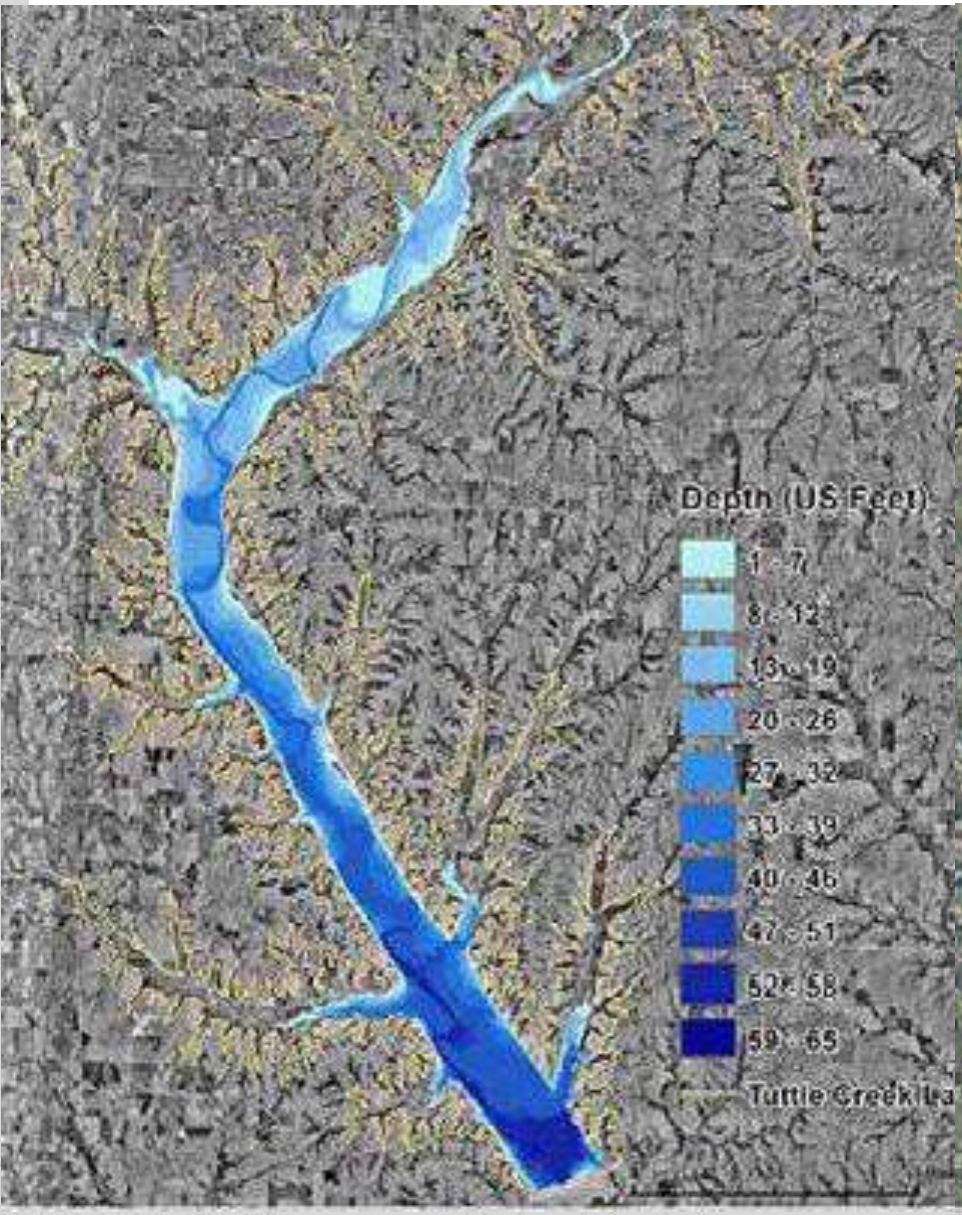


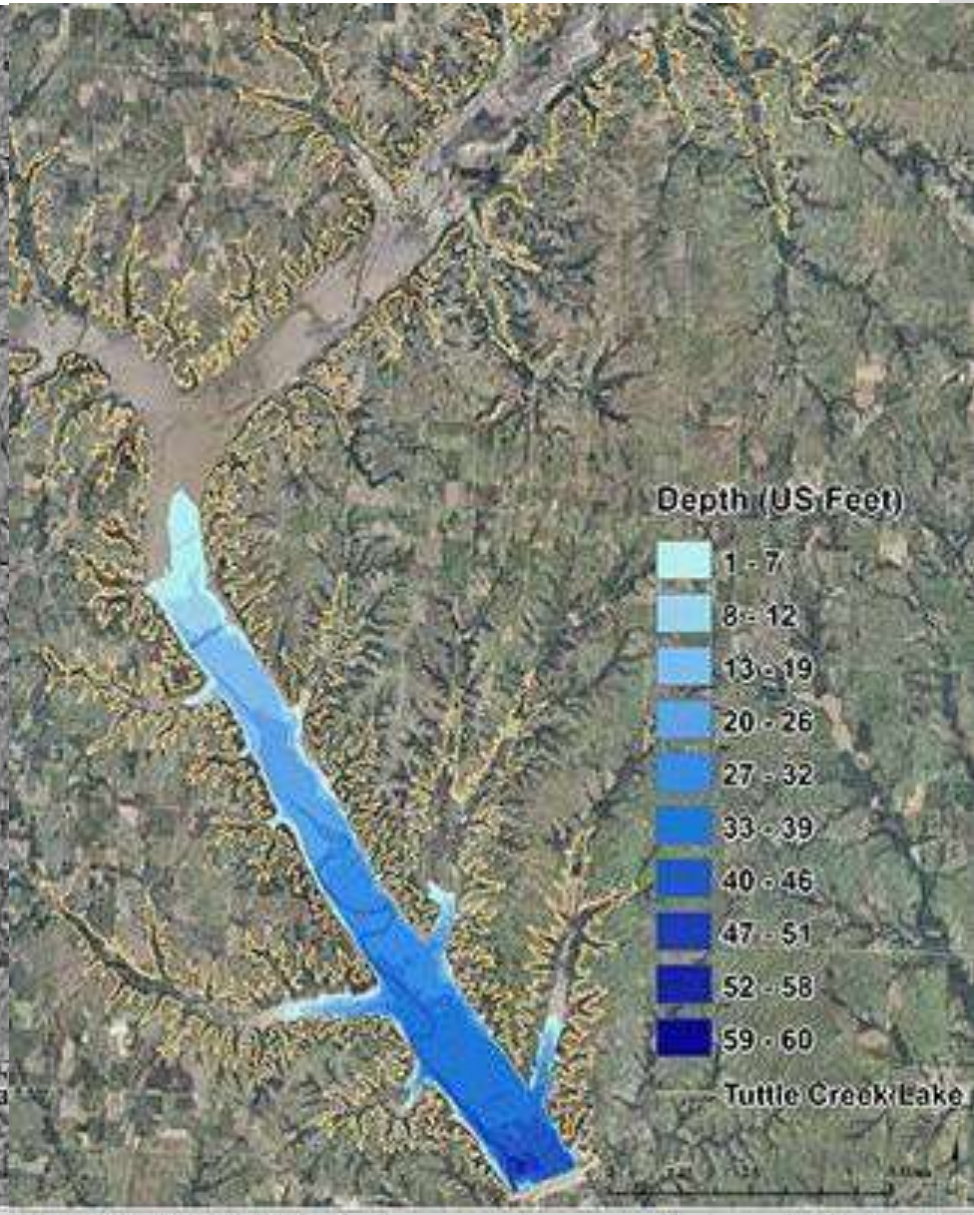
Kanopolis Lake: Prognosis



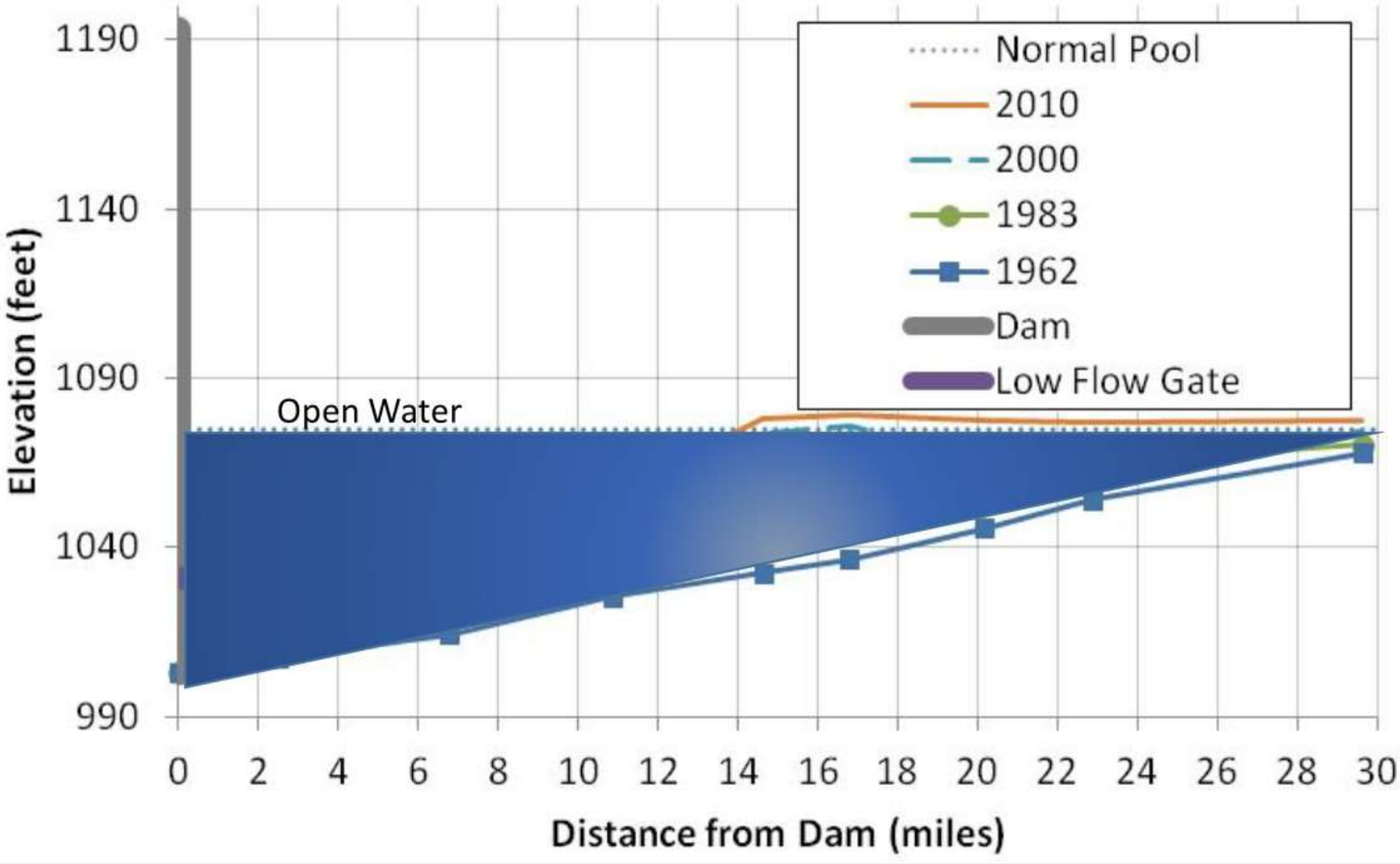
Kanopolis Multipurpose Pool Will be 58% Full by 2067

Tuttle Creek Lake: 1962 - 2010

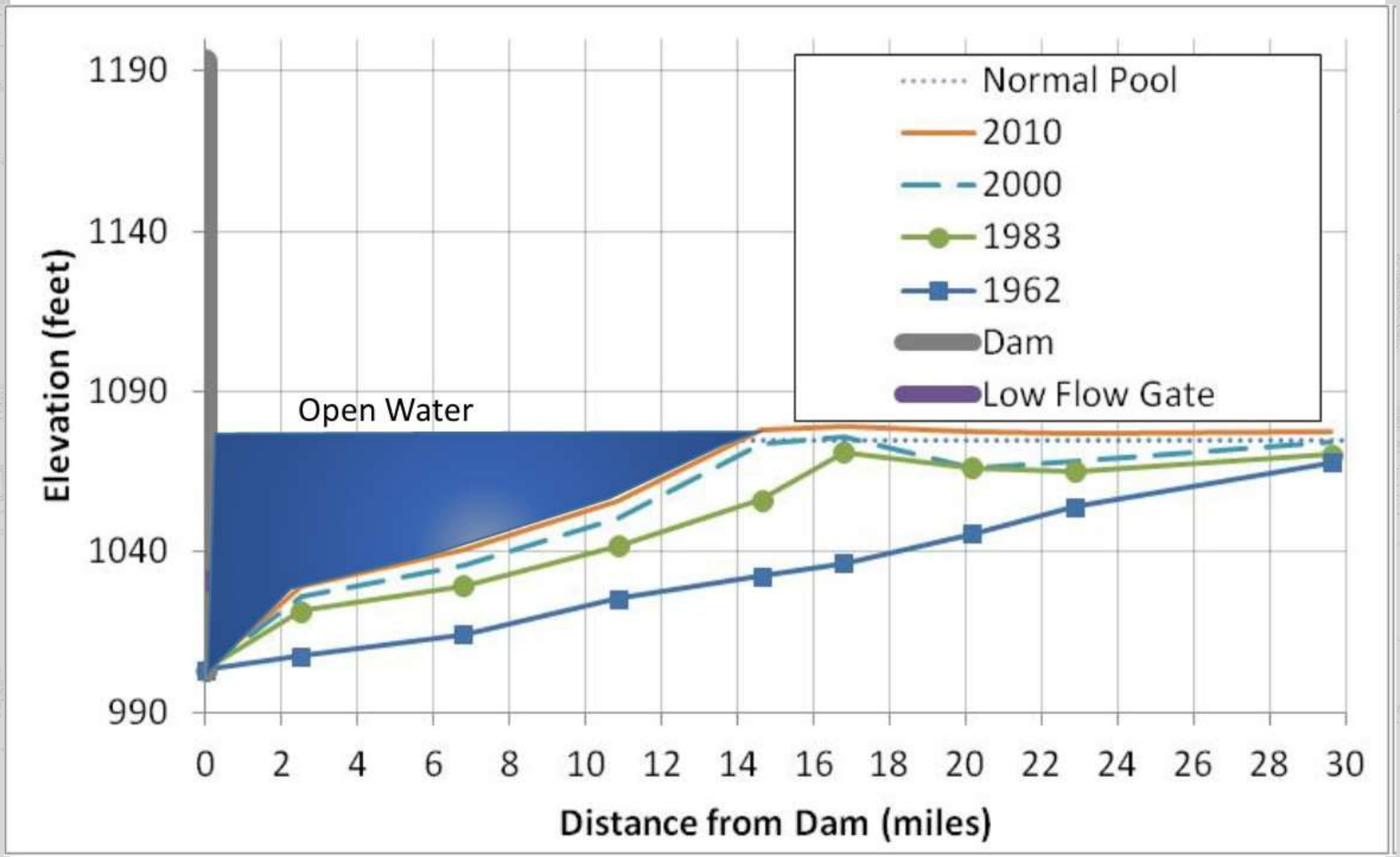




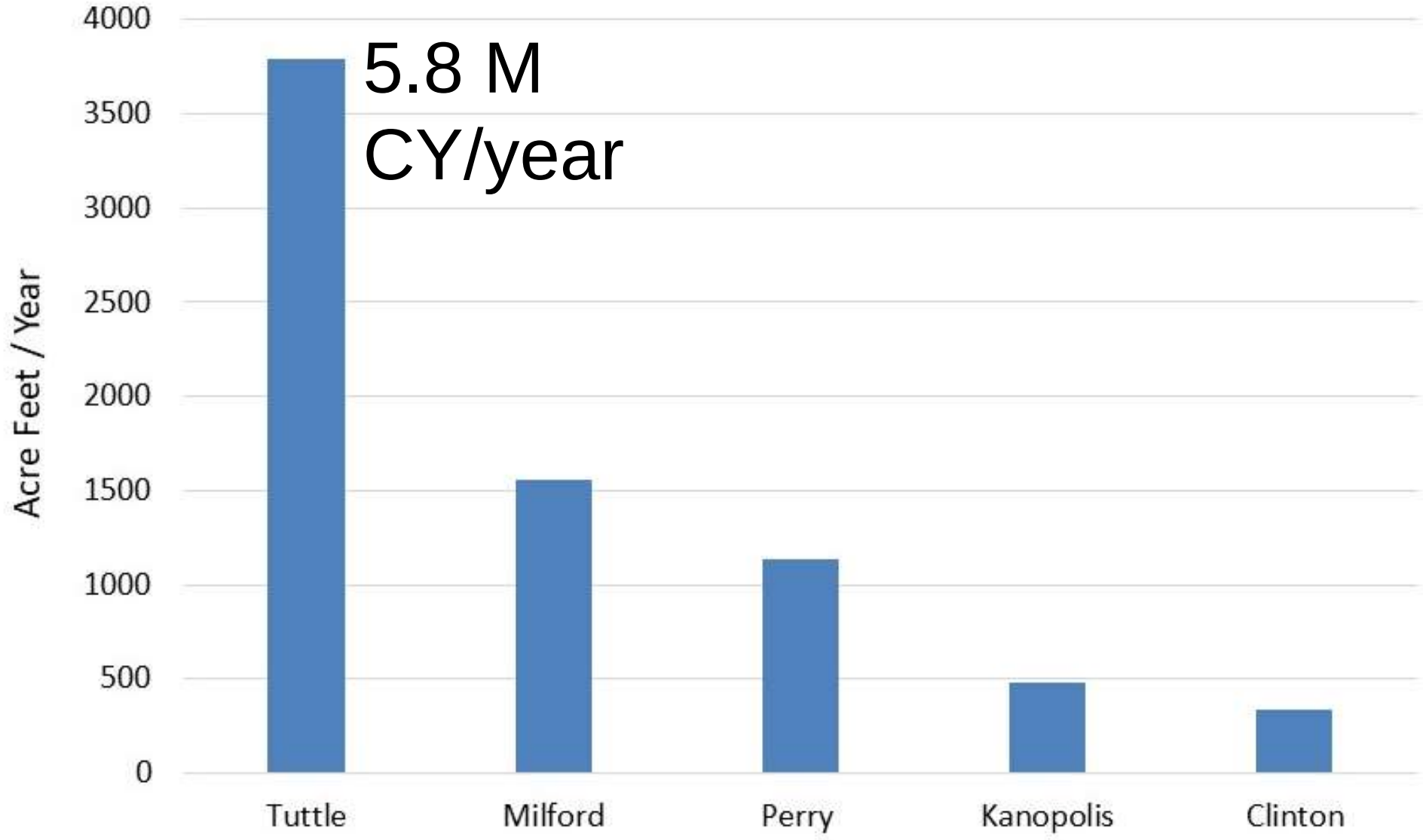
Tuttle Creek Lake: 1962



Tuttle Creek Lake: 2010



Sediment Accumulation in the Multipurpose Pool

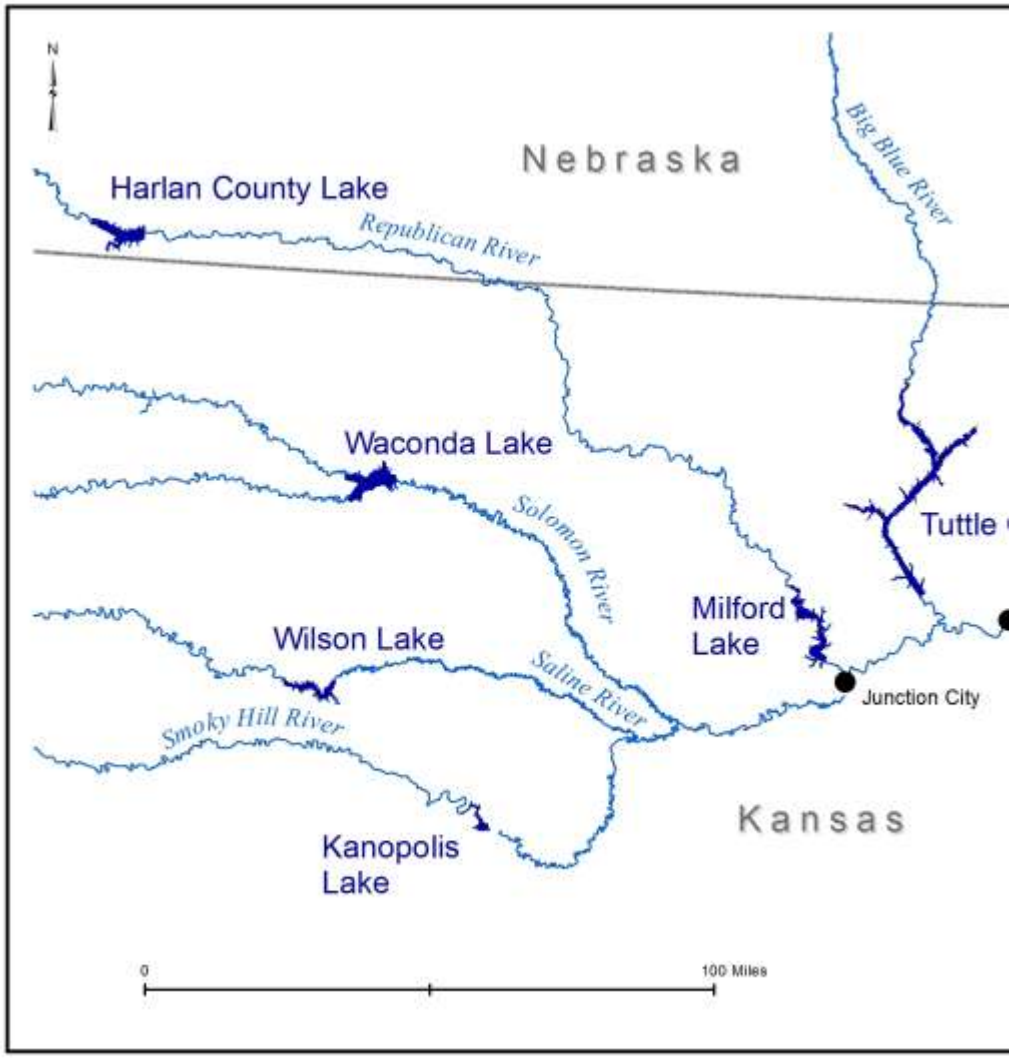


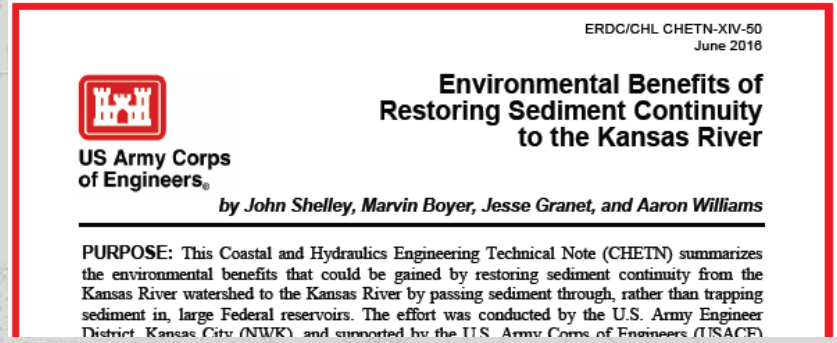
Environmental Impacts: Kansas River

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

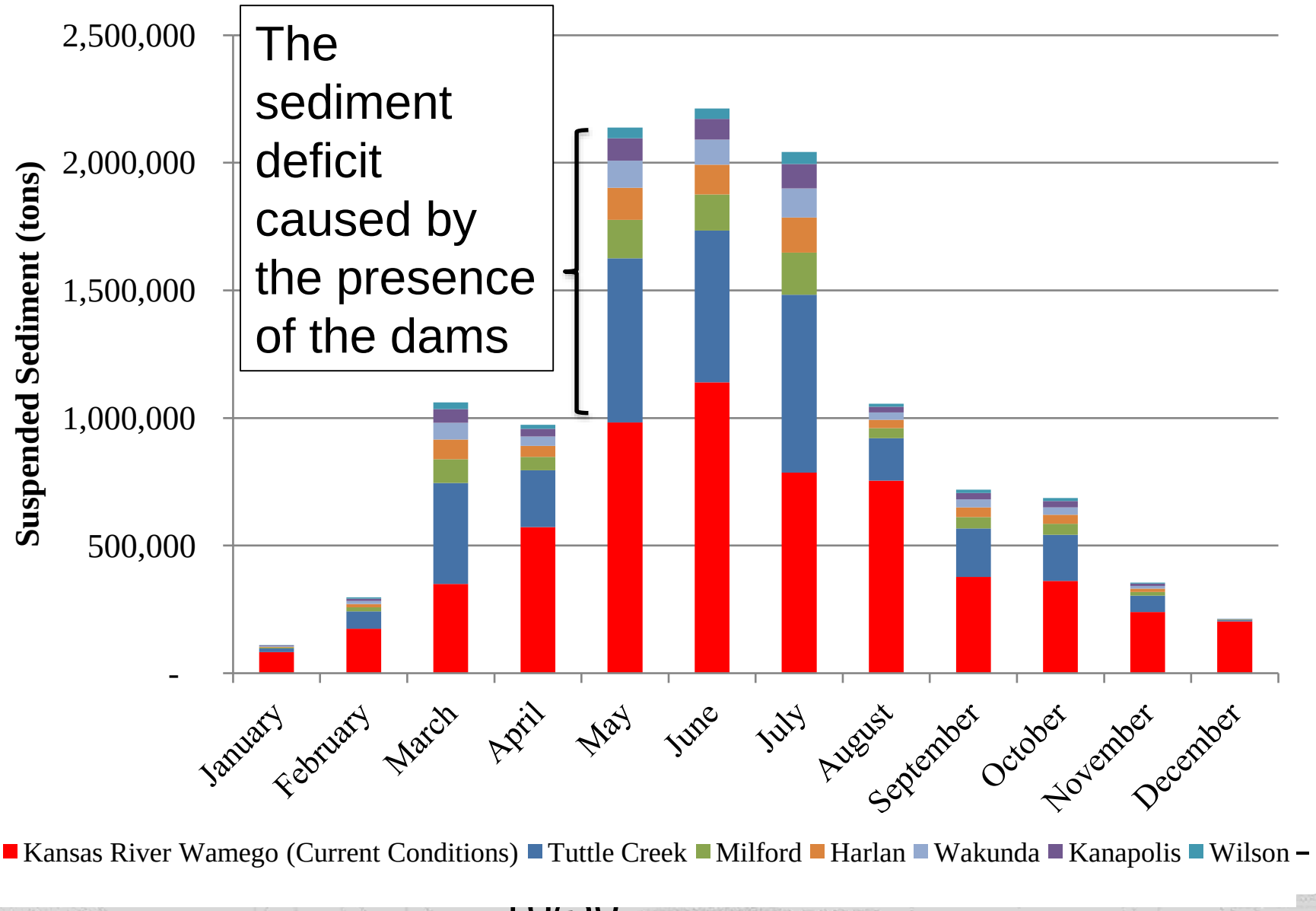
Environmental Benefits of Restoring Sediment Continuity to the Kansas River

US Army Corps of Engineers®

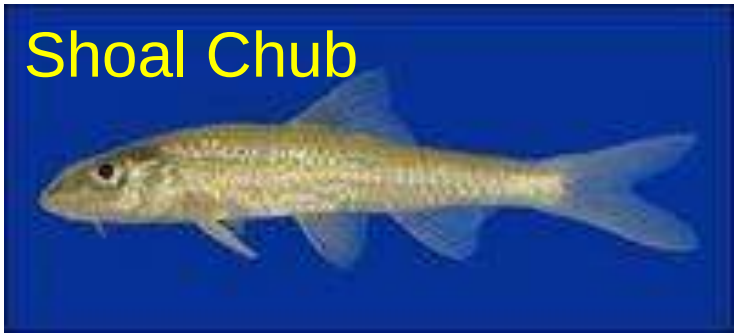
by John Shelley, Marvin Boyer, Jesse Granet, and Aaron Williams

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 sediment in, large Federal reservoirs. The effort was conducted by the U.S. Army Engineer District, Kansas City (NWK), and supported by the U.S. Army Corps of Engineers (USACE)

The dam-induced sediment deficit



Downstream on the Kansas River



Downstream on the Kansas River

http://www.kansas.net/~tjhittle/dredge.jpg

“The only way to sustainably manage the nation’s reservoirs is to pass the sediment downstream.”

-- Rollin Hotchkiss, Chair of the Corps Environmental Advisory Board, Speaking at the Kansas Water Conference

Outline

Why we all should care

Examples and Methods

Water Injection Dredging

Outline

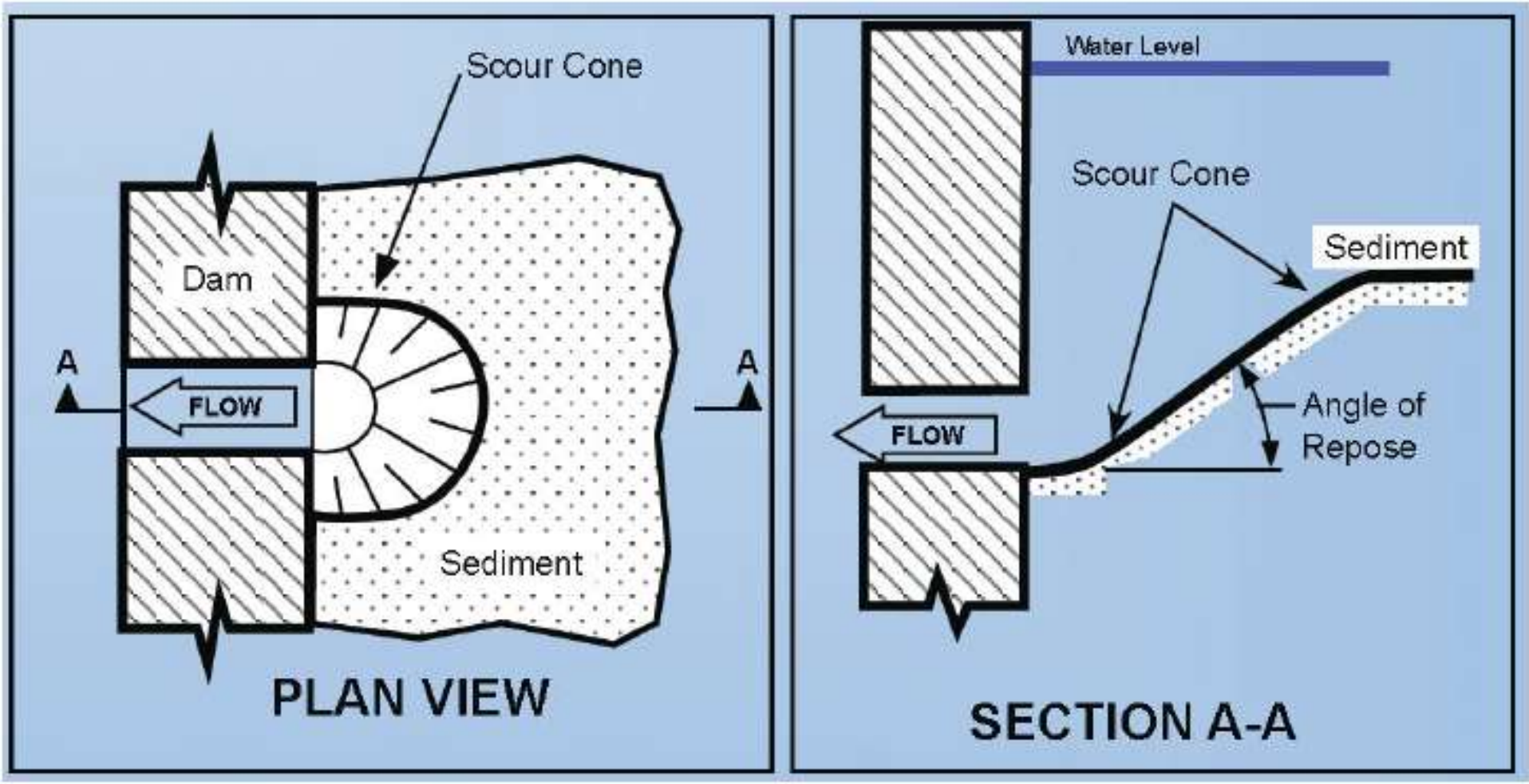
Why we all should care

Examples and Methods

- Lake maintenance
- Reservoir sustainability

Water Injection Dredging

Pressure Flushing



Credit: Gregory L. Morris

Pressure Flushing

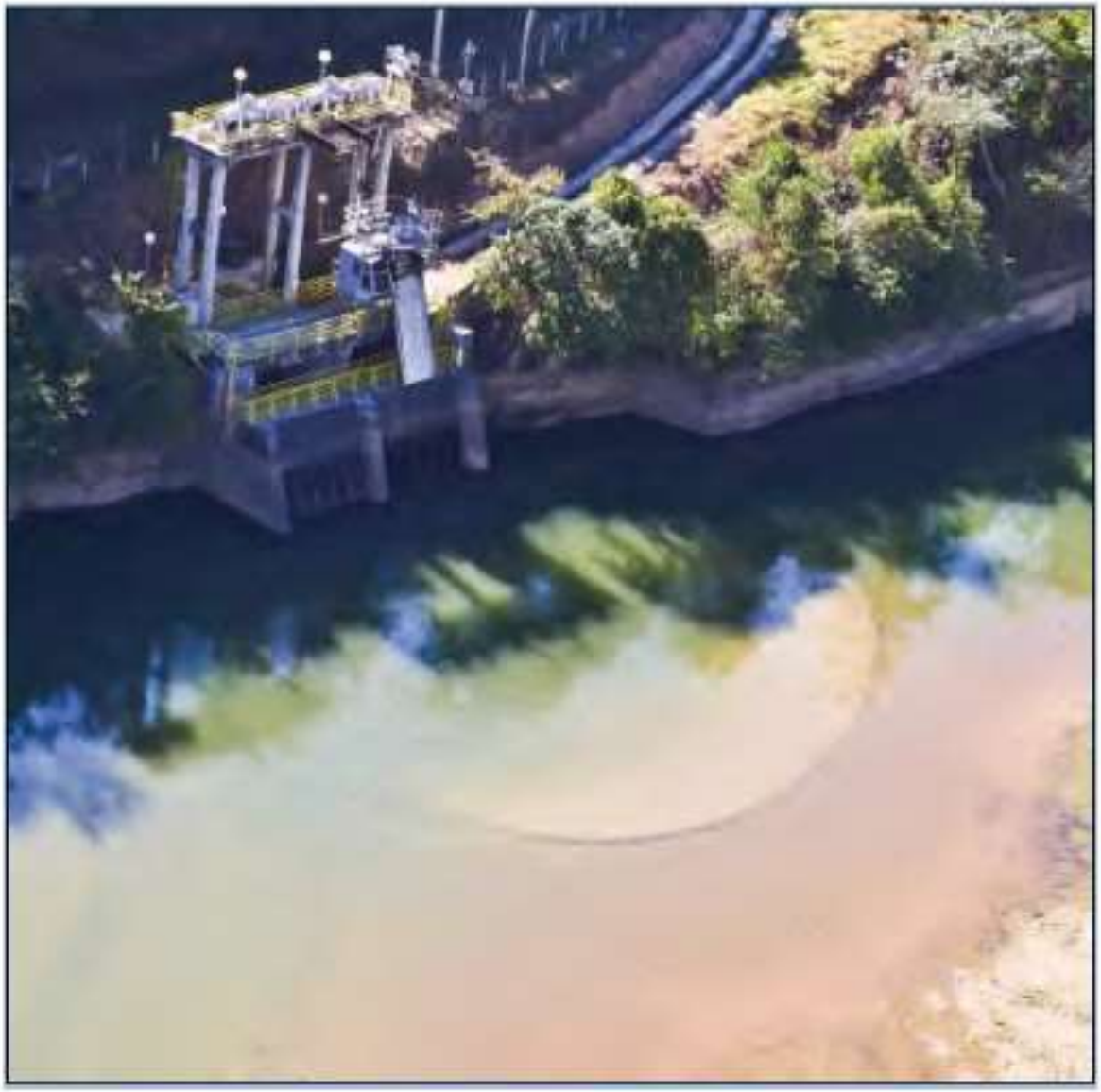


Photo: Gregory L. Morris

Cherry Creek Flush

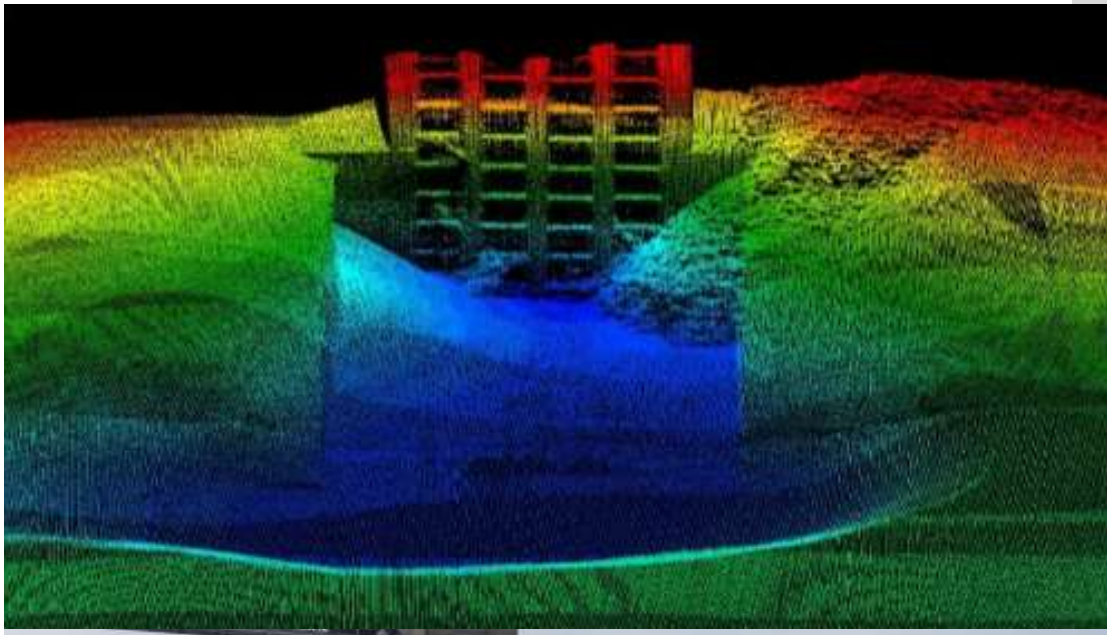
- **Pressure flush to maintain operational capability at low level outlet**
- **Every year alternating high (1300 cfs) and low (250 cfs) flow**

Blue Springs Lake, KC Metro Area

https://www.youtube.com/watch?v=qPKpueit7Qo

What about Kanopolis Lake?

- **Pressure flushes ineffective**
- **Mechanical dredging**
- **Hydraulic dredging**



Outline

Why we all should care

Examples and Methods

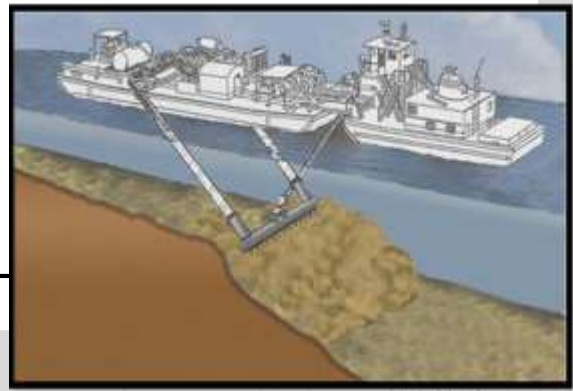
- Lake maintenance
- Reservoir sustainability

Water Injection Dredging

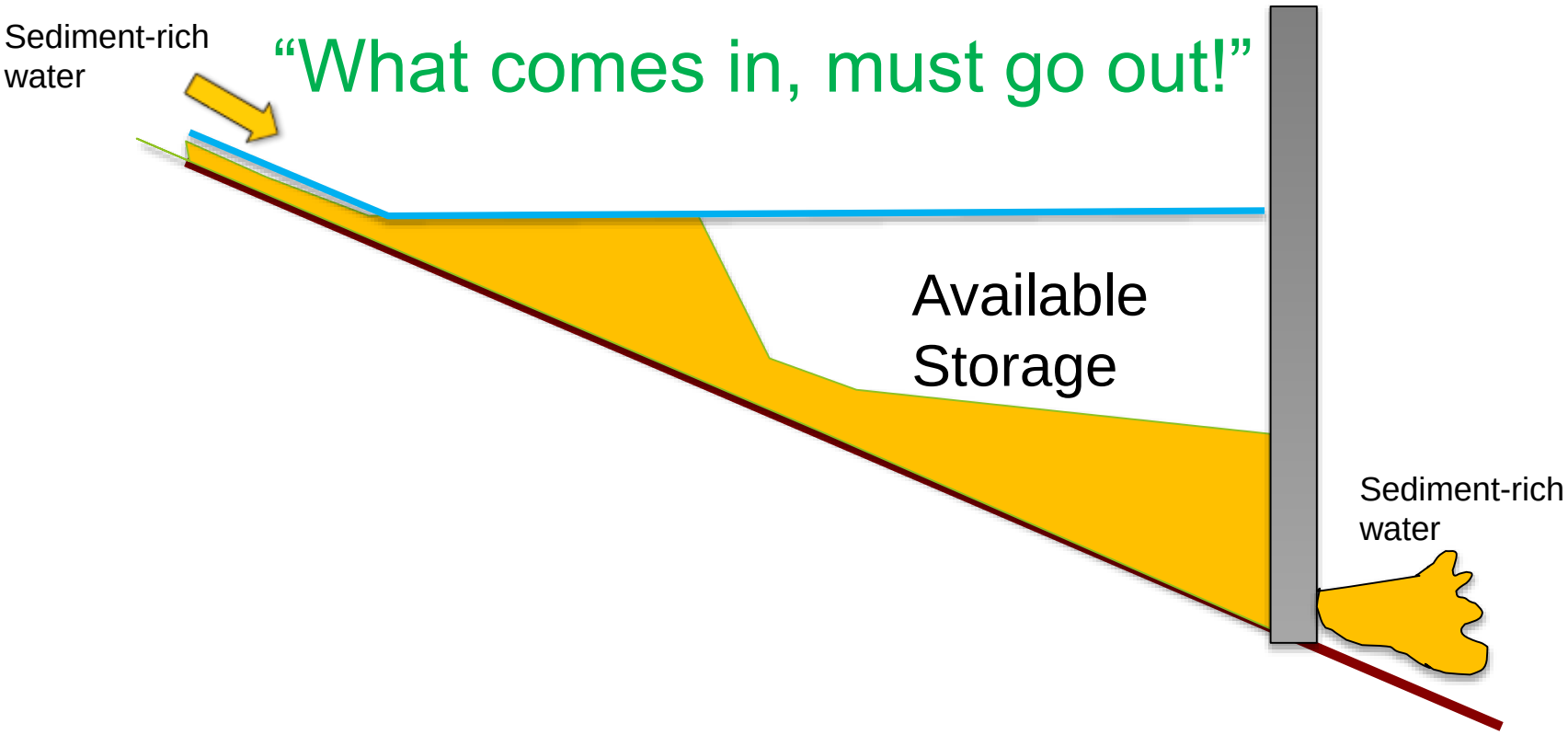
Array of Potential Solutions

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

Photo: Gregory L. Morris



Reservoir Sediment Sustainability



Dredging with Land Disposal?

Not a long-term strategy

Cost increases as available disposal sites are filled

Does not address the sediment deficit downstream

How to save 40% - 60% of total project cost:

Recharge the sediment downstream

Dredging with Downstream Discharge Example - Millsite Reservoir

Dredging Example – Millsite Reservoir

Dredging Example – Millsite Reservoir

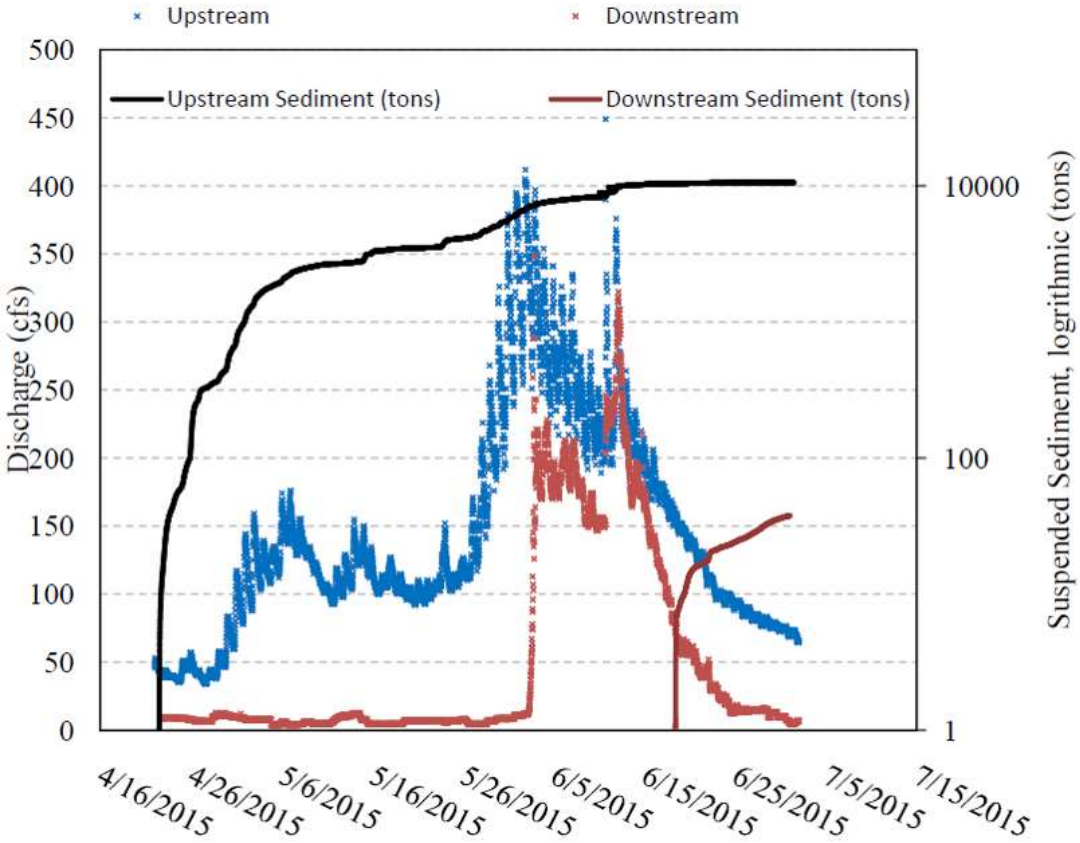
Dredging Example – Millsite Reservoir

Dredging Example – Millsite Reservoir

Dredging Example – Millsite Reservoir

Saves 40% - 60% of total project cost

Potential for positive ecosystem benefits



RESERVOIR SEDIMENT MANAGEMENT

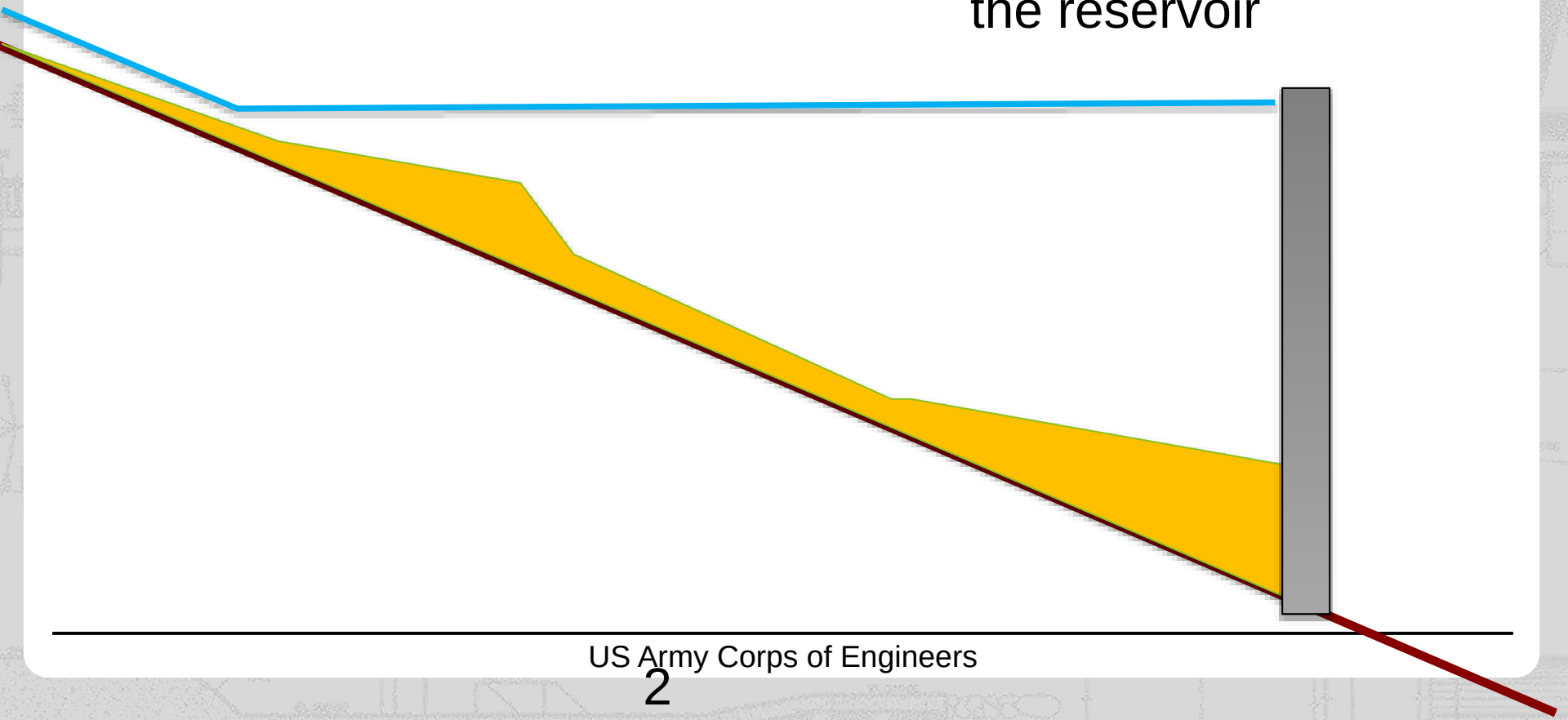
JOHN SHELLEY, PH.D., P.E.
U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT

Part 2/2

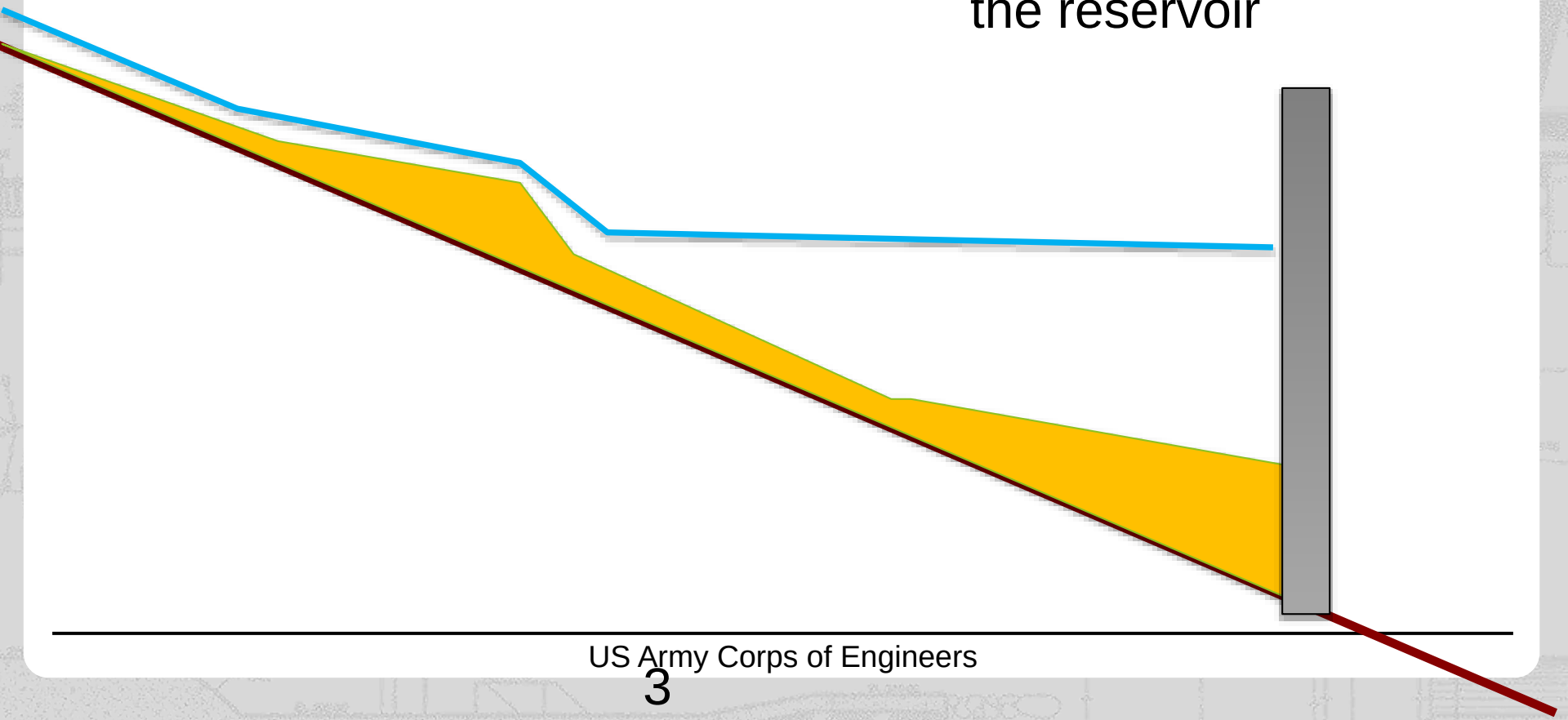
US Army Corps of Engineers

U.S. ARMY

Reservoir Drawdown Flushing

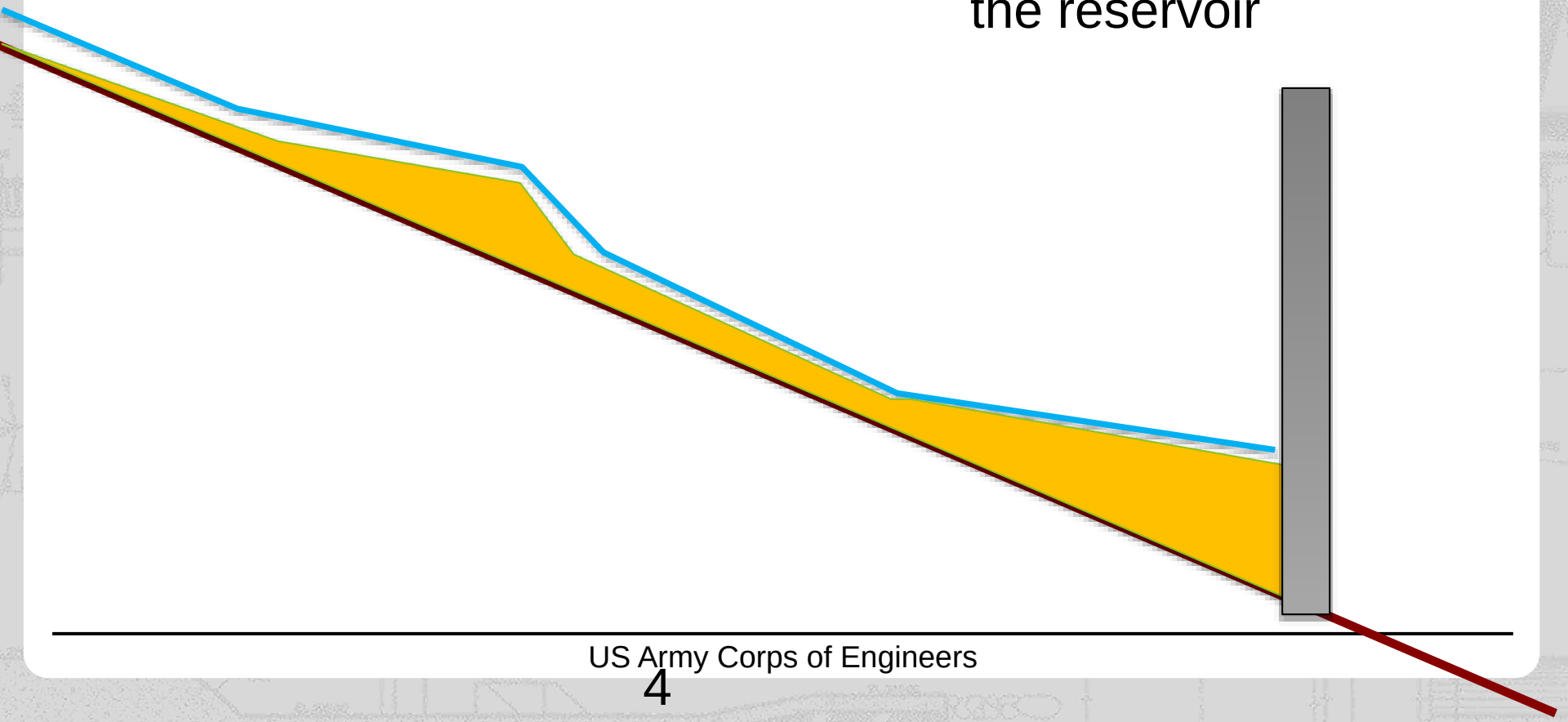


Reservoir Drawdown Flushing

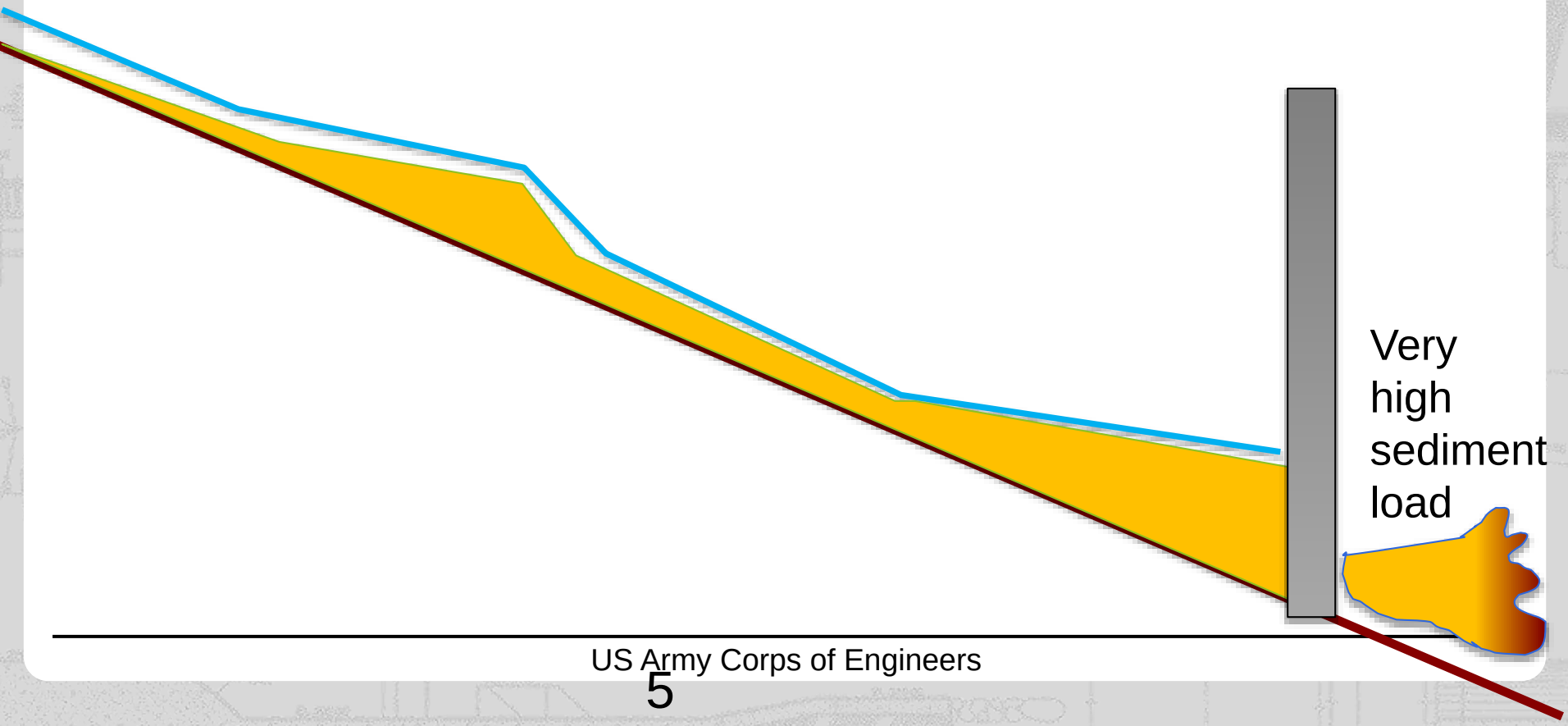


Reservoir Drawdown Flushing

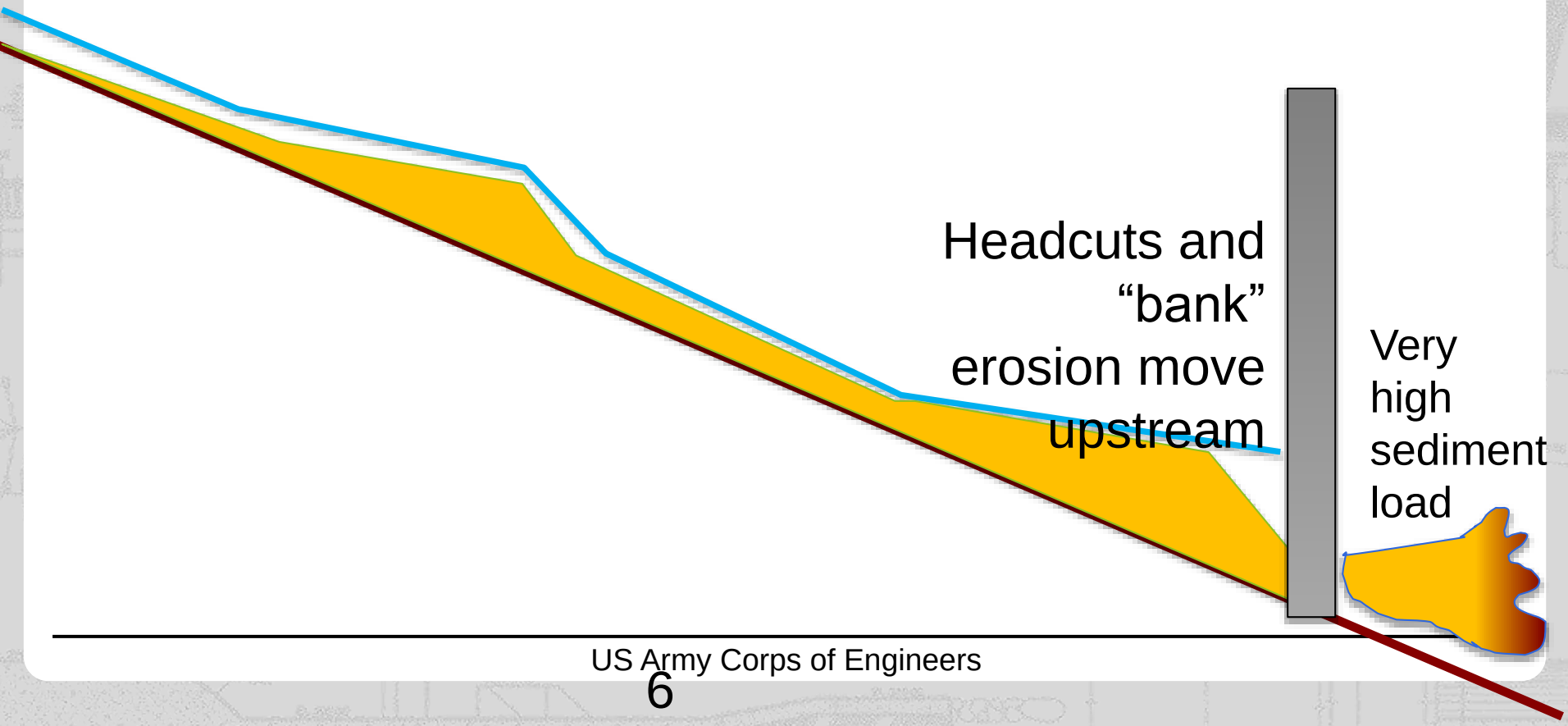
Draw down
the reservoir



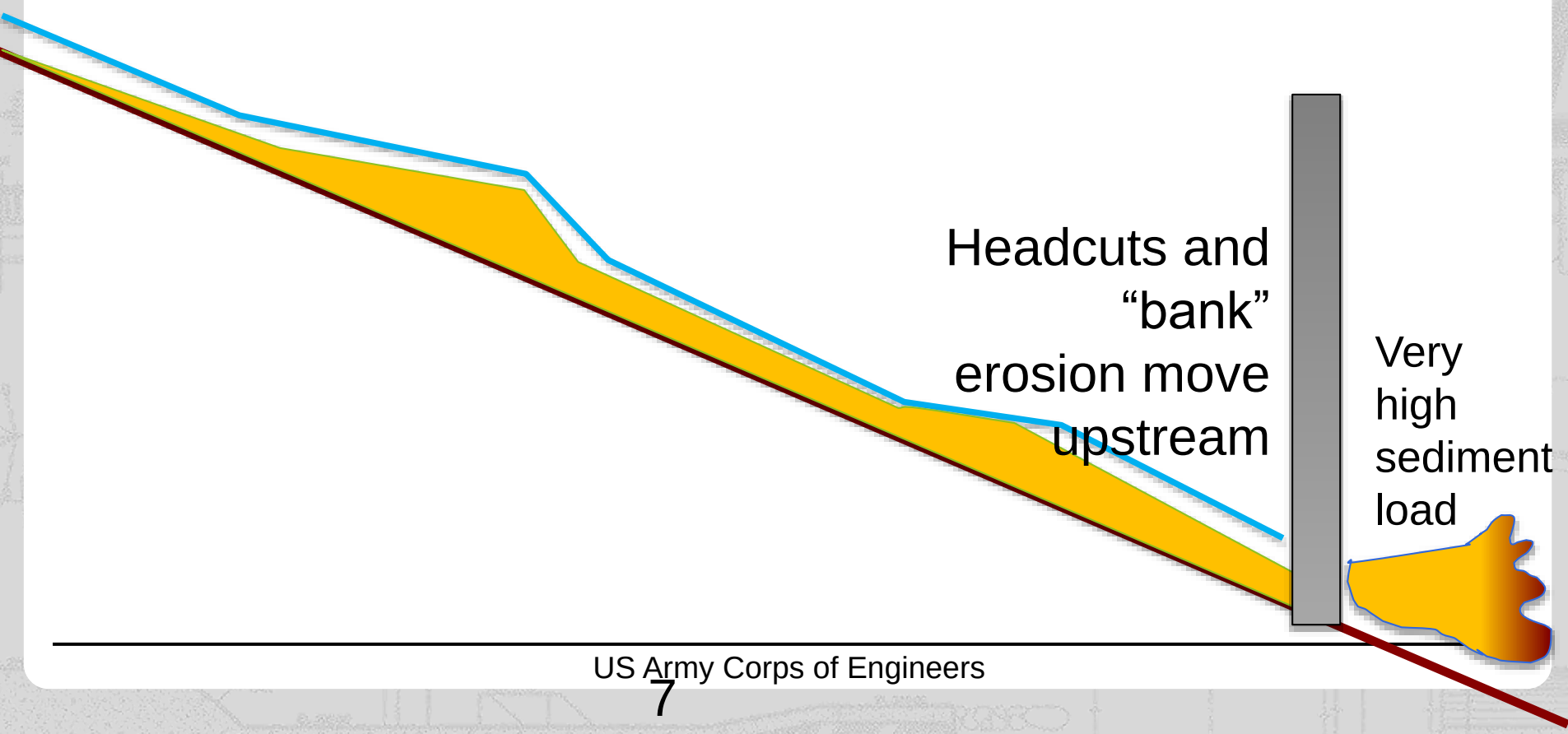
Reservoir Drawdown Flushing



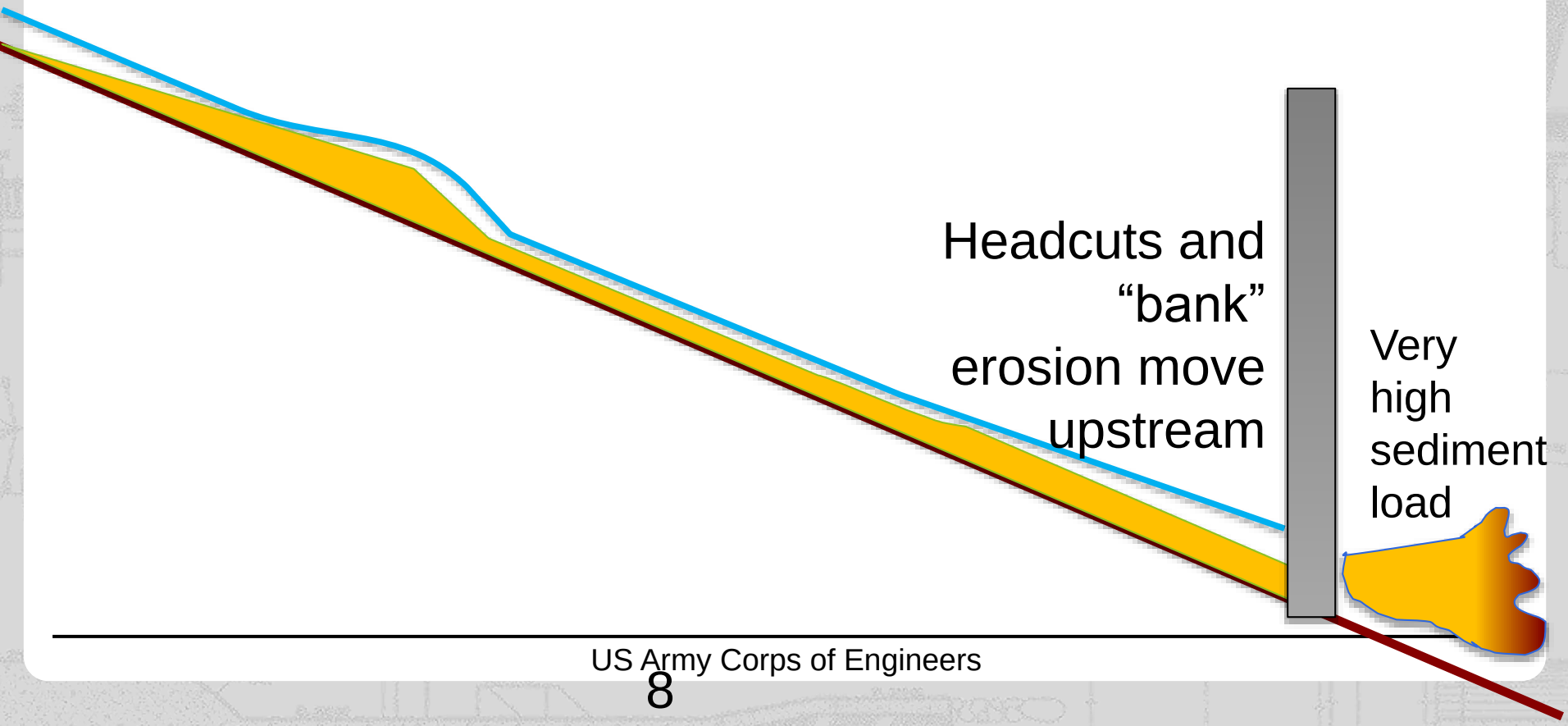
Reservoir Drawdown Flushing



Reservoir Drawdown Flushing

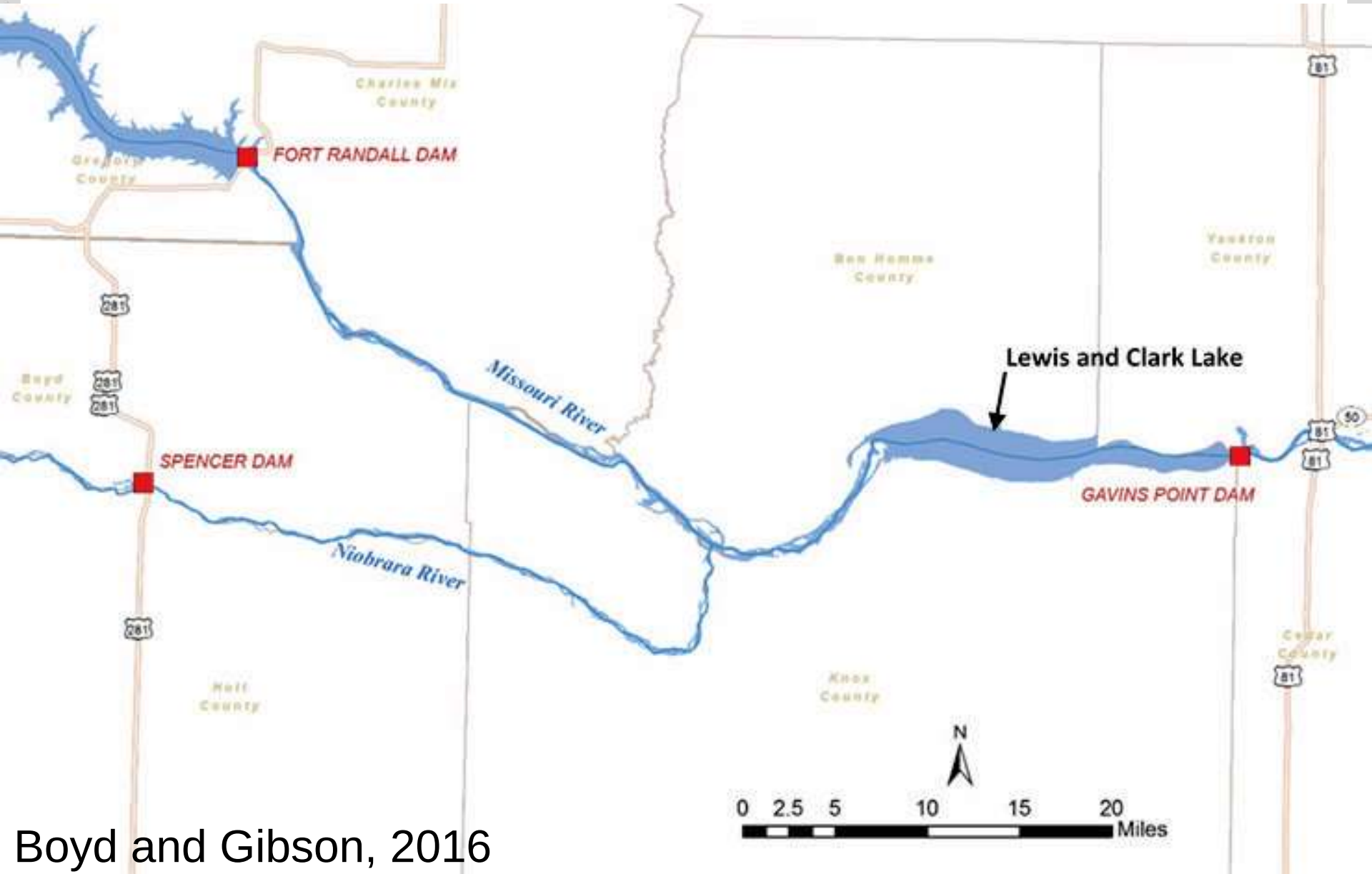


Reservoir Drawdown Flushing



Reservoir Flushing: Fall Creek

Reservoir Flushing: Spencer Dam



Boyd and Gibson, 2016

Reservoir Flushing: Spencer Dam

Reservoir Flushing Challenges

- Must have a low-elevation gate
- Uses ALL the water
- Will not usually flush out the “floodplain” i.e. maintained reservoir storage typically much less than the original
- Sediment-laded effluent – high concentration short duration

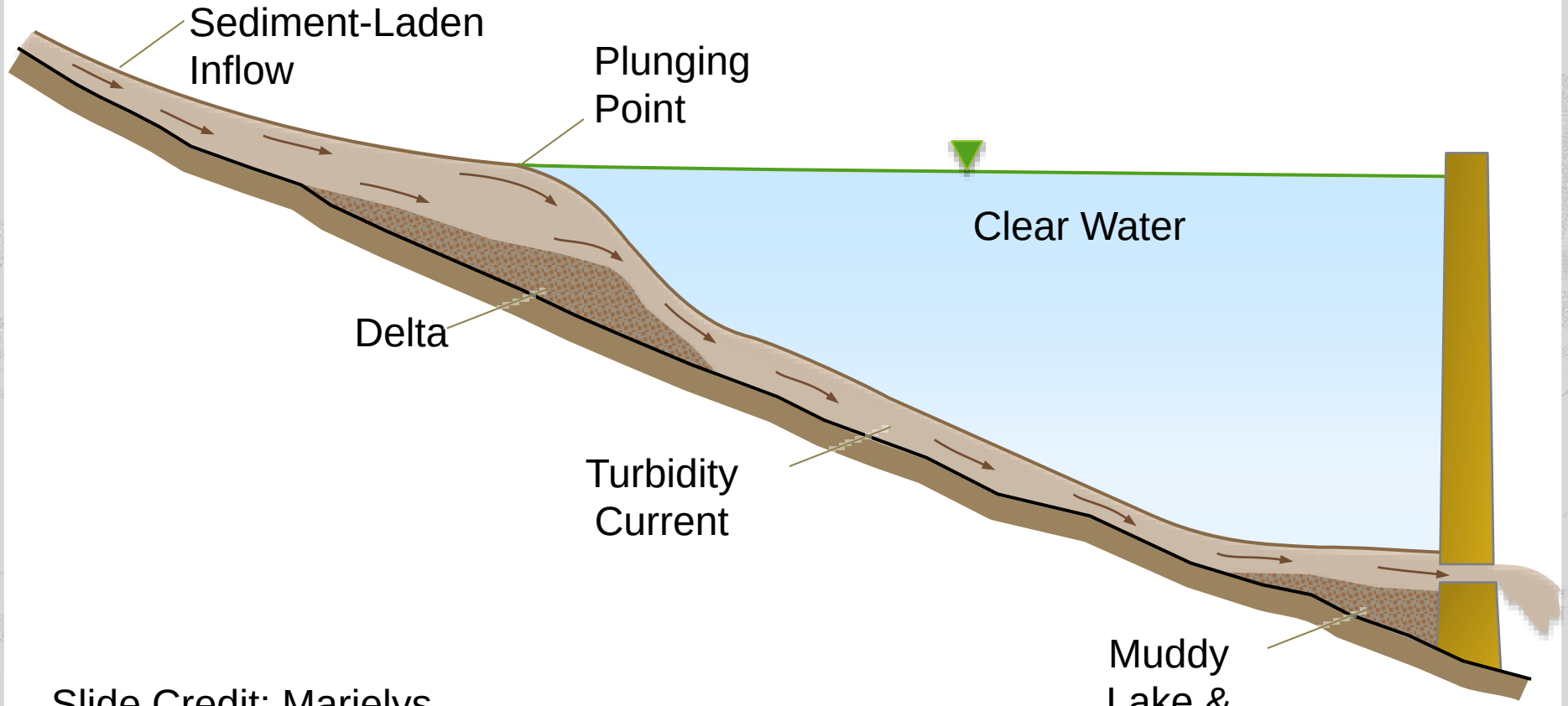
Gebidim Dam Flushing

Drawdown flushing is for small (typically hydropower) reservoirs

- Spencer Dam was able to maintain 10% of its original storage by flushing twice a year for two weeks

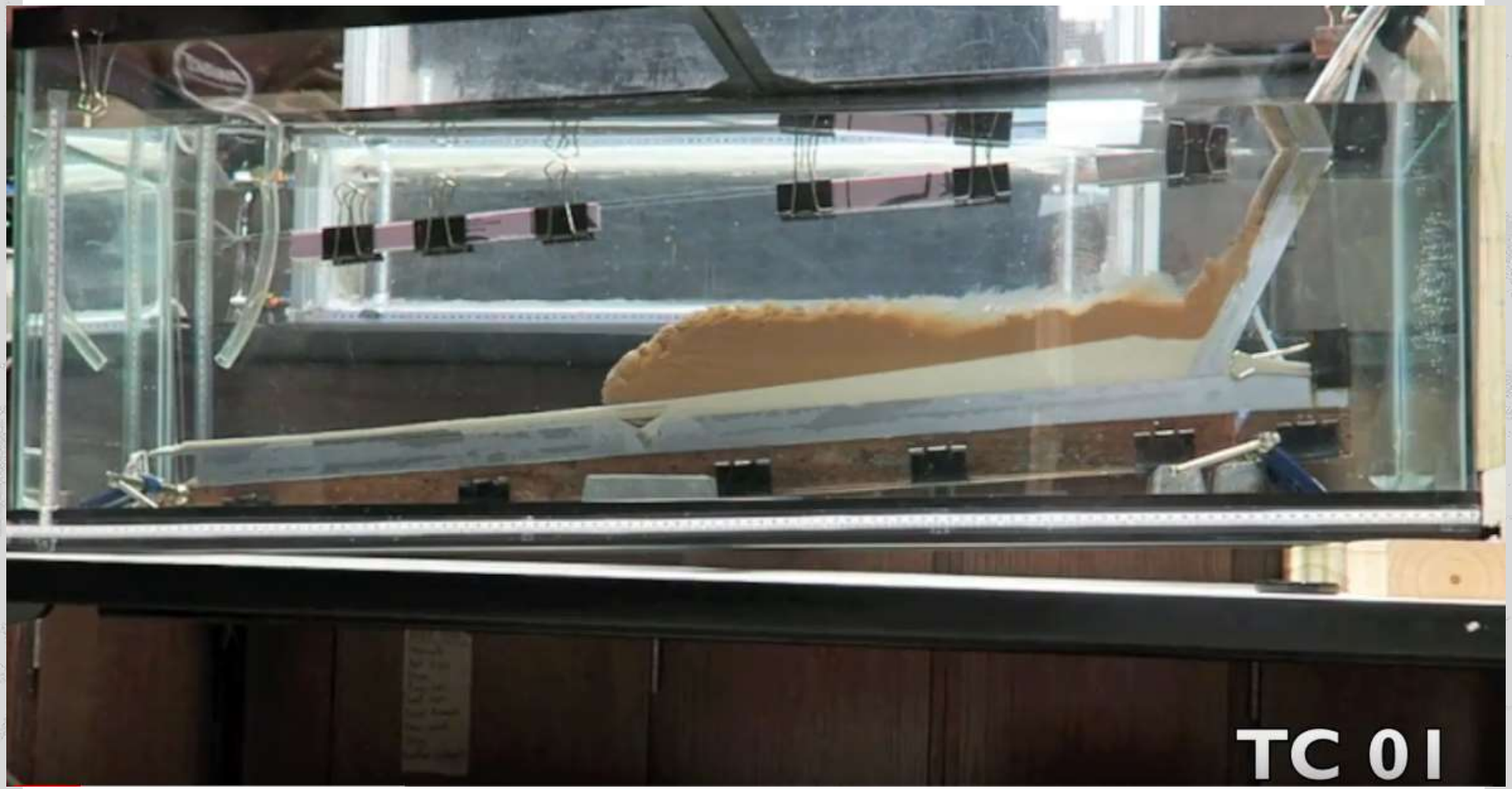
- If agitation, water injection, or some other type of dredging were employed along with the flush, a larger pool could have been maintained.

TURBIDITY CURRENT VENTING



Slide Credit: Marielys Ramos-Villanueva

Turbidity Current: Flume Study



https://www.youtube.com/watch?v=HP7tnryvIfs&t=23s

Photo Source:
Greg Morris


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


Conchas Dam
October, 2017
Legend
Google Earth
N
500 ft


Cochiti Lake
August 2009
Legend
Cochiti Lake
Google Earth
2 mi
N


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


Cochiti Dam
August 2009
Legend
Google Earth
1000 ft
N

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

Outline

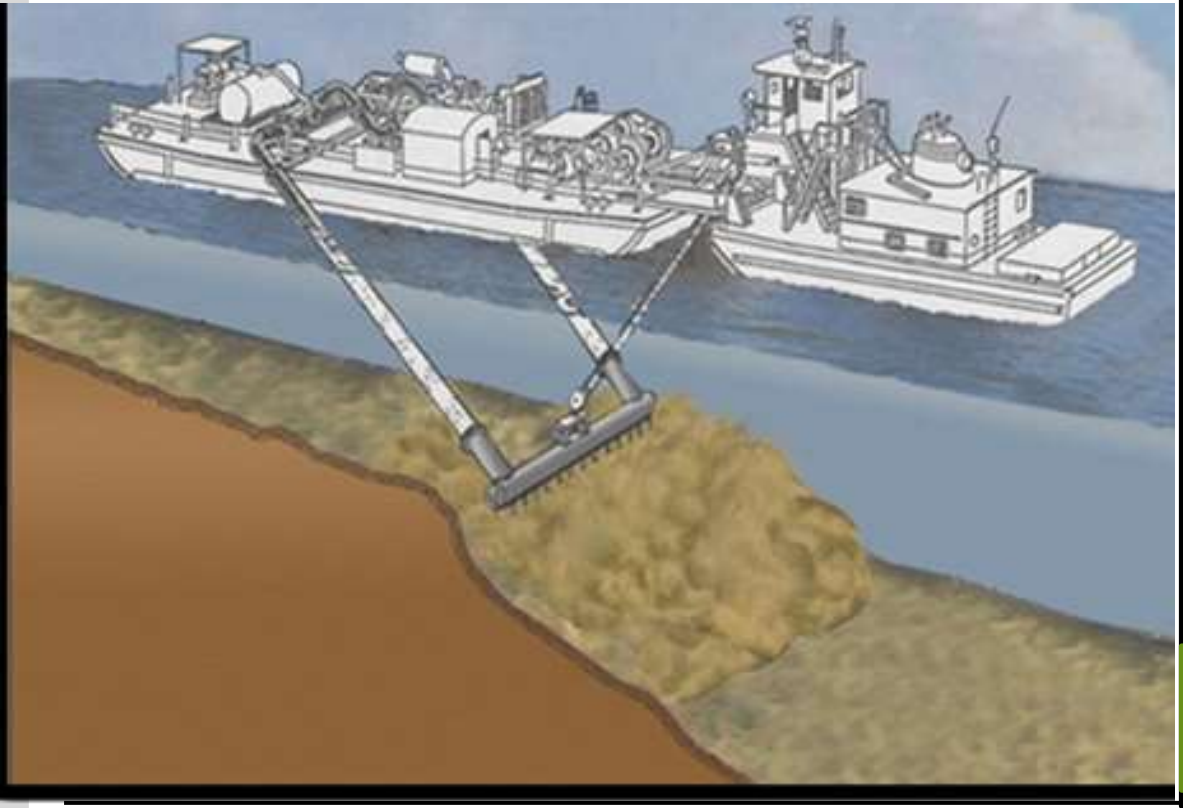
Why we all should care

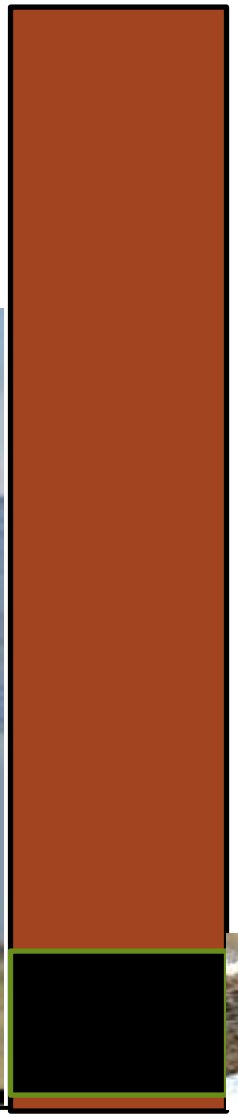
Examples and Methods

Water Injection Dredging

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

Water Injection Dredging (WID)





US Army Corps of Engineers

https://www.youtube.com/watch?v=JfVK5rLYXiM

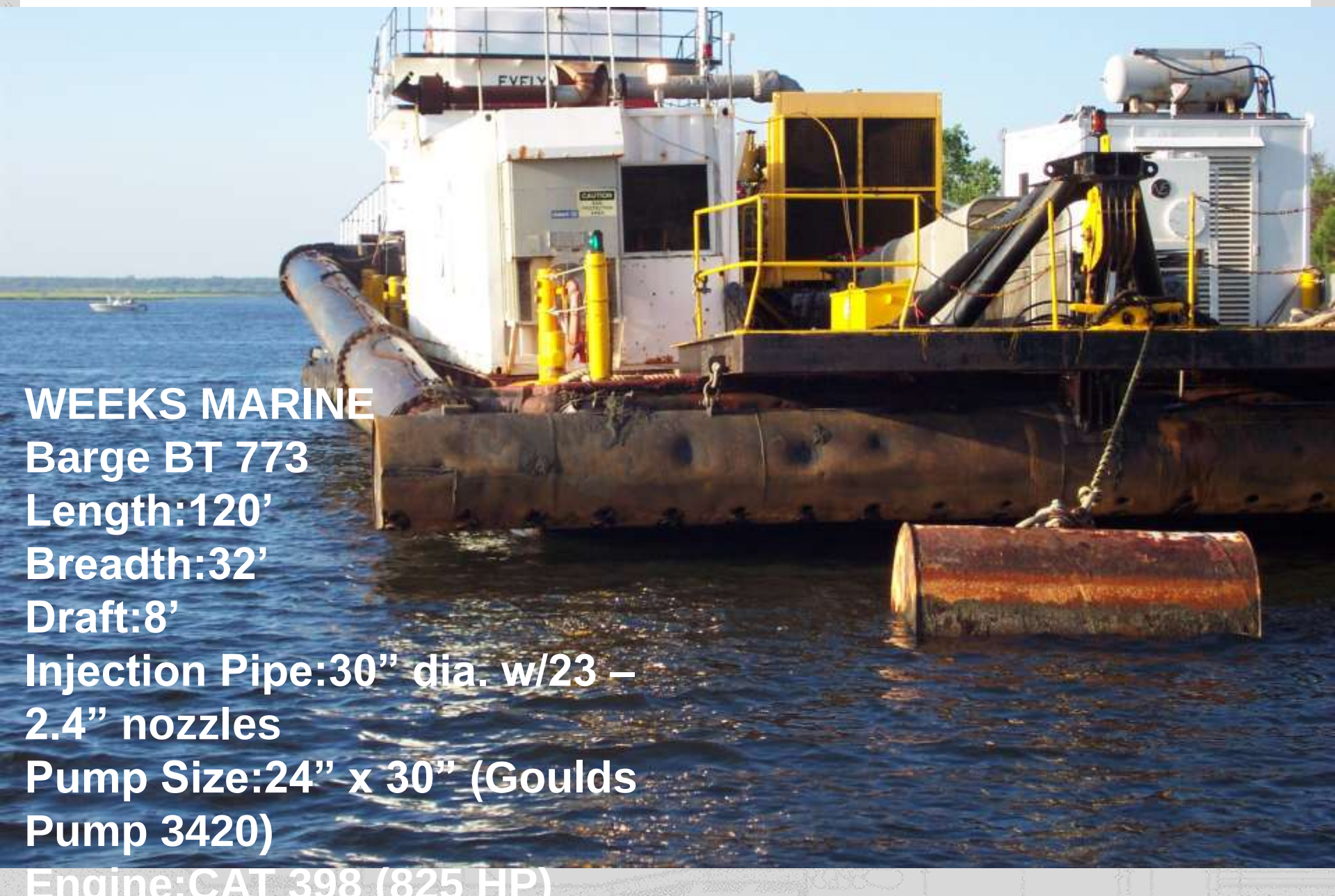
Worldwide WID

US Army Corps

Worldwide WID

The Marine Group “150 m^3/hr in s
material”

Water Injection Dredge (WID)
Weeks Marine BT 773



WEEKS MARINE
Barge BT 773
Length:120’
Breadth:32’
Draft:8’
Injection Pipe:30” dia. w/23 – 2.4” nozzles
Pump Size:24” x 30” (Goulds Pump 3420)
Engine:CAT 398 (825 HP)

US WID Dredging Projects

Traditional Operations
Private Dock Work
Mississippi River
- Grain Dock –Convent, LA
- Refinery –Baton Rouge, LA
- Refinery –Sunshine, LA
- Grain Dock –Destrehan, LA
- Chemical –Plaquemines, LA
- Refinery –St. James, LA
- Barge Dock -Jefferson, LA
- Refinery –St. James, LA
- Refinery –Jefferson, LA
- Refining Facility –Baton Rouge, LA
- Agricultural –Jefferson, LA

Atchafalaya River
- Refinery –Krotz Springs, LA

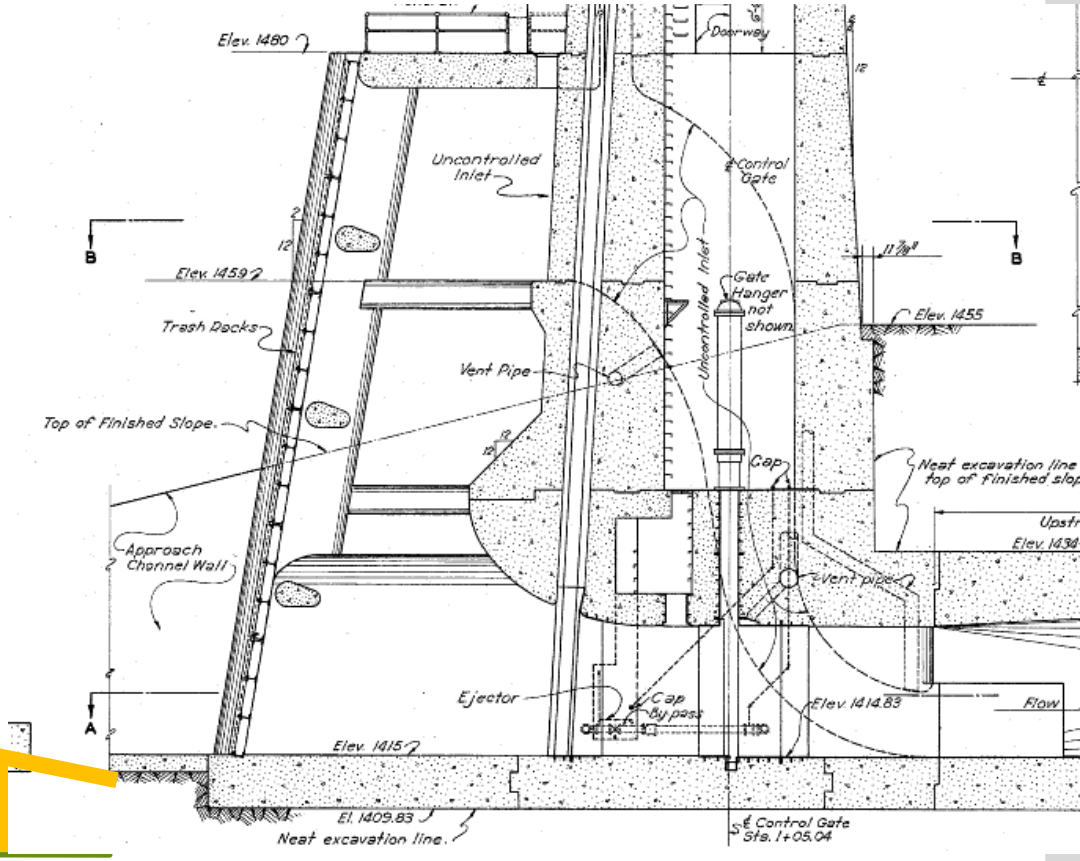
Federal Navigation
New Orleans District
- New Orleans Harbor
- Michoud Canal
- Miss. River Gulf Outlet
- E & W Calumet Floodgates
- Tiger Pass Channel

Galveston District
- Houston Ship Channel
- Bayport Ship Channel

Mobile District
- Horn Island

Source: WEEKS MARINE

More Good News: Tuttle Creek Lake Infrastructure

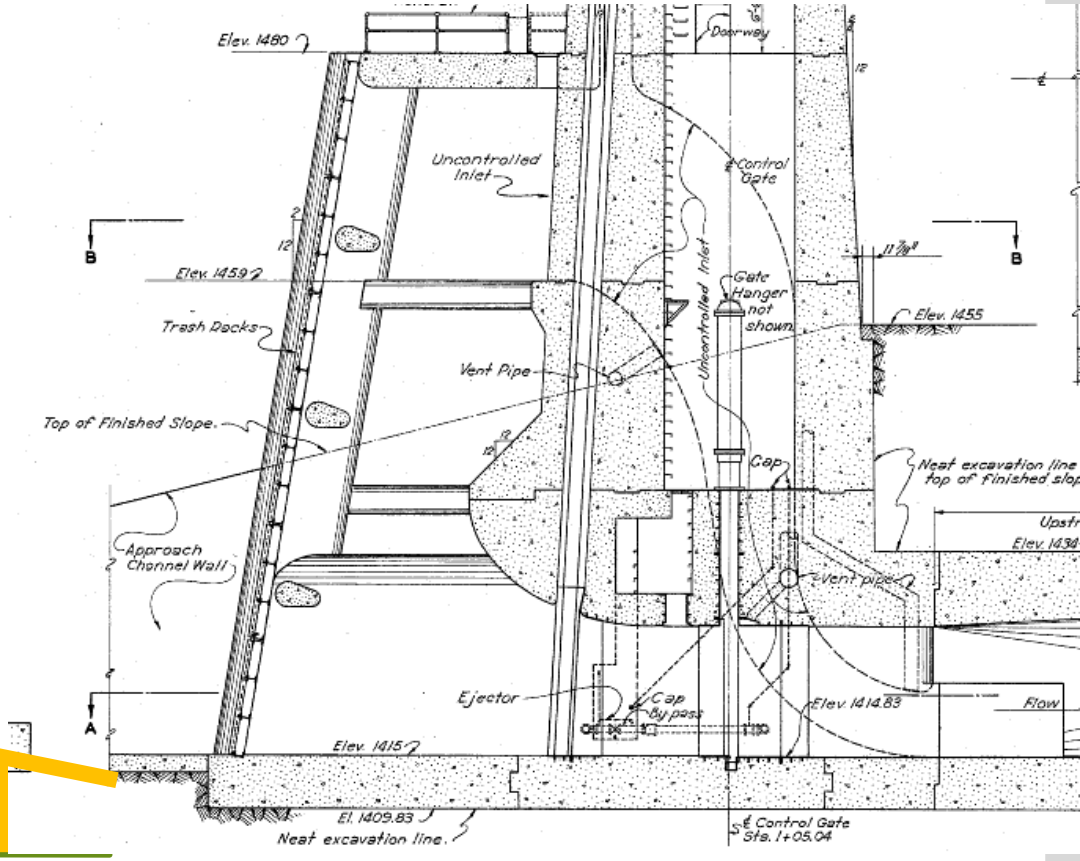


Lake Bottom

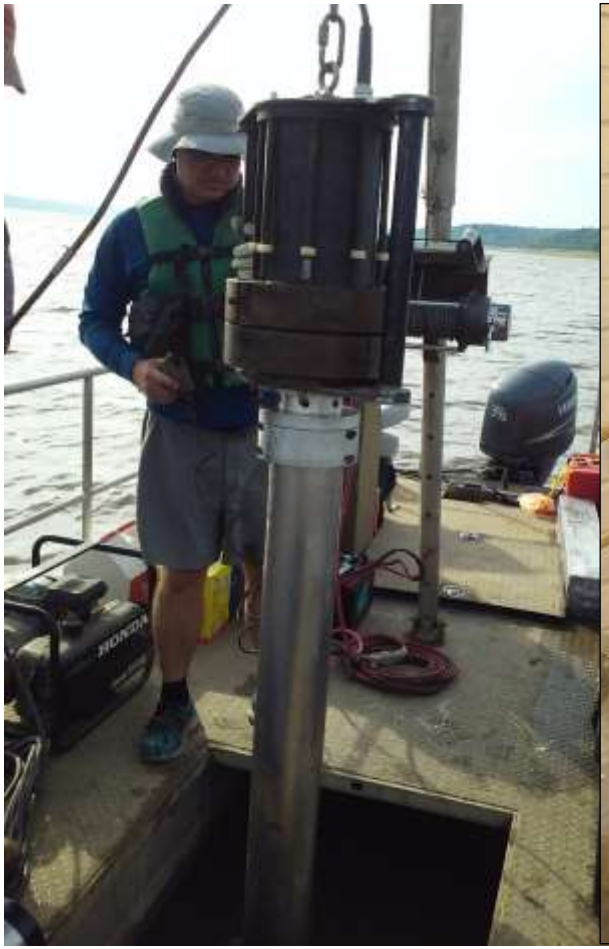
More Good News: Sediment is Clean

Sediment tests: Not contaminated

Lake Bottom



More Good News: Sediment is Fine and Erodible

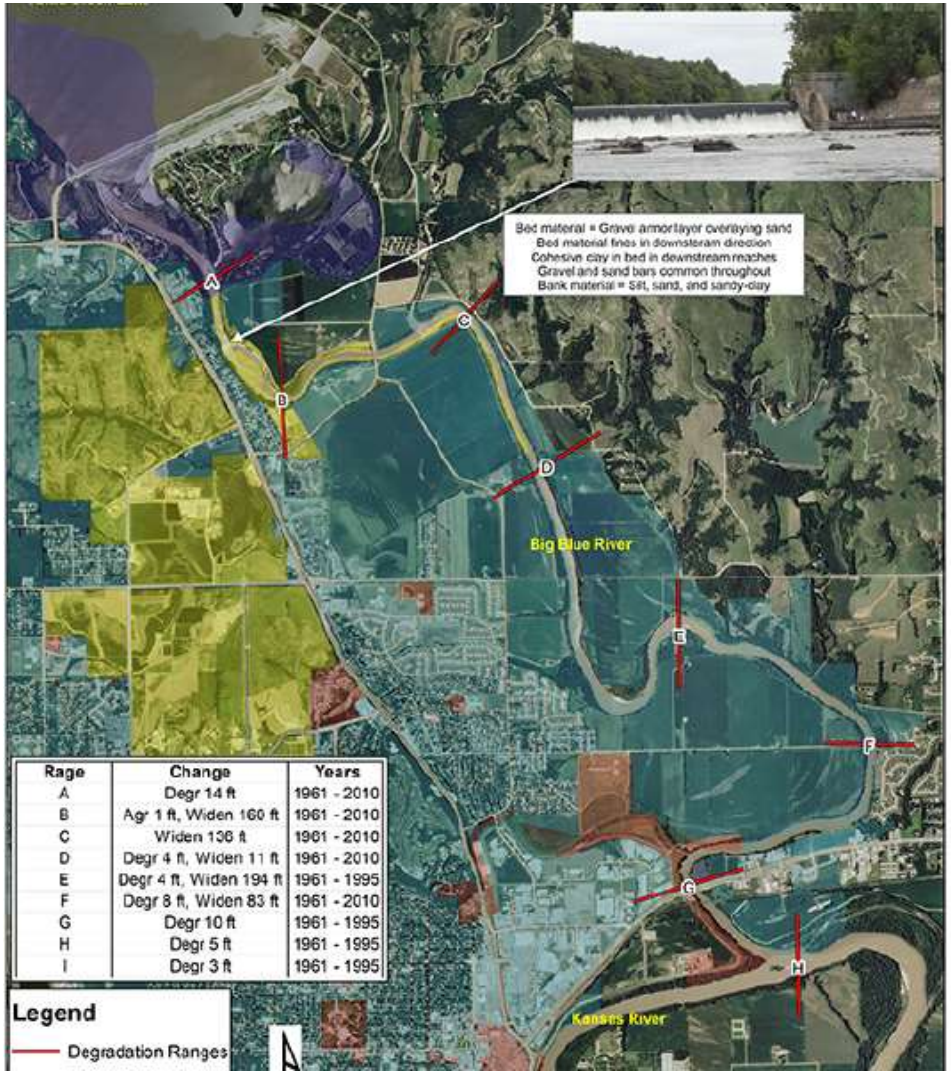


More Good News: Sediment is Fluidizable

https://youtu.be/VU3eExJjAsM

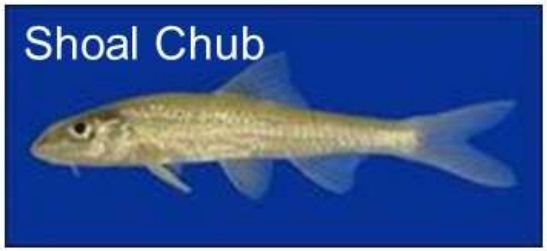
More Good News: Downstream Channel Conditions Favorable

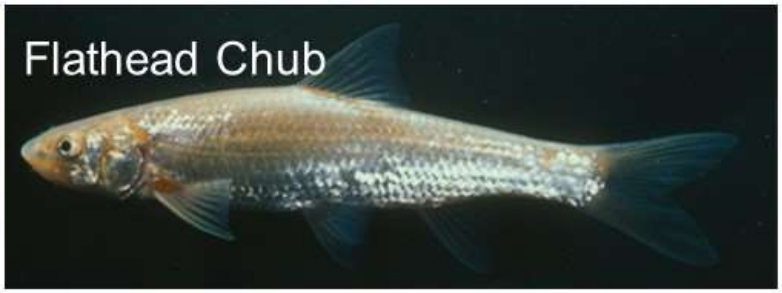
Downstream Channel is Starved for Sediment



Rage	Change	Years
A	Degr 14 ft	1961 - 2010
B	Agr 1 ft, Widen 160 ft	1961 - 2010
C	Widen 136 ft	1961 - 2010
D	Degr 4 ft, Widen 11 ft	1961 - 2010
E	Degr 4 ft, Widen 194 ft	1961 - 1995
F	Degr 8 ft, Widen 83 ft	1961 - 2010
G	Degr 10 ft	1961 - 1995
H	Degr 5 ft	1961 - 1995
I	Degr 3 ft	1961 - 1995

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

Mississippi River Delta

http://mississippiriverdelta.org/our-coastal-crisis/wasted-sediment/

Dams Upriver

Valuable land-building sediment is trapped behind locks and dams on the Missouri, Mississippi and Ohio Rivers. Since 1850, the amount of sediment in the Lower Mississippi River has decreased by more than 70 percent.

Production Rates: 83 to 3,645 yd^3/hr

Table 1. USACE WID projects.

Project Name	Project Site	Cost ($)	Volume (yd^3)	Duration (hr)	Production Rate (yd^3/hr)
Upper Mississippi River 1992	WI and IL	NA	8,000	96	83
Calumet 1994	LA	41,438	15,644	24	652
New Orleans Harbor 1998	LA	731,975	650,482	1,368	476
New Orleans Harbor 2001	LA	794,260	334,530	849	394
Houston Ship Channel Emergency 2001	TX	335,810	113,200	96	1,179
Houston Ship Channel Bayport Flare 2001	TX	NA	116,671	48	2,431
Houston Ship Channel Carpenters to Green Bayou 2001	TX	NA	26,259	96	274
Houston Ship Channel Bayport Flare 2001	TX	NA	97,900	72	1,360
New Orleans Harbor 2002	LA	1,619,968	888,406	960	925
Michoud Canal 2002	LA	79,264	232,235	96	2,419
MRGO* 2003	LA	98,900	350,000	96	3,645
Houston Ship Channel Mid Bay 2004	TX	1,183,014	566,507	2,136	265
New Orleans Harbor 2005	TX	2,339,686	531,046	672	790
Calumet 2010	LA	260,436	22,406	24	934

Tuttle Creek Lake

- How effective could Water Injection Dredging be at Tuttle Creek Lake?
- How will the downstream ecosystem react?
- Need a short-term test
- https://kwo.ks.gov/projects/water-injection-dredging-(wid)-study-demonstration-at-tuttle-creek-lake

Summary

Why we all should care

Examples and Methods

Water Injection Dredging

QUESTIONS?