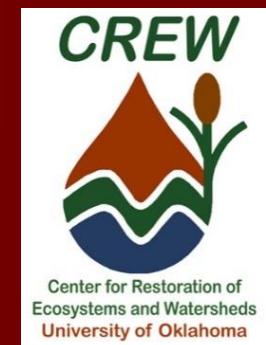


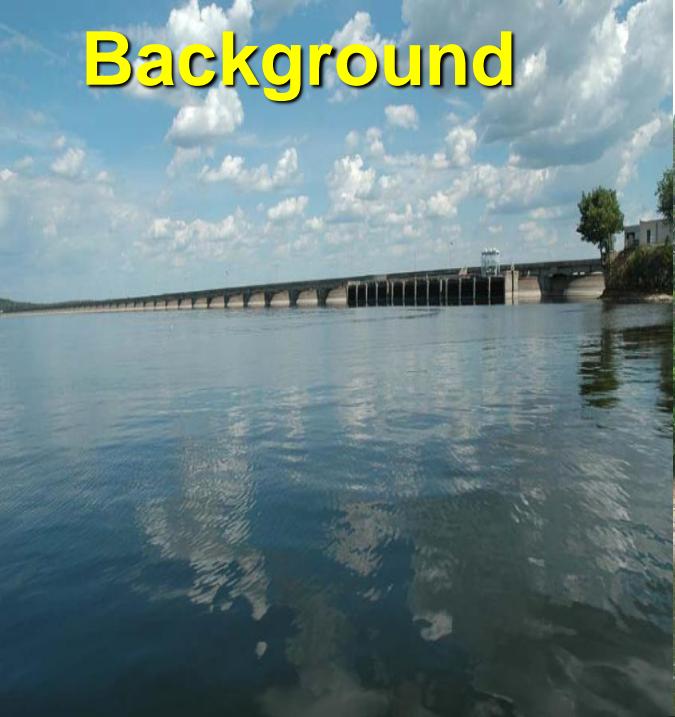
# Sediment Metal Concentrations in Selected Coves of Grand Lake O' the Cherokees

S. Zawrotny, J. Arango, L. Diede, A. McLeod,  
M. Salisbury, G. Rutelonis, J. LaBar, R. Knox,  
D. Townsend and R. Nairn

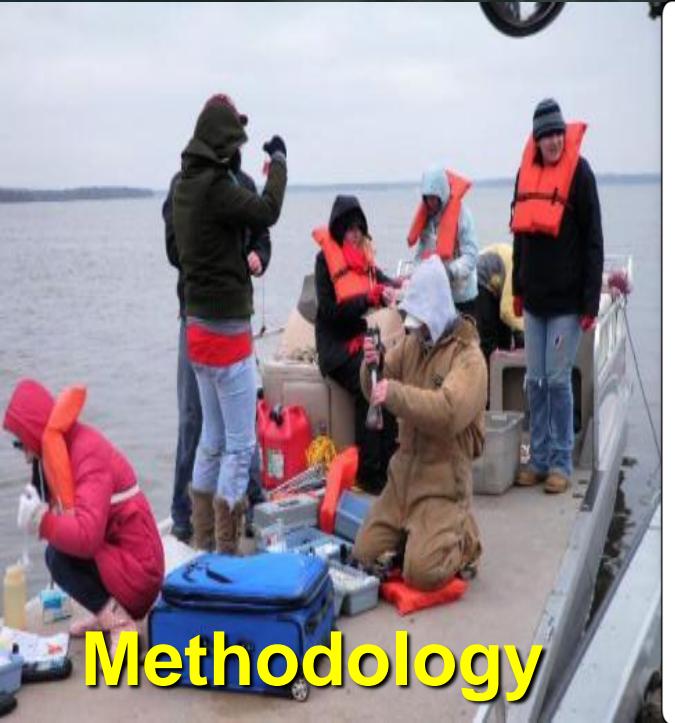
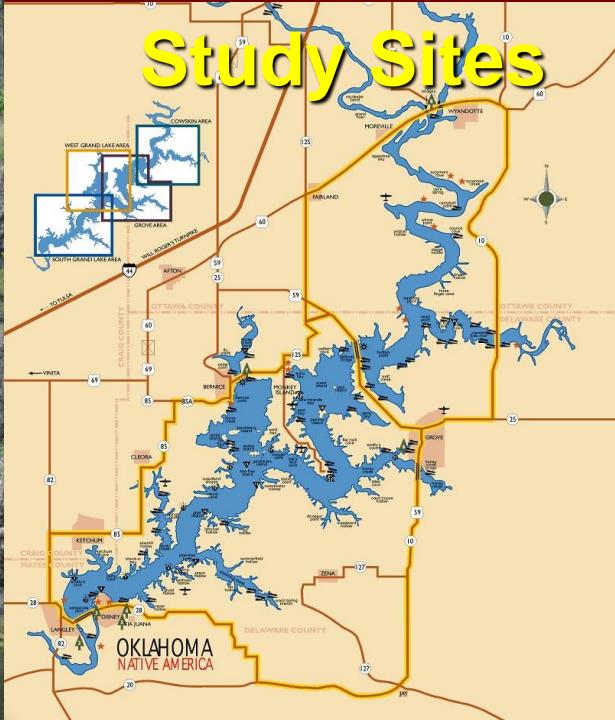
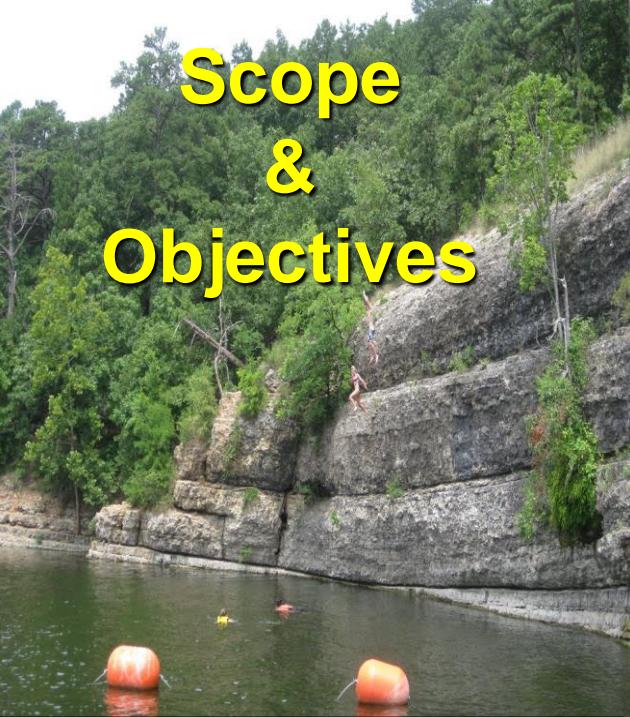
Center for Restoration of Ecosystems and Watersheds  
School of Civil Engineering and Environmental Science  
The University of Oklahoma, Norman, OK



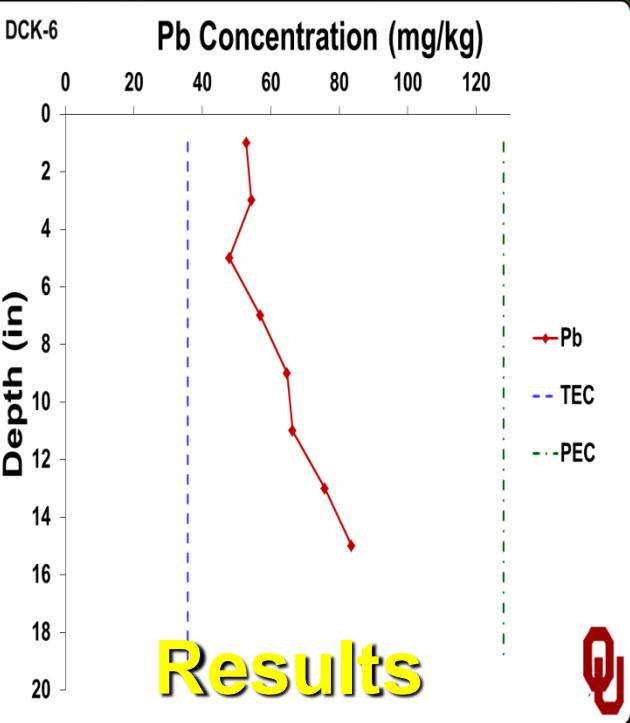
# Background



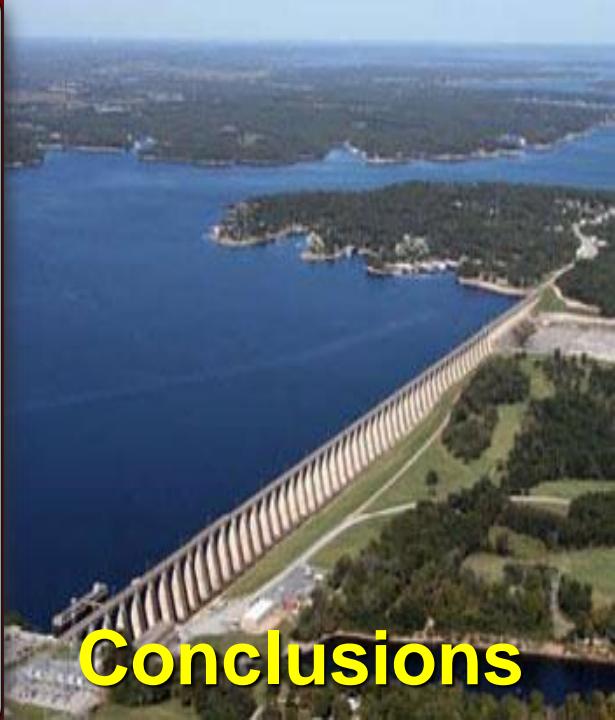
# Scope & Objectives



# Methodology



# Conclusions



A photograph of a wide river or lake under a blue sky filled with white and grey clouds. In the distance, a long, low dam stretches across the water. On the right bank, there's a small concrete structure and a few trees. The water in the foreground is slightly rippled.

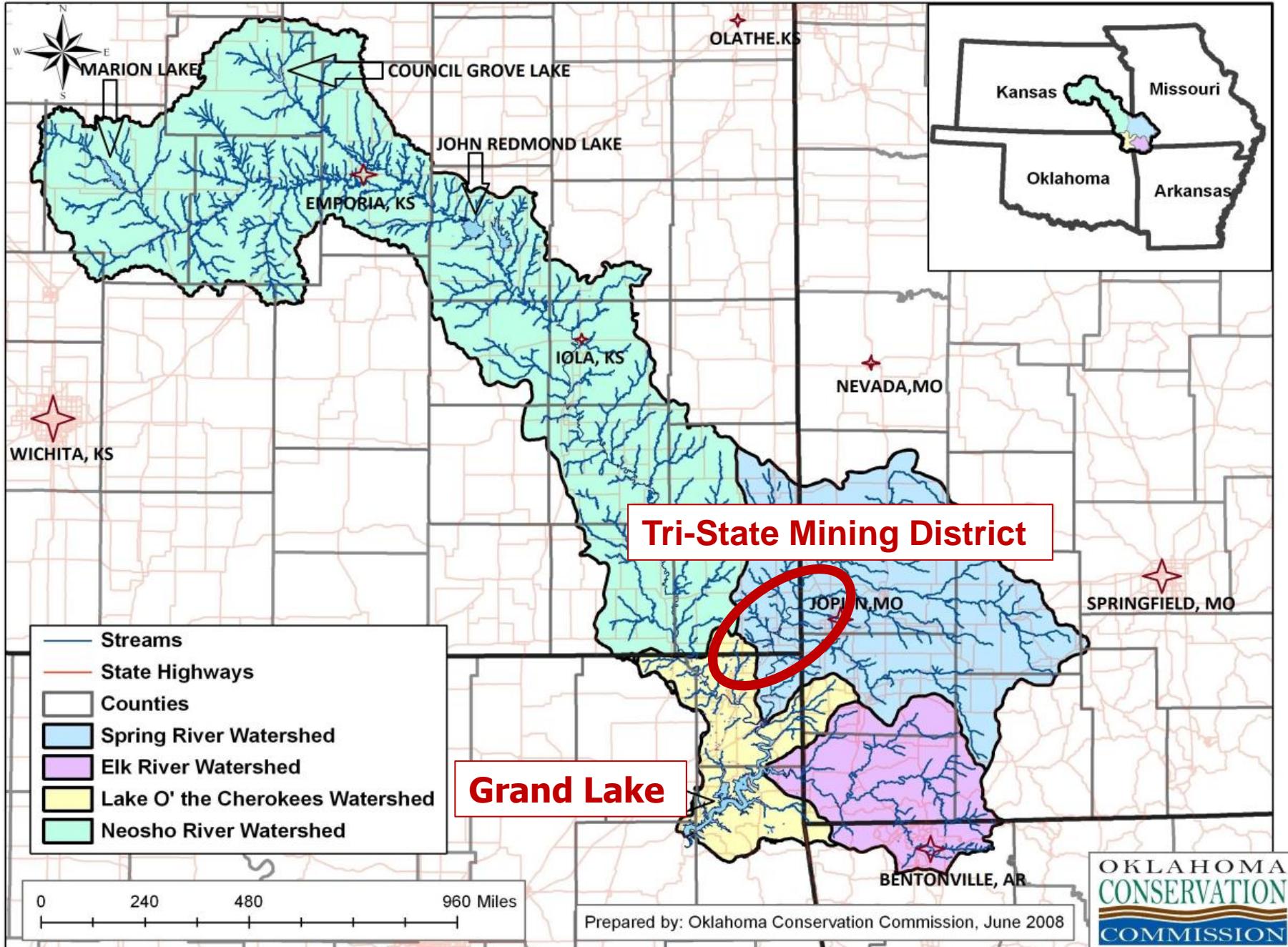
# Background

# 2012 Capstone Project

- Outgrowth of long-term cooperative efforts
- Focus on reservoir sediment contamination
- Historic mining impacts
- Management implications



# Grand Lake Watershed



# Grand Lake O' the Cherokees

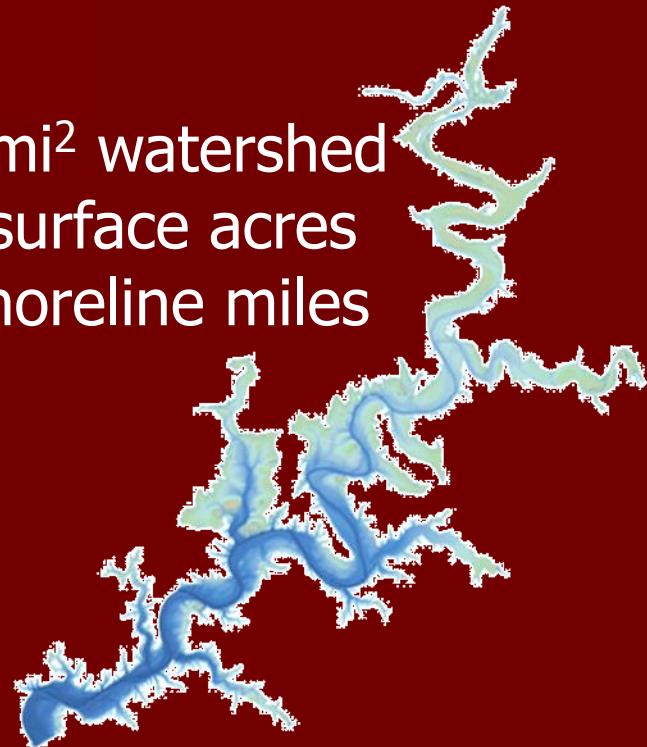
- Third largest reservoir in Oklahoma

- 10,298 mi<sup>2</sup> watershed
- 46,500 surface acres
- 1,300 shoreline miles

- Beneficial uses

- Hydroelectric power
- Flood control
- Water supply
- Recreation
- Fish and wildlife propagation

- Operated by GRDA



- Pensacola Dam (1940)
- Largest multiple arch dam

# Grand Lake O' the Cherokees

- Premier recreation destination
- Near shore development
  - Boat docks
  - Sediment dredging



One weekend  
\$26 million economic impact

# Tri-State Mining District

- 1200 mi<sup>2</sup> mined  
~1838-1970
- Mississippian sulfides
  - Galena (PbS)
  - Sphalerite (ZnS)
- Four USEPA CERCLA Sites



A photograph of a cliffside with dense green trees at the top. A person is captured mid-air, leaping off a rocky ledge into a dark body of water below. Two orange buoys are visible in the water. The cliff face is made of layered rock.

# Scope & Objectives

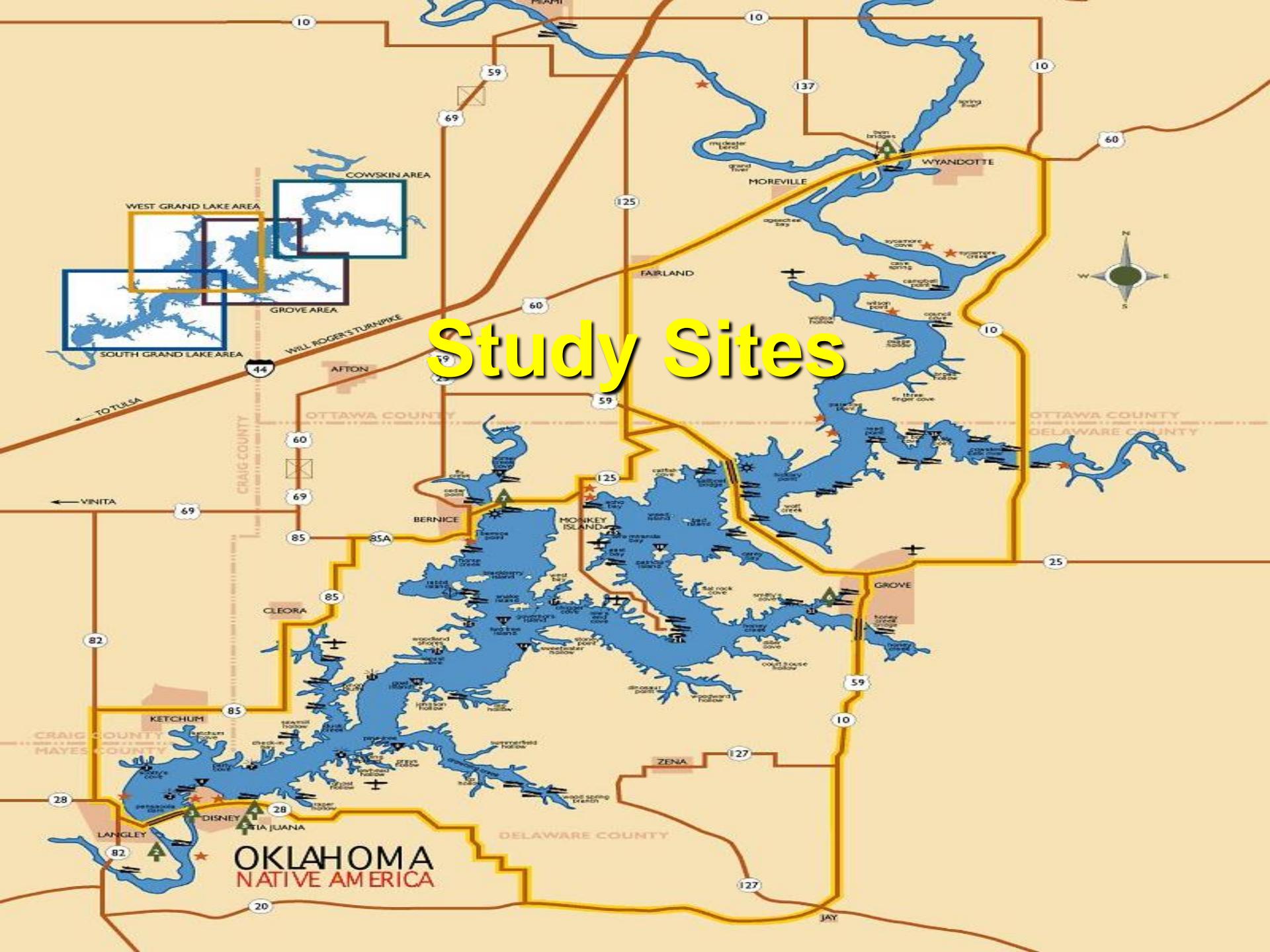
# Project Scope

- Lake shore development often requires sediment dredging
- GRDA Shoreline Management Plan
  - Total metals concentrations compared to Sediment Quality Guidelines (SQGs)
- Examine sediment metal concentrations

# Project Objectives

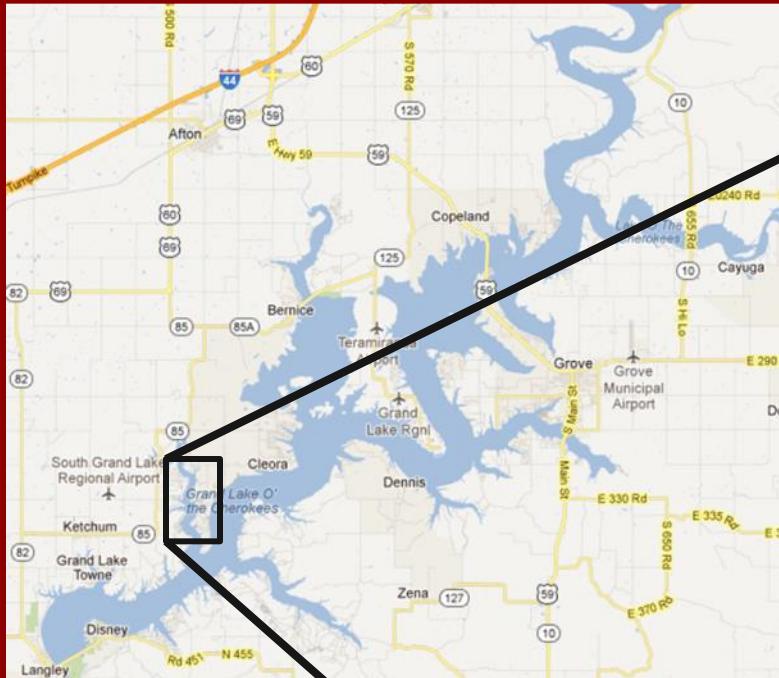
- Focus on metals associated with the TSMD
- Compare sediment metal concentrations to both general and site-specific SQGs
- Compare sediment metal concentrations in developed and undeveloped coves

# Study Sites



# Sampling Locations

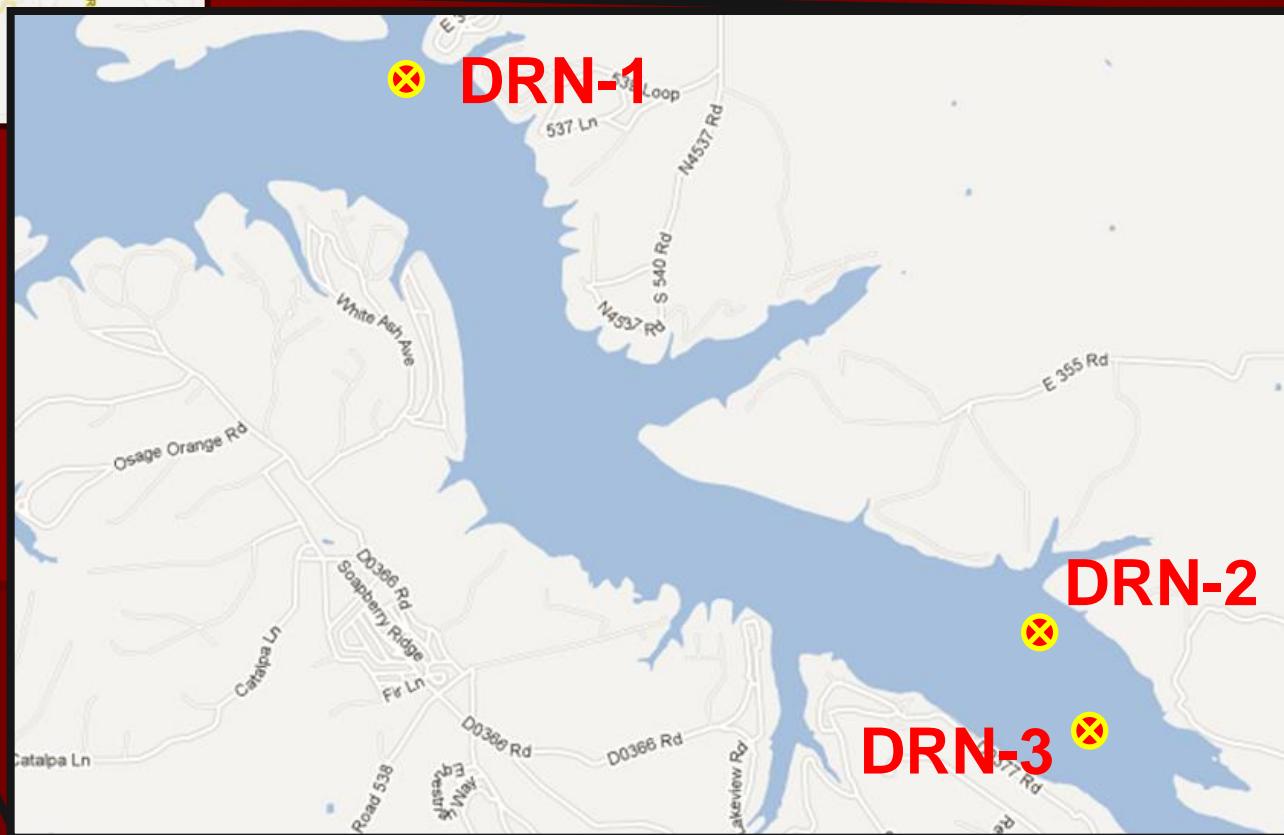
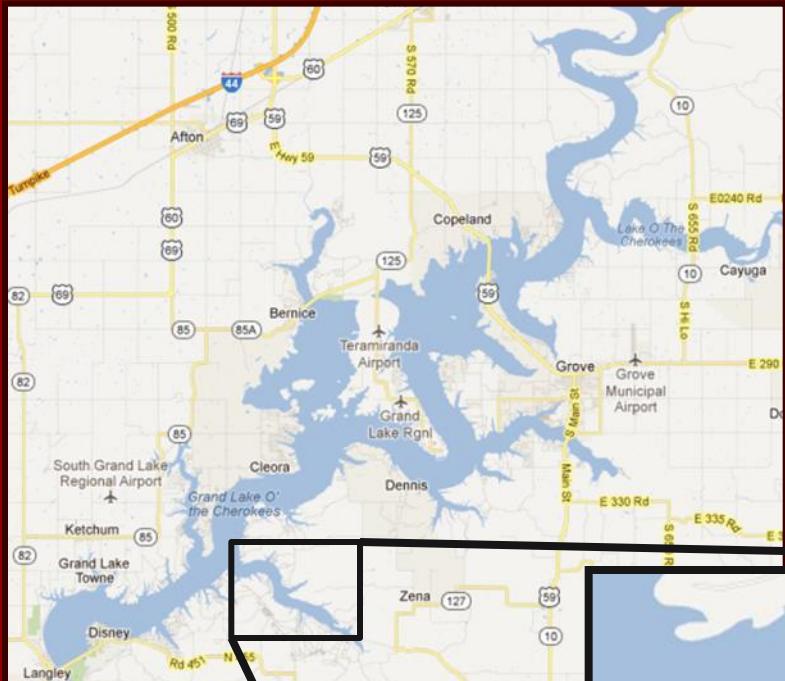




Duck Creek



# Drowning Creek



A photograph showing a group of people on a boat deck. In the foreground, a person in a red parka is crouching. To their right, another person in a brown parka is kneeling, working on some equipment. In the background, several other people are standing or sitting, wearing heavy winter clothing and life jackets. The boat is on a body of water under a clear sky.

# Methodology

# Water – 1 m above sediment

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2012

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|                             |   |
|-----------------------------|---|
| In situ physical parameters | X |
| Total metals*               | X |
| Alkalinity                  | X |
| Nitrate                     | X |
| Nitrite                     | X |
| Ammonia                     | X |
| Phosphate                   | X |
| Turbidity                   | X |

\*Al, As, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Zn

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# Sediment

- 2" diameter gravity corer
- Incremented 2" sections

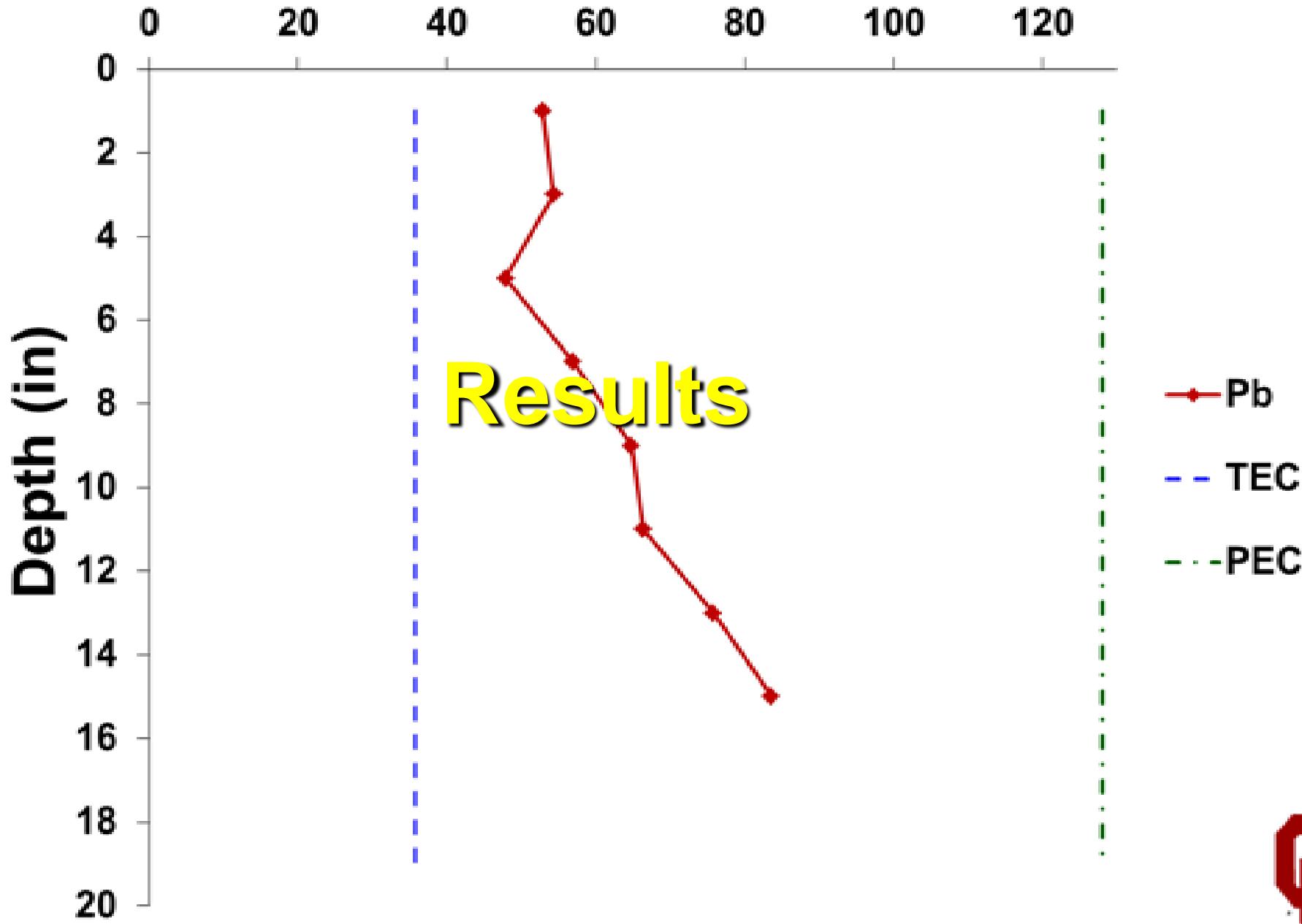
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|                  | <b>2012</b> |
|------------------|-------------|
| Moisture content | X           |
| Organic matter   | X           |
| Total metals     | X           |
| Total mercury    | X           |

---



# Pb Concentration (mg/kg)

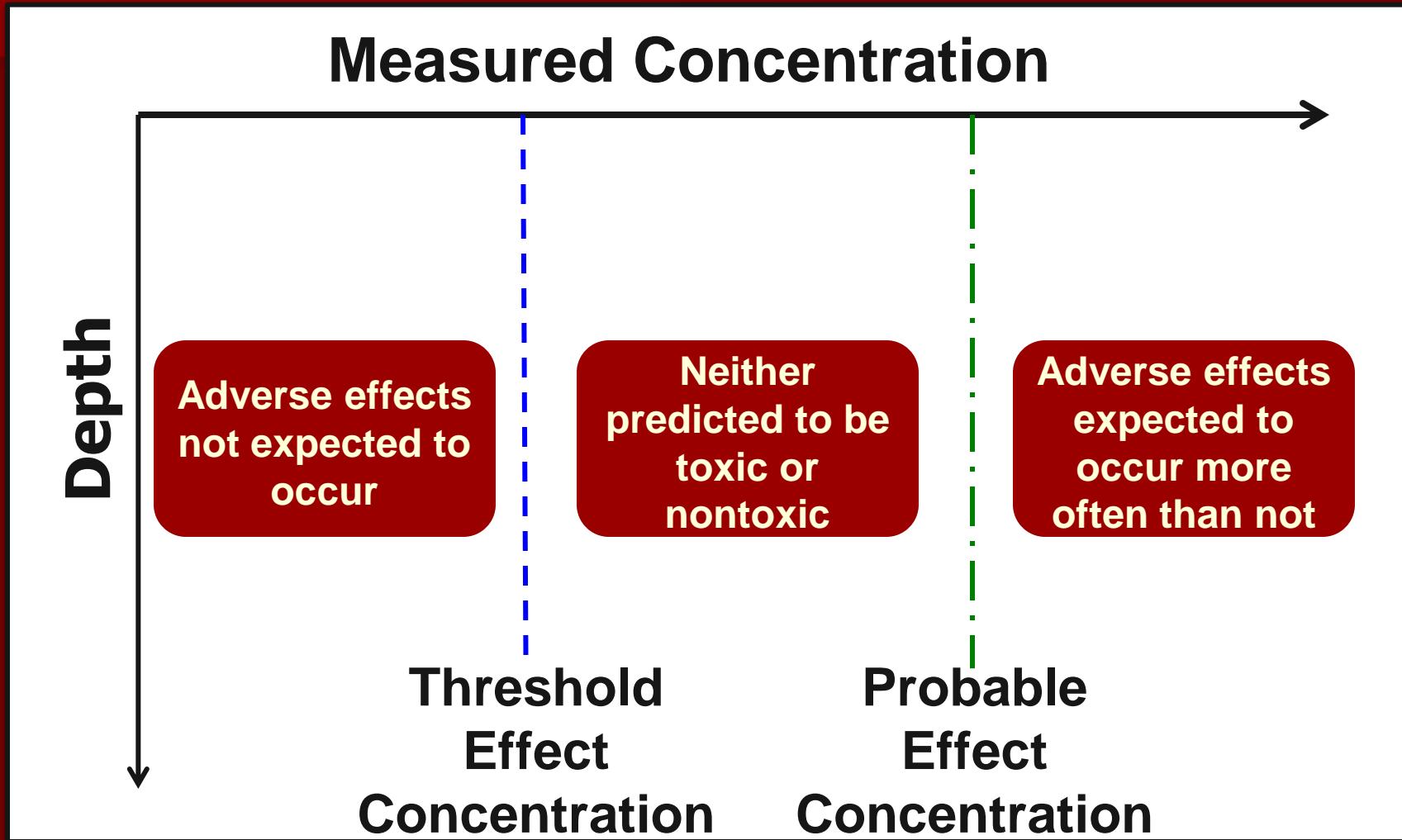


# Water Quality Results

- Phosphate > in-lake criteria in all samples
- Ammonia and nitrate < in-lake criteria
- Cd > chronic criteria at DCK-1

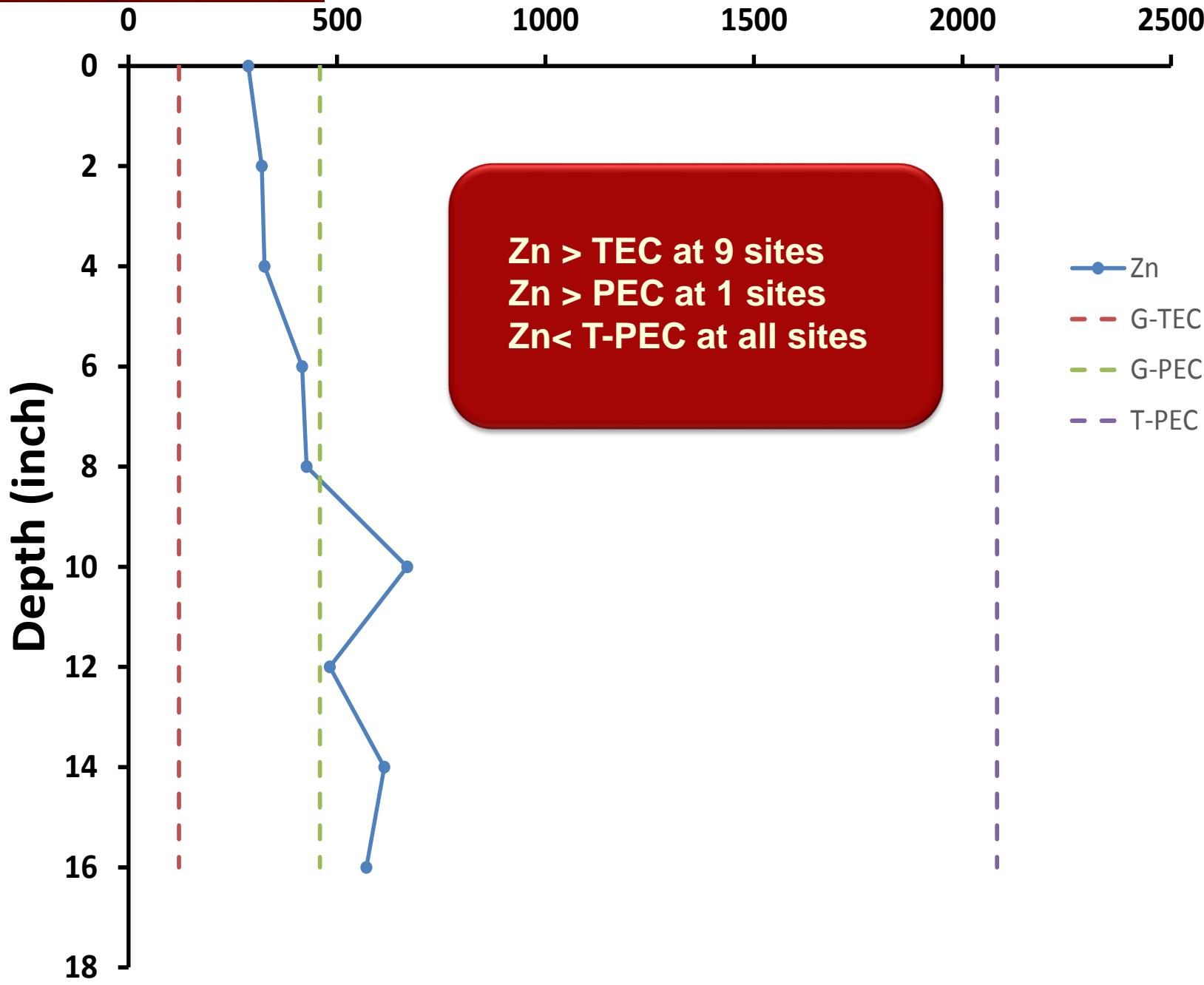


# Sediment Quality Guidelines



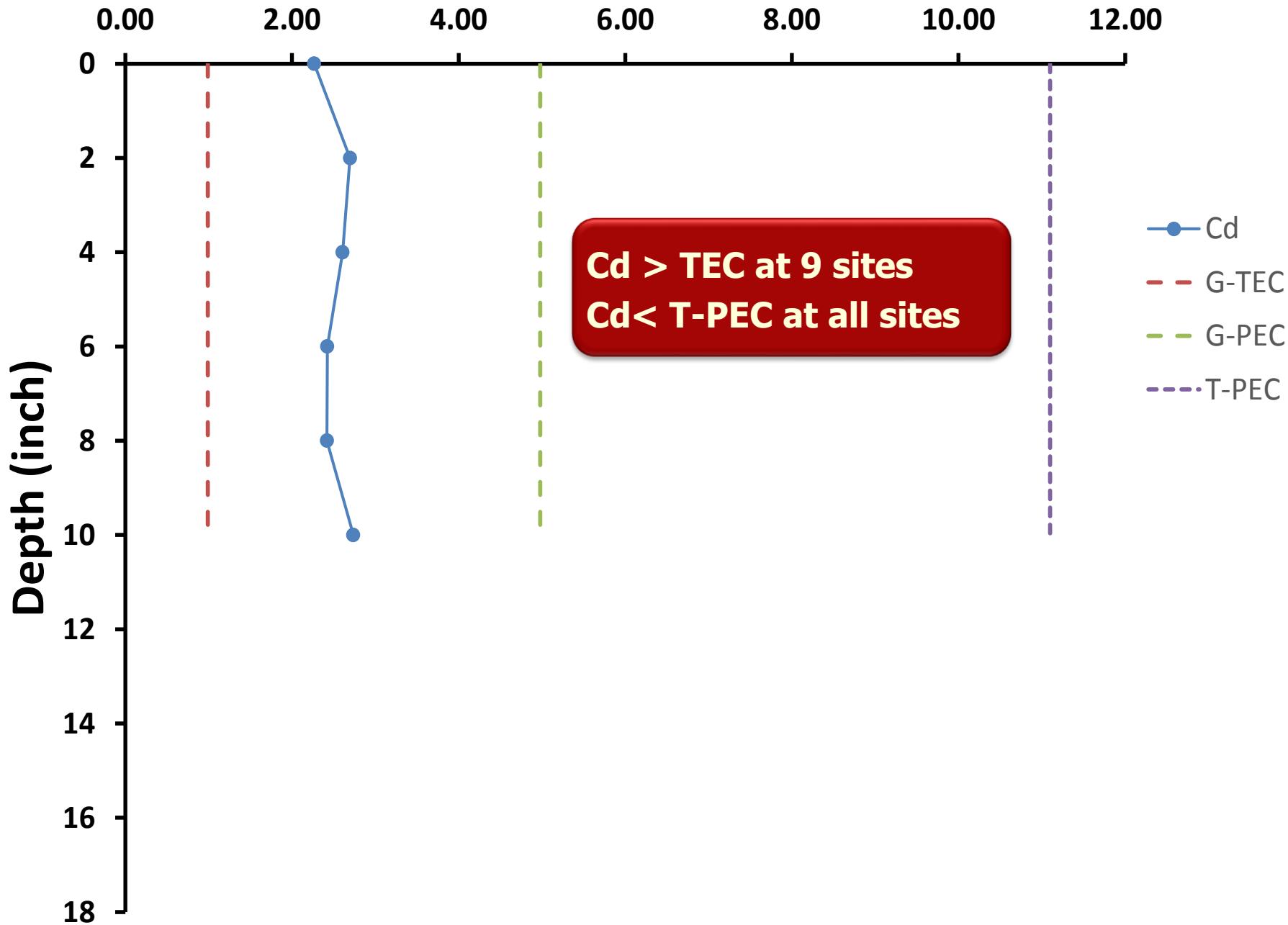
# DCK-4

## Zn Concentration (mg/kg)



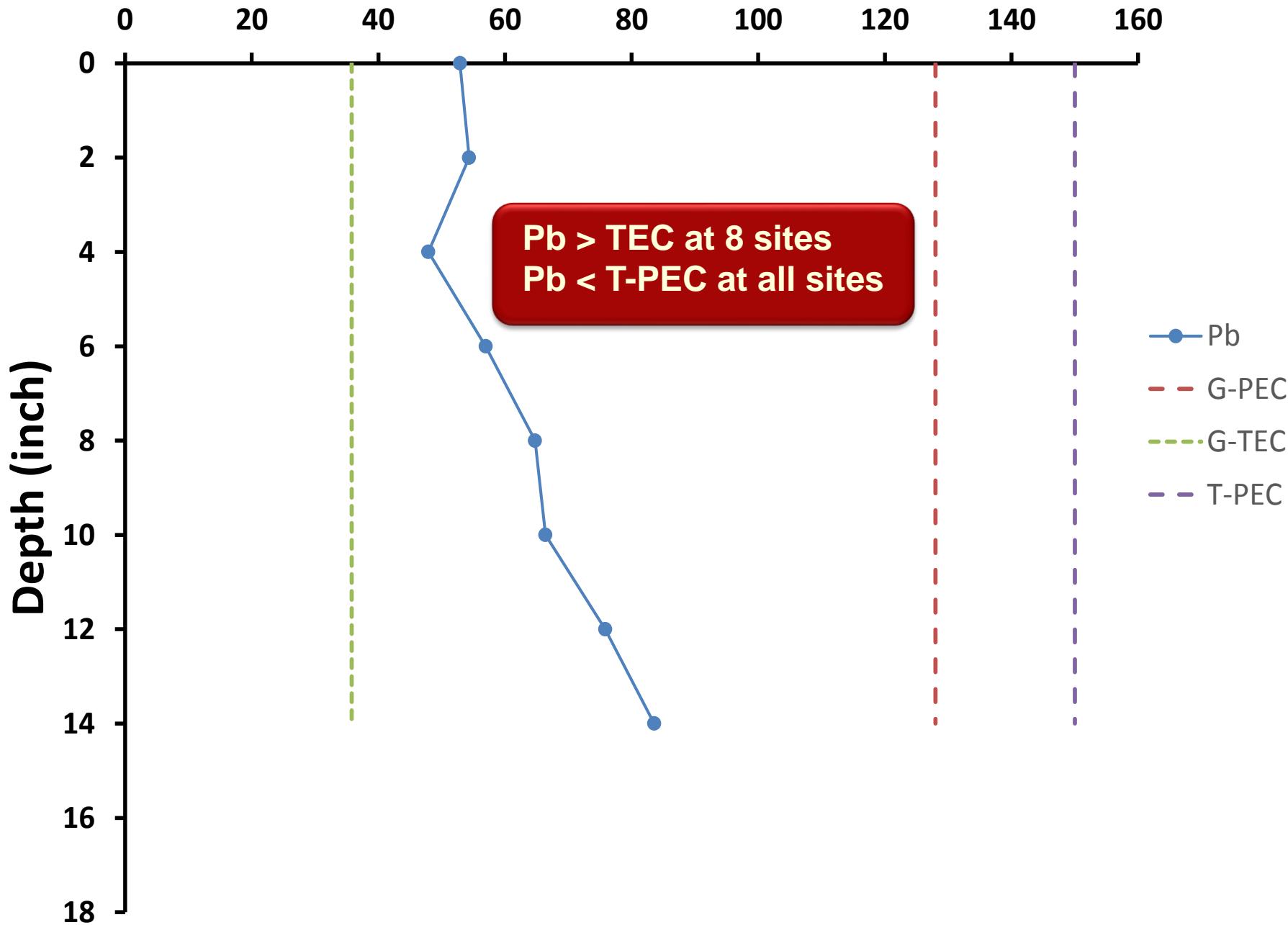
# DCK-1

## Cd Concentration (mg/kg)

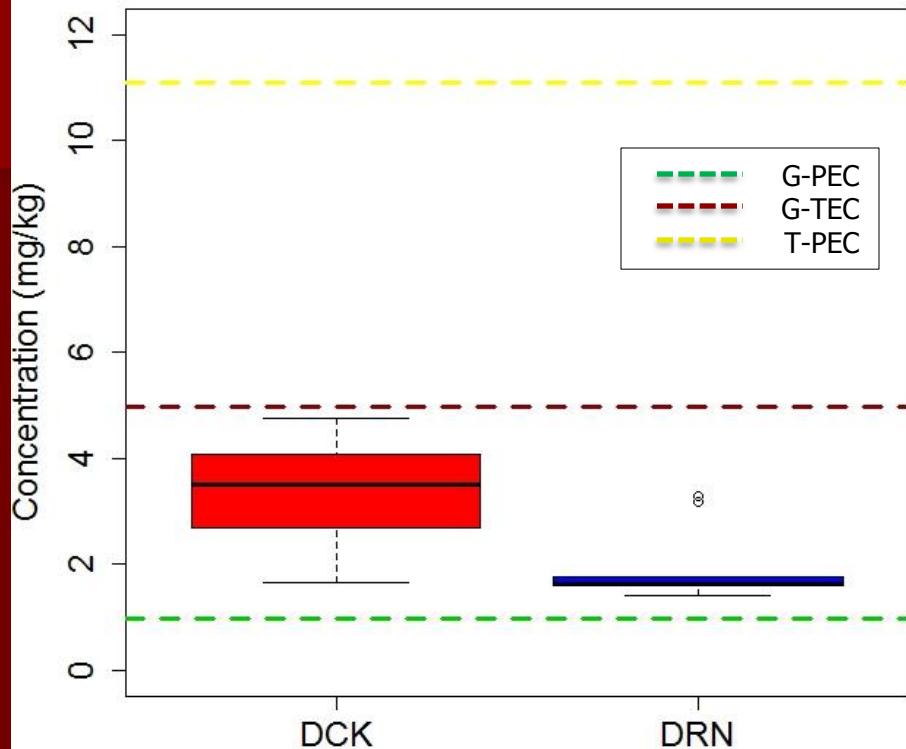


# DCK-6

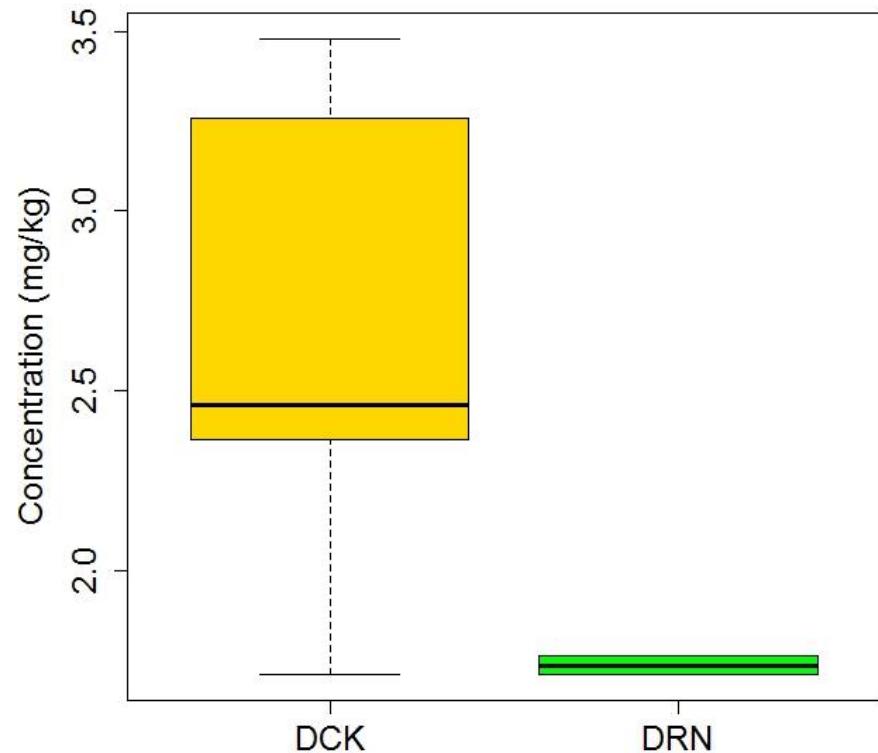
## Pb Concentration (mg/kg)



### Mean [Cd] (mg/kg)



### 0-2 Inch Increment [Cd] (mg/kg)

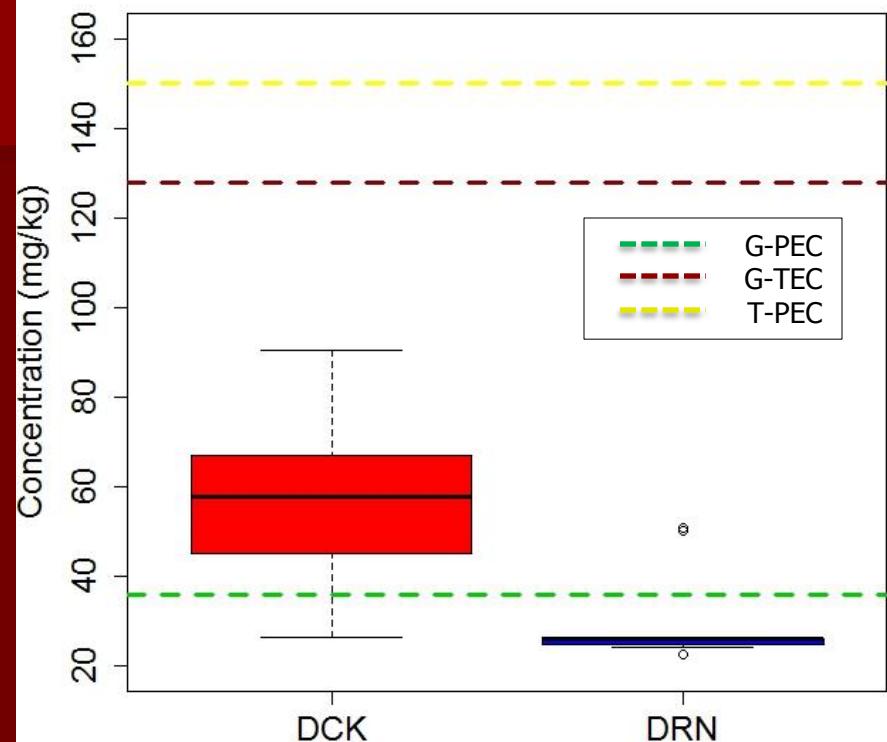


| Parameter               | p-value   |
|-------------------------|-----------|
| Total Cd Concentration  | 0.0001915 |
| 0-2 Inches increment Cd | 0.007787  |

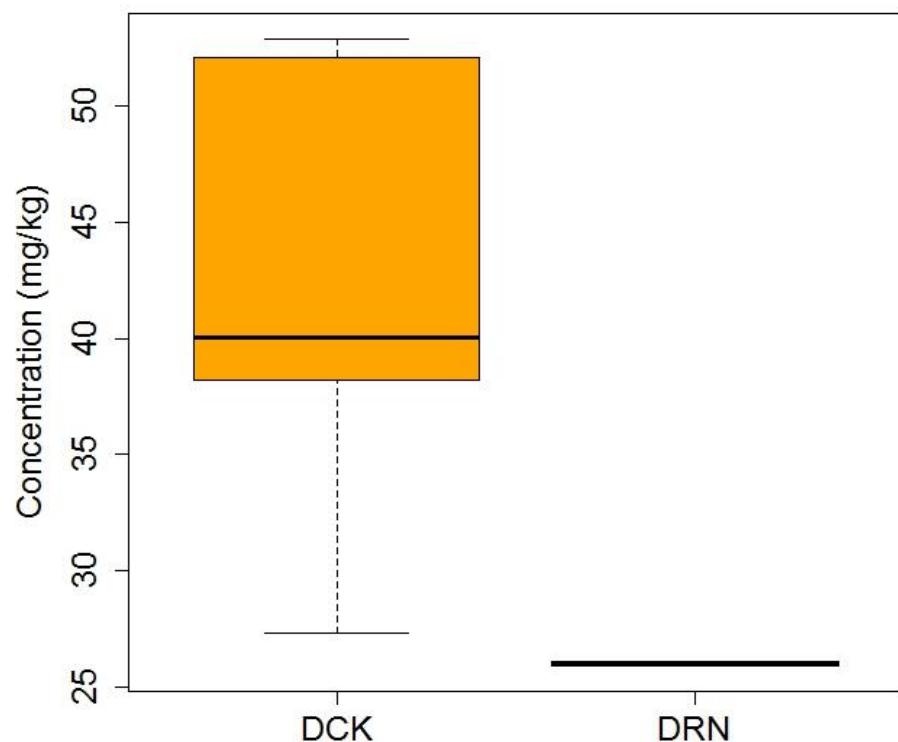


p-values<0.05

### Mean [Pb] (mg/kg)



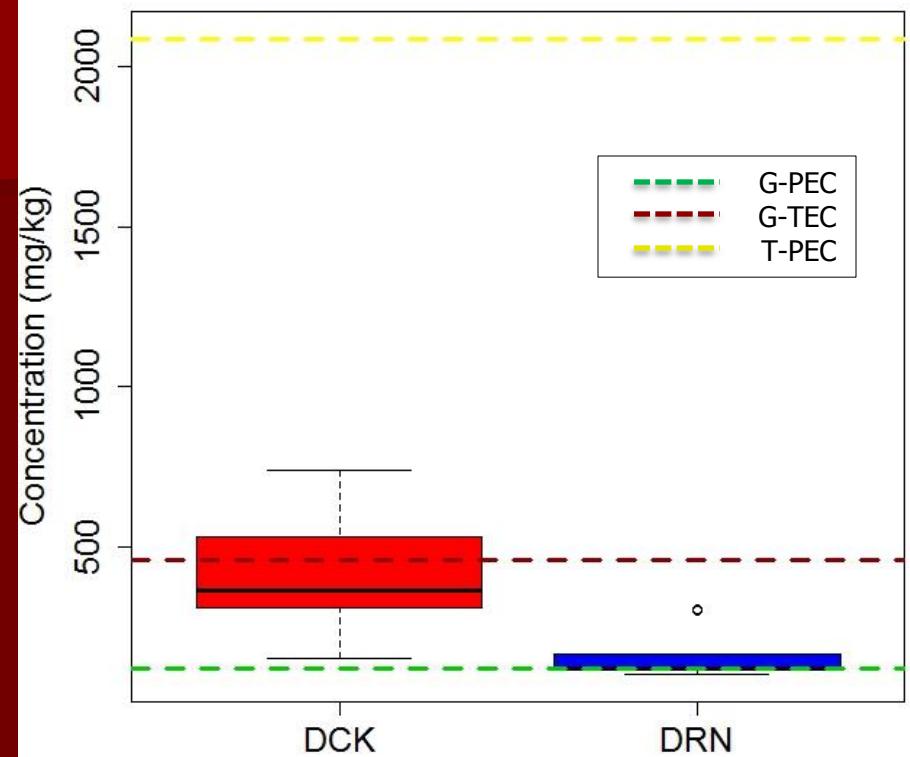
### 0-2 Inch Increment [Pb] (mg/kg)



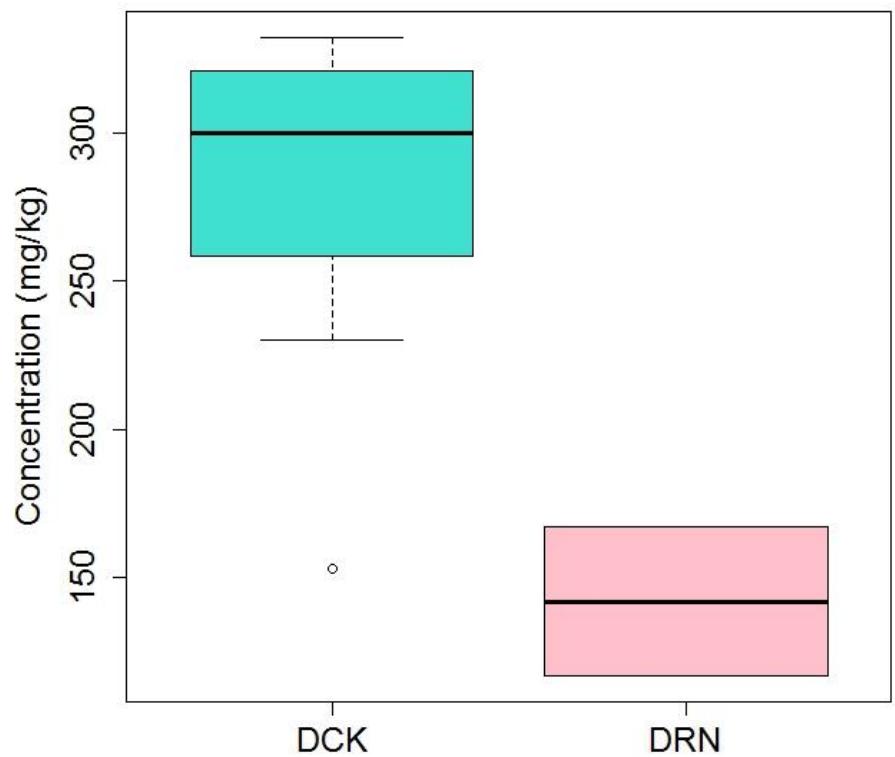
| Parameter               | P-value    |
|-------------------------|------------|
| Total Pb Concentration  | 3.652e-0.5 |
| 0-2 Inches Increment Pb | 0.003615   |

p-values<0.05

### Mean [Zn] (mg/kg)



### 0-2 Inch Increment [Zn] (mg/kg)



| Parameter               | p-value   |
|-------------------------|-----------|
| Total Zn Concentration  | 4.504e-07 |
| 0-2 inches increment Zn | 0.02533   |

p-values < 0.05

An aerial photograph of a massive concrete dam spanning a wide river. The dam features a long, low section in the foreground and a higher, more traditional dam wall further upstream. A road or walkway runs along the top of the dam. In the background, a large, calm reservoir stretches towards a distant shoreline with green fields and small buildings under a clear blue sky.

# Conclusions

# Conclusions – Water

- Lake water quality
  - Turbidity and phosphorus exceed applicable criteria
  - Cd > chronic criteria in one sample; requires rechecking

# Conclusions – Sediment Metals

- Shoreline Management Plan dictates further action if  $[M+] >$  general TEC
- Some  $[M+]$  exceed general TEC and PEC, but none exceed site-specific PEC
- Metals concentrations at Duck Creek (developed) are greater than Drowning Creek (undeveloped)

- For site-specific SQGs, none of the sediment increments exceeded the PEC values

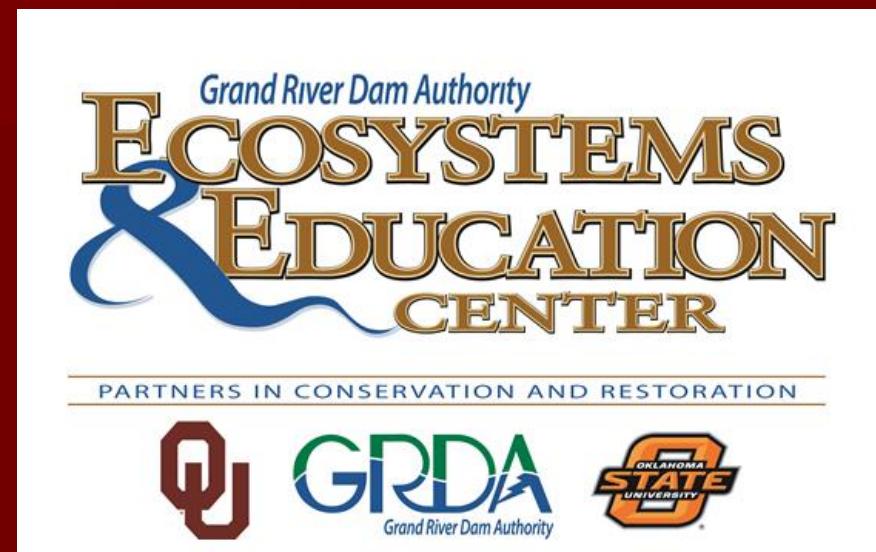
|           | %G-TEC<br>Exceedance |     | % G-PEC<br>Exceedance |     | % T-PEC<br>Exceedance |     |
|-----------|----------------------|-----|-----------------------|-----|-----------------------|-----|
|           | DCK                  | DRN | DCK                   | DRN | DCK                   | DRN |
| <b>Cd</b> | 100                  | 100 | 0                     | 0   | 0                     | 0   |
| <b>Pb</b> | 91                   | 22  | 0                     | 0   | 0                     | 0   |
| <b>Zn</b> | 100                  | 67  | 38                    | 0   | 0                     | 0   |

# Recommendations

- Further sediment research needed
  - Sample more coves
  - Collect more cores
  - Complete particle size analyses
  - Age-date cores
  - Assess native soils
- Disposal plans must be considered prior to dredging

# Acknowledgements

- Jacklyn Jaggars
- Roger Simmons
- Darrell E. Townsend II
- Michael Willhoite
- Sam Ziara
- Lake Patrol Officers
- GRDA EEC





Questions?

<http://CREW.ou.edu>