

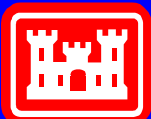
# TVA Kingston Fly Ash Transport and Fate Study

## Post-Spill Site Overview



**Steve Scott - ERDCWES – Principal Investigator**

**Craig Zeller – EPA Region 4 Remediation Project Manager**



**US Army Corps  
of Engineers**

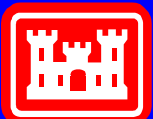
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# TVA Kingston Fly Ash Transport and Fate Study

## Sediment Transport and Fate Study Goals

- **PHASE 1:** Evaluate transport and fate of fly ash from the Kingston site into Watts Bar reservoir : 2009 – 2010
- **PHASE 2:** Evaluate the effectiveness of the Monitored Natural Recovery (MNR) concept for Watts Bar reservoir: 2011

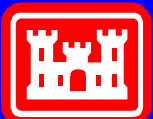




# TVA Kingston Fly Ash Transport and Fate Study

## Sources of Ash Transported Below the Site

- Ash transported downstream from the momentum of the spill
- Ash transported downstream due to Emory River flood flows
- Ash transported downstream due to dredging activities



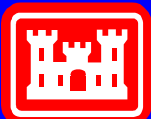
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# TVA Kingston Fly Ash Transport and Fate Study

The Emory River Impacted by Two Million Cubic Yards of Ash



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# TVA Kingston Fly Ash Transport and Fate Study

## Immediate Impacts to the Emory River

- **Reduced Channel Capacity / Increased Flood Risk (+ 8.0 feet for a 100 year return flood)**
- **Increased River Sediment Transport Capacity / Fly Ash transport Risk**
- **TVA initiated a comprehensive dredging program to restore channel capacity and reduce flood and transport risk**

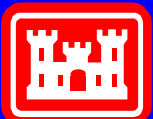




# TVA Kingston Fly Ash Transport and Fate Study

## Phase 1 Sediment Transport and Fate Methodology

- Evaluate fly ash and natural sediment transport characteristics in the ERDCWES SEDflume
- Develop a 2D model (AdH) of the Emory, Clinch, and Tennessee rivers
- Incorporate SEDflume results into the 2D model
- Simulate the May 2009 flood event (~70,000 cfs peak flow)
- Simulate erosion, entrainment, and transport of fly ash throughout the domain (TVA Kingston site to Watts Bar reservoir)

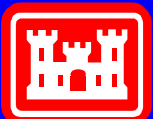




# TVA Kingston Fly Ash Transport and Fate Study

## SEDflume Description

- **Laboratory scale flume at ERDCWES**
- **Measures erosion rate of sediment cores**
- **Measures critical shear stress for erosion**

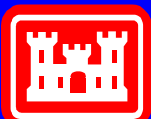




# TVA Kingston Fly Ash Transport and Fate Study

## SEDflume Description

ShearStress	Flow Rate
Pa	gpm
0.1	6.1
0.2	9.8
0.4	13.5
0.6	16.8
0.8	20.1
1.2	25.0
1.6	29.8
2.4	36.9
3.2	44.0
4.0	49.3
5.0	55.8
6.4	65.0
8.0	72.9
10.0	82.7



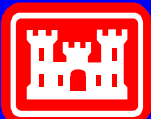




# TVA Kingston Fly Ash Transport and Fate Study

## 2D Sediment Transport Model

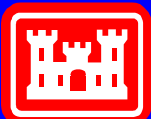
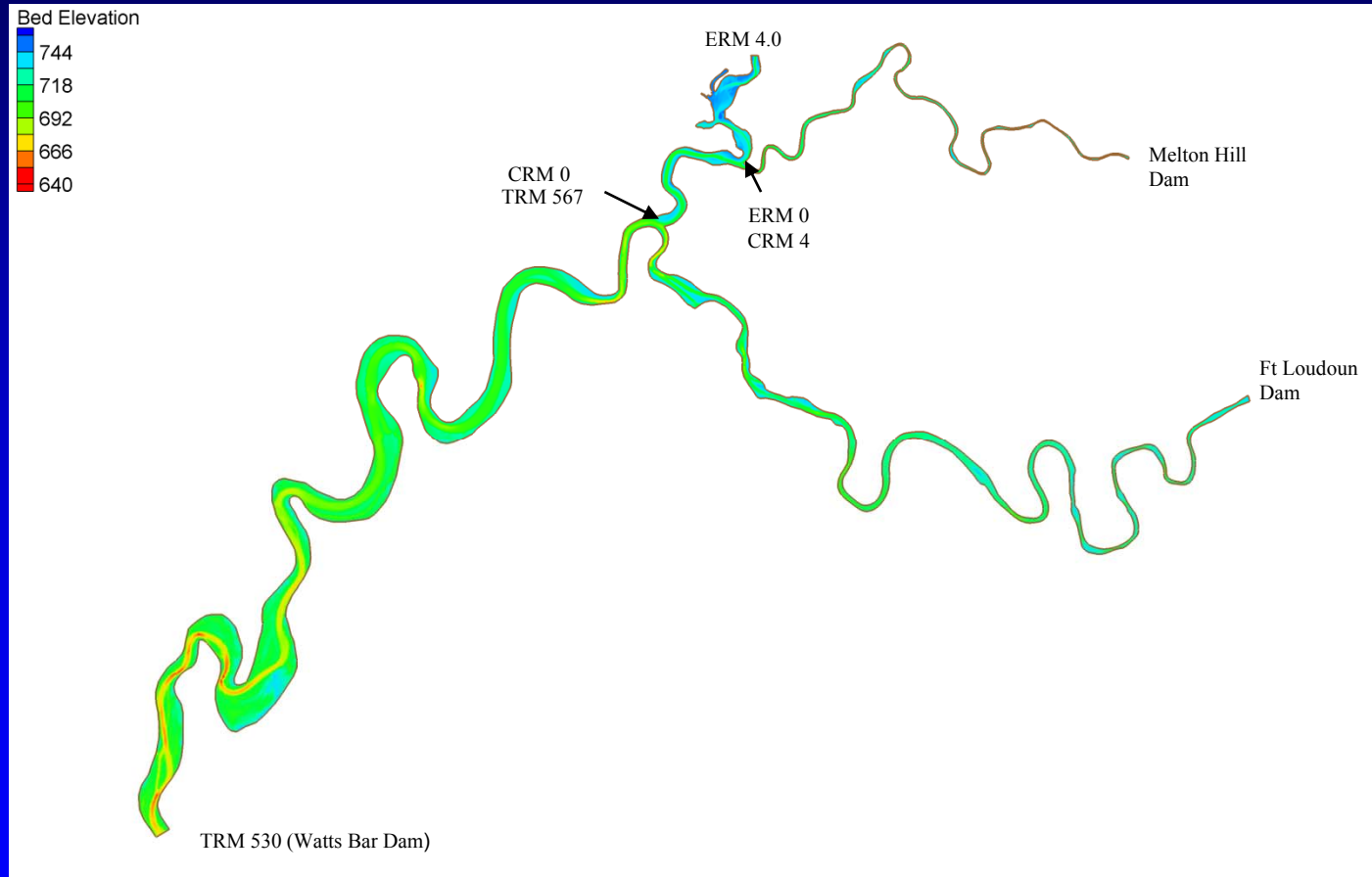
- Model domain from the Kingston site to Watts Bar dam
- The ERDC Adaptive Hydraulics model (AdH) was used for the simulations
- Model consisted of 13 grain sizes (6 ash and 7 sediment) representing clay – sand size classes





# TVA Kingston Fly Ash Transport and Fate Study

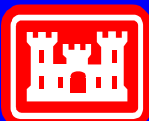
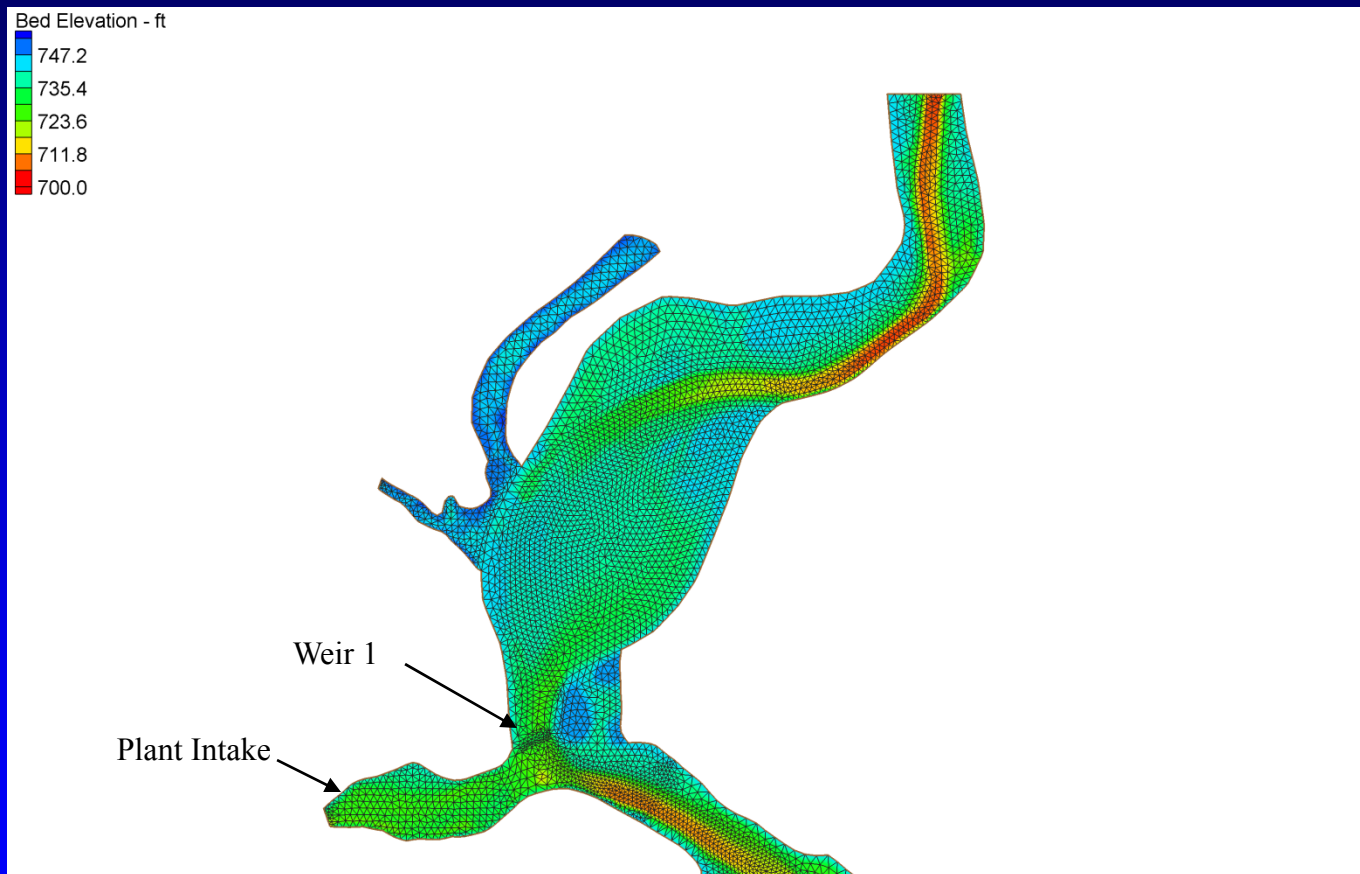
## Model Domain





# TVA Kingston Fly Ash Transport and Fate Study

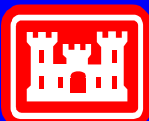
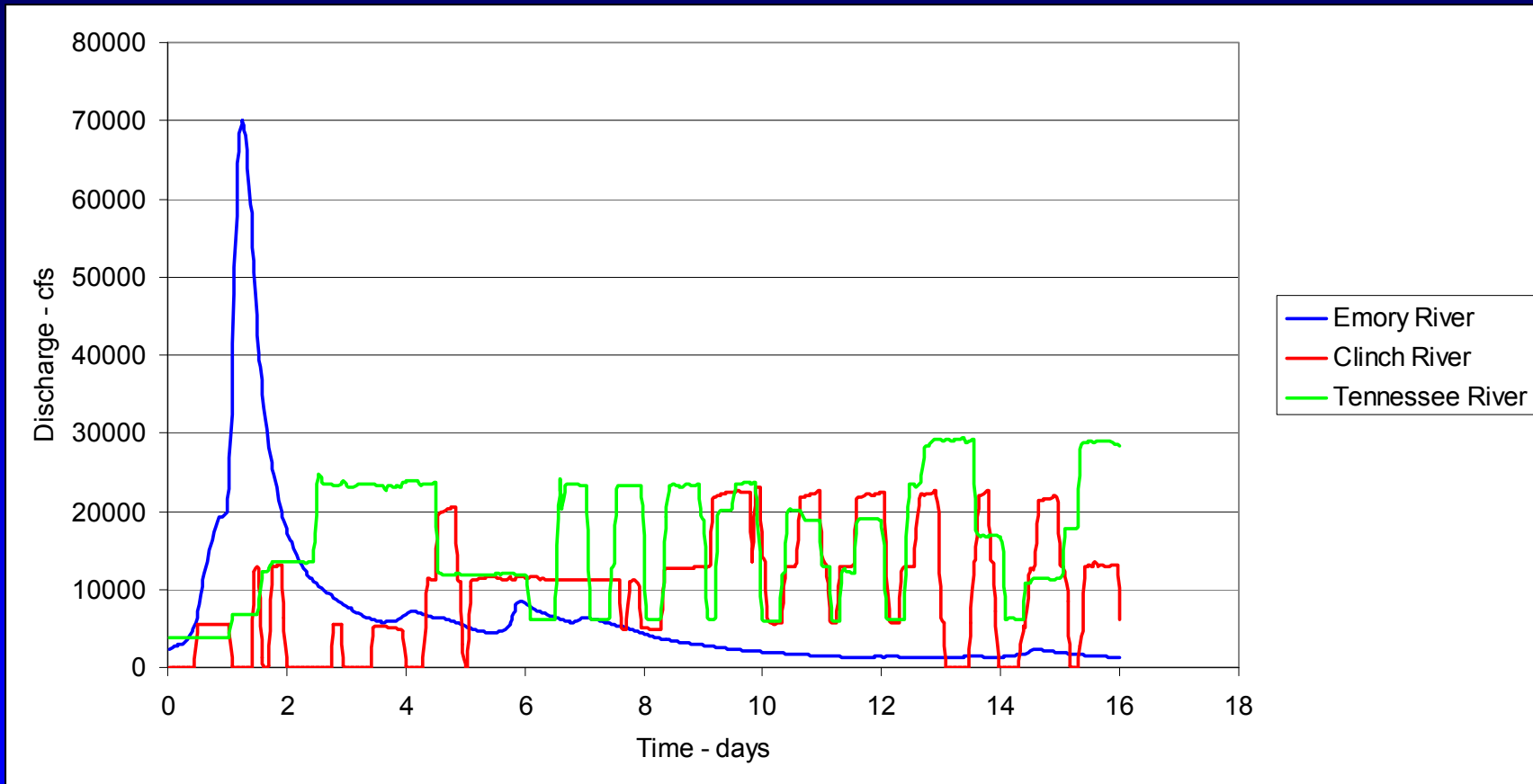
## Model Domain – Kingston Site





# TVA Kingston Fly Ash Transport and Fate Study

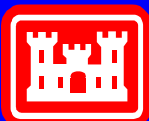
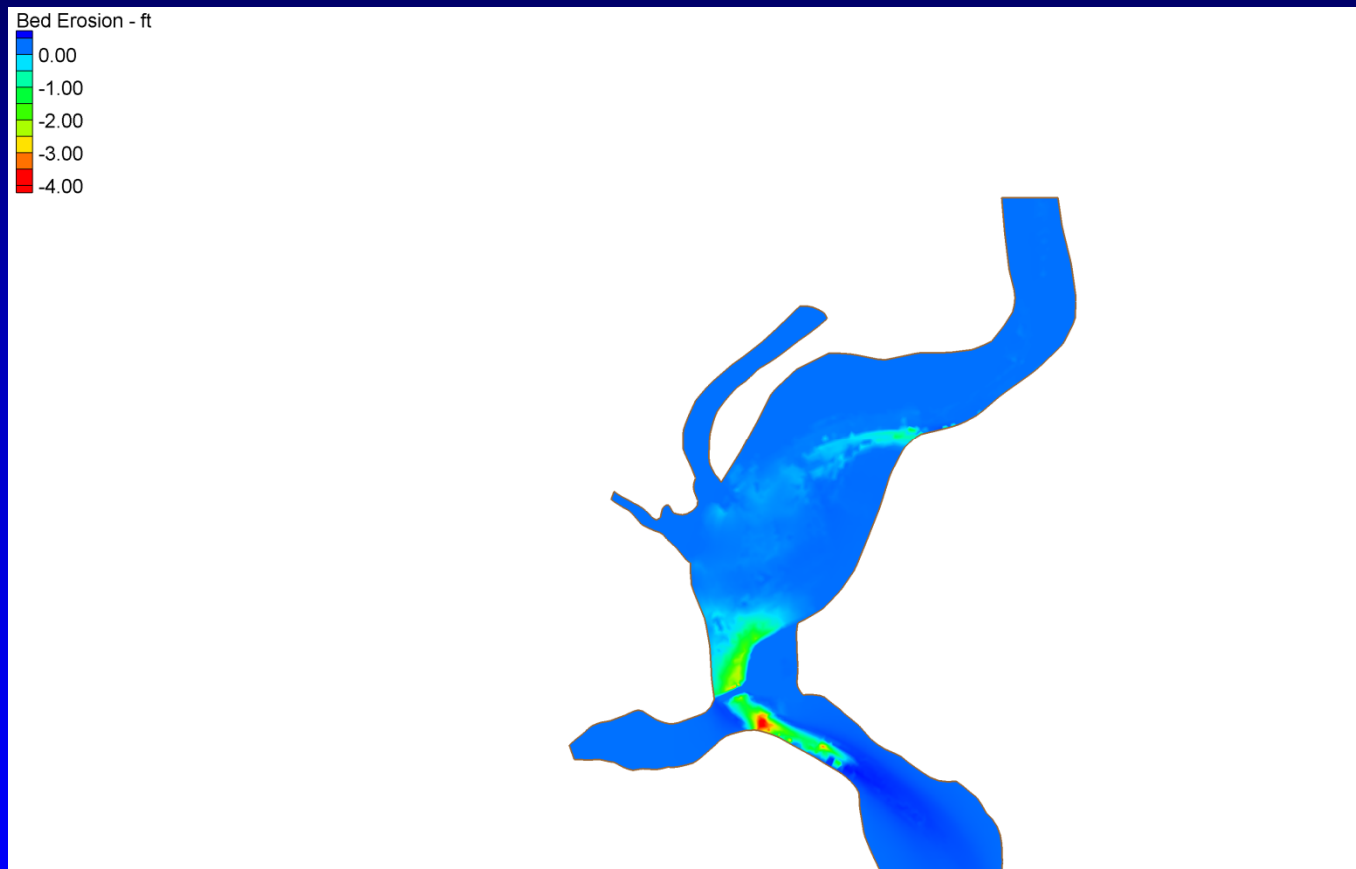
## Inflowing Hydrographs May 3 – May 18 2009





# TVA Kingston Fly Ash Transport and Fate Study

## Bed Change (Erosion) in the Emory River for the May Event



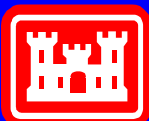
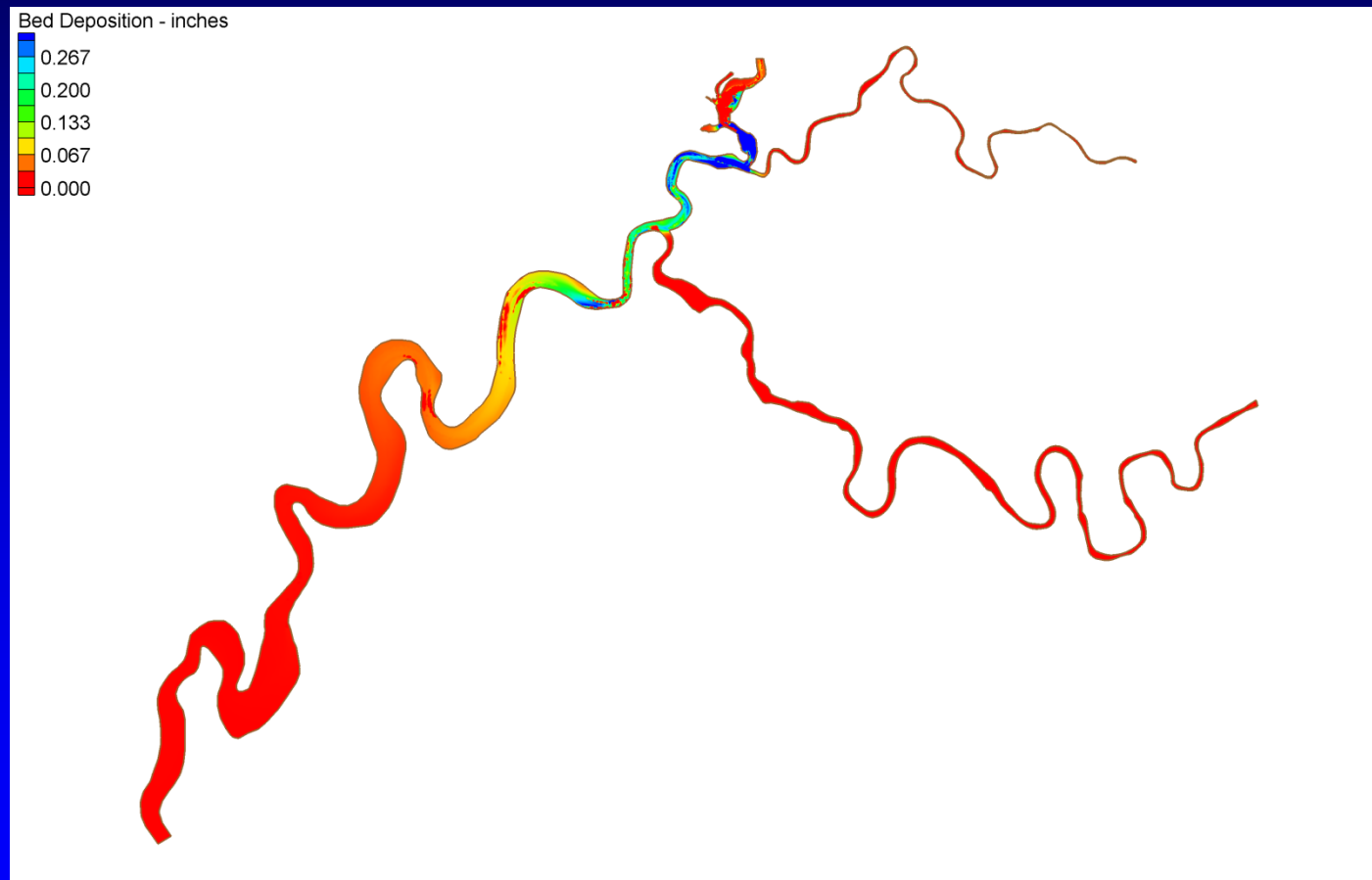
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## Bed Change (Deposition)



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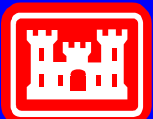
# TVA Kingston Fly Ash Transport and Fate Study

## The Monitored Natural Recovery Concept (MNR)

*“Let Nature Take its Course with Long -Term Monitoring of Ecosystem Recovery”*

**Primary Mechanism:** Natural Sediment Delivery from the Emory, Clinch, and Tennessee Rivers to Dilute and Cap Remaining Ash Deposits.

Chosen Remedy in 1995 for the Lower Watts Bar Record of Decision (ROD) Oak Ridge Reservation Superfund Site



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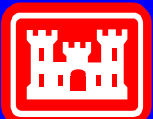
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# TVA Kingston Fly Ash Transport and Fate Study

## Phase 2 Methodology – Simulate MNR Concept

- **Simulate 2 years of record to evaluate the potential of natural Sediment load to mix / cap ash deposits in Watts Bar**
- **Year 1 – Average Emory River flow (1995 water year)  
Year 2 – High Emory River (2003 water year)**
- **Evaluate ash and natural sediment mixing by analysis reach**



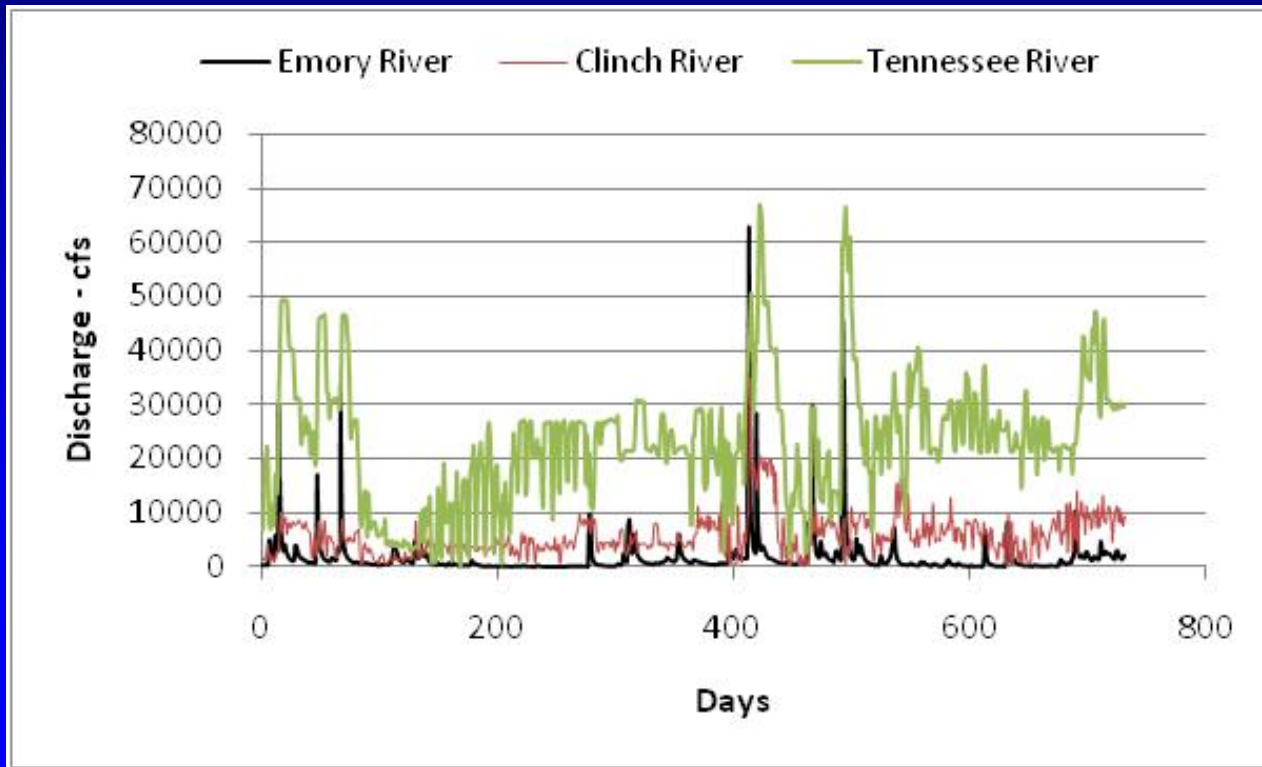




# TVA Kingston Fly Ash Transport and Fate Study

## Phase 2 Model Boundary Condition – Inflows

Year 1 (1 – 365 days) low flow      Year 2 (366 – 730 days) high flow



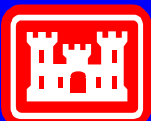
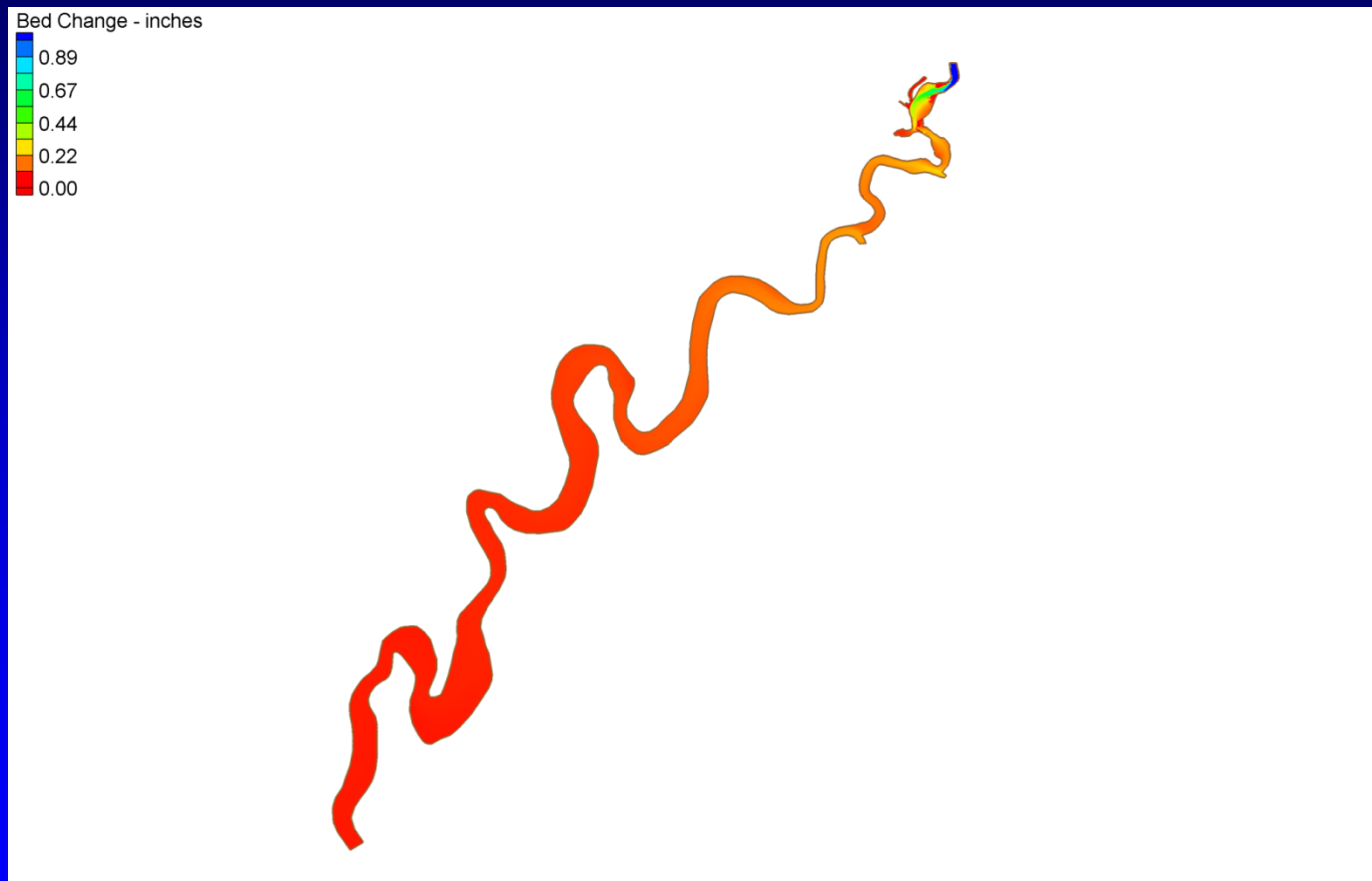
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# TVA Kingston Fly Ash Transport and Fate Study

## Phase 2 Model Results: Net Bed Change Year 1



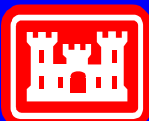
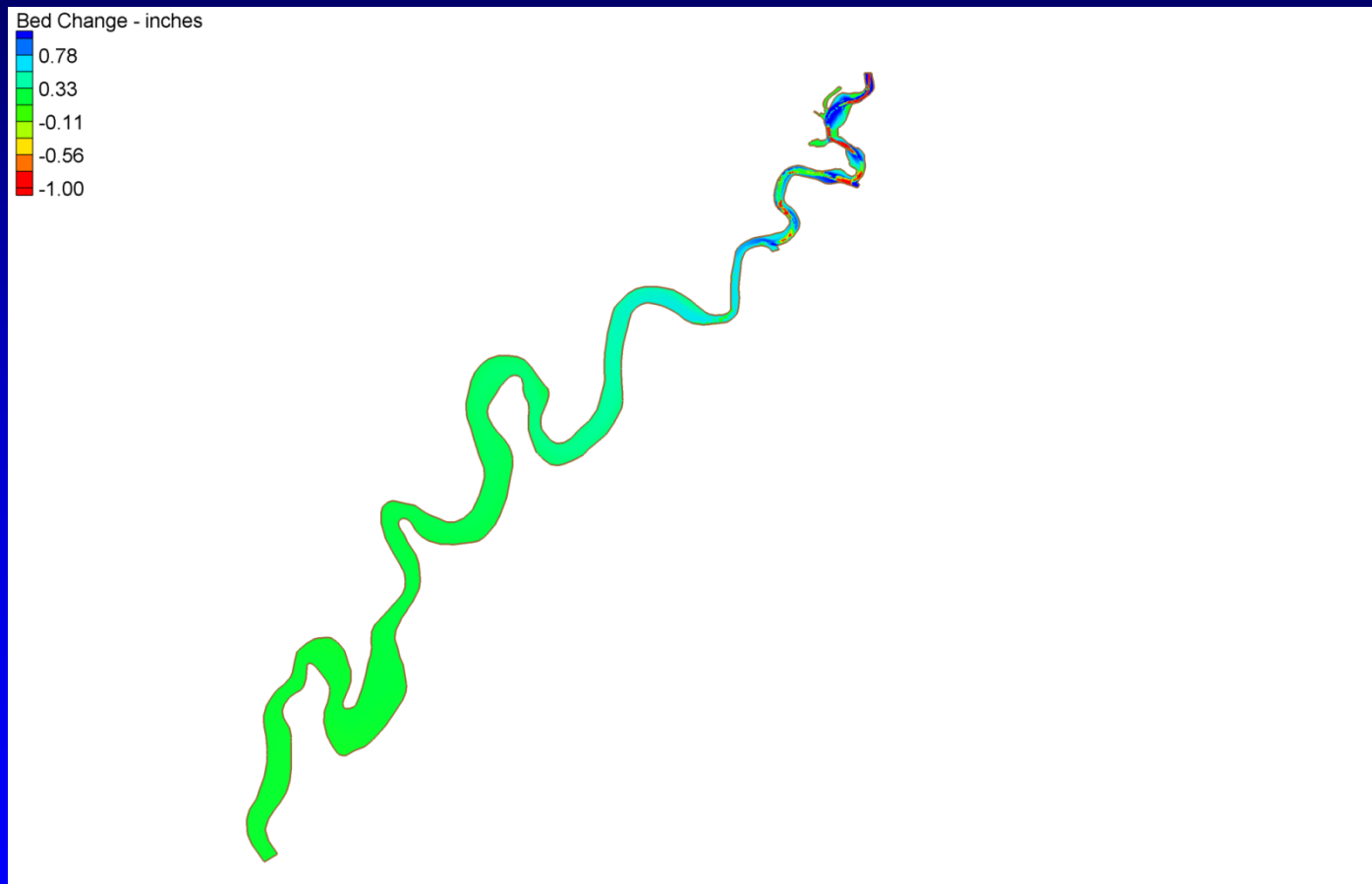
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# TVA Kingston Fly Ash Transport and Fate Study

## Phase 2 Model Results: Net Bed Change Year 2



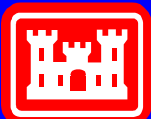
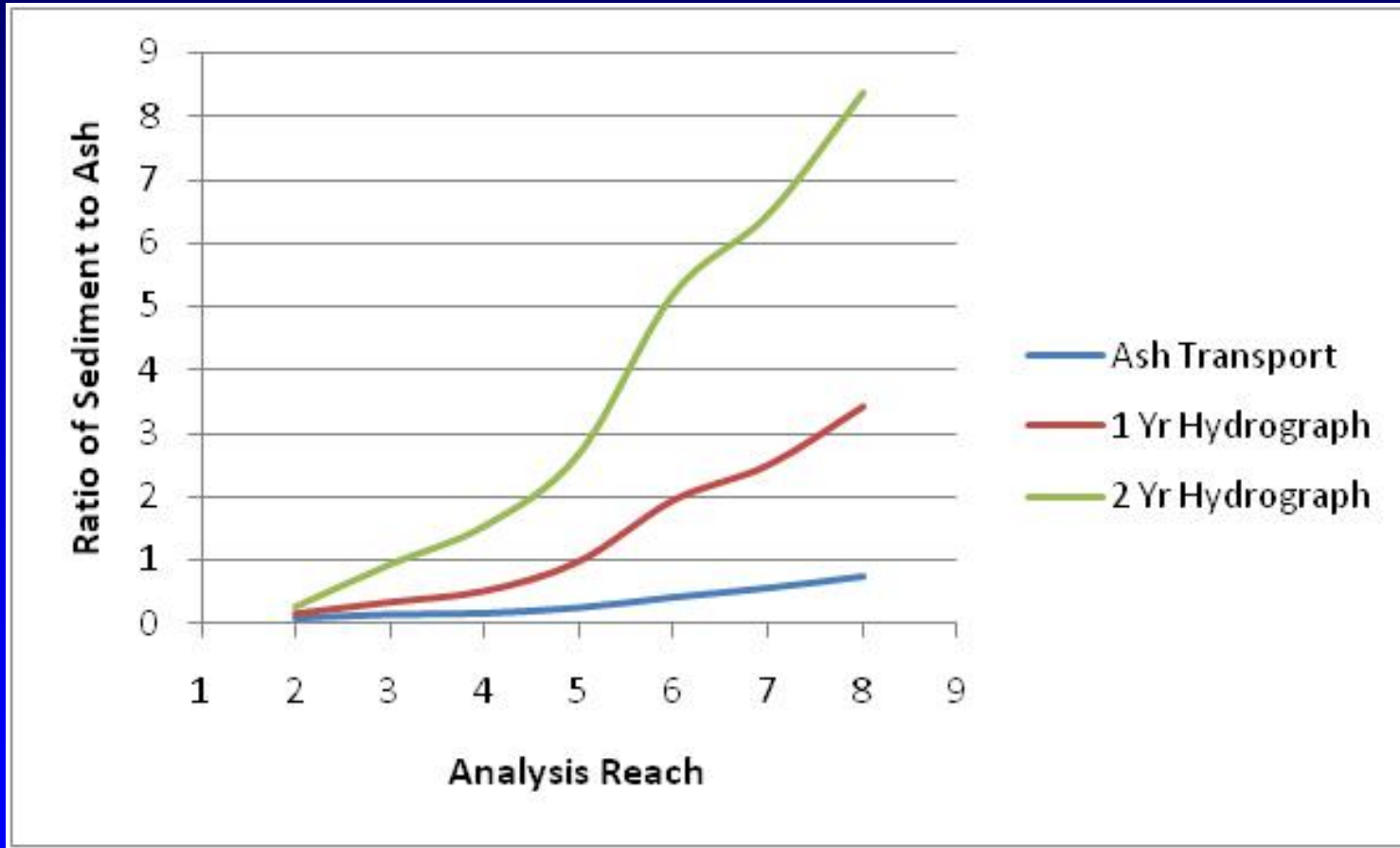
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# TVA Kingston Fly Ash Transport and Fate Study

## Phase 2 Model Results: Ratio of Sediment to Ash



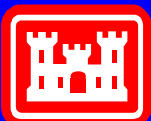
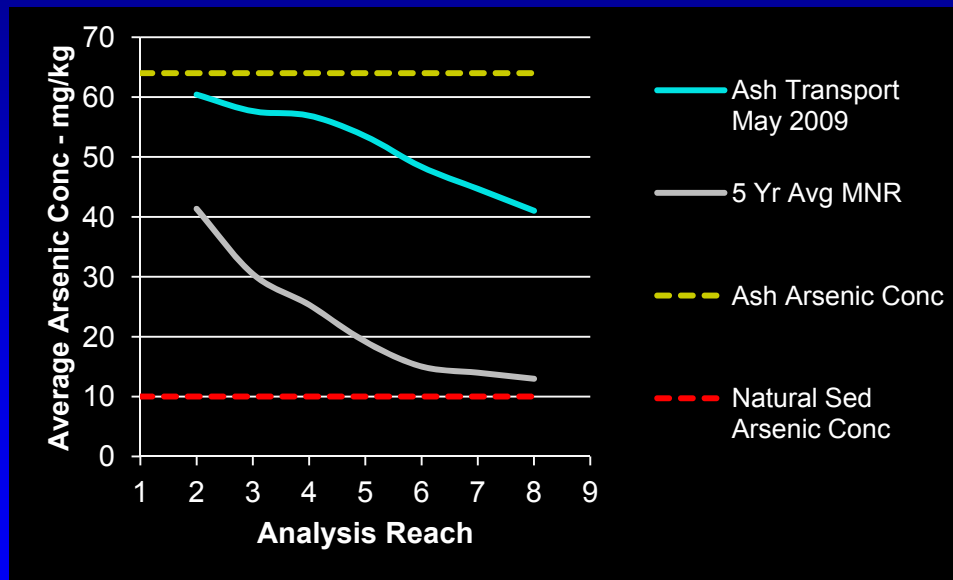


# TVA Kingston Fly Ash Transport and Fate Study

## Phase 2 Model Results: Weight Averaged Arsenic Concentration

\*Assuming Arsenic Concentration of Ash = 64 mg/kg

\*Arsenic Concentration of Natural Sediment = 10 mg/kg

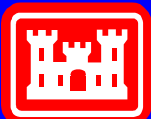


# TVA Kingston Fly Ash Transport and Fate Study

## Conclusions

### Fly Ash Transport Simulation – May 2009 Event

- Model results indicate approximately 90,000 – 120,000 cubic yards of fly ash transported below the Kingston site during the May 2009 flow event (~20% of all ash transported below the site)
- Coarse sized ash particles (0.16 – 0.022 mm) deposited in the channel below the site while finer size fractions transported throughout Watts Bar reservoir
- Depth of fly ash deposits ranged from 3 inches in the lower Emory River, 0.3 inches in the lower Clinch River, and < 0.1 inches in lower Watts Bar reservoir

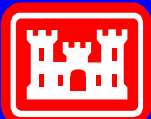


# TVA Kingston Fly Ash Transport and Fate Study

## Conclusions

### Two Year MNR Simulations

- Watts Bar Reservoir is depositional for the one year average flow condition
- MNR simulations indicate substantial mixing of ash and sediment in lower Watts Bar Reservoir (TRM 567 – 530)
- Model results extrapolated out to 5 years suggests a mass dilution of contaminants associated with ash to background levels in lower Watts Bar Reservoir



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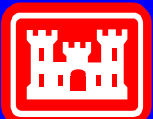
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# TVA Kingston Fly Ash Transport and Fate Study

## On-Going Studies

### *30 Year MNR Simulation*

- Simulate 30 years of flow in Emory River (1978 – 2008)
- Evaluate impacts of large storms for delivering or scouring sediment
- Results will provide guidance on how to best mitigate residual ash deposits



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