Human and Ecological Risk Characterization for the River System at the TVA Kingston Ash Recovery Project

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Acknowledgements
Outline

• Site Setting & History
• HHRA Highlights
• BERA Overview
• Risk Management
• Summary & Conclusions
Site Setting & History

December 22, 2008

~5.4 million cy coal ash

Unprecedented release

Dire predictions of ecosystem collapse
Watts Bar Reservoir

Emory River
- Reference—above ERM 6.0
- Reach C—ERM 3.5 to 6.0
- Reach B—ERM 1.5 to 3.5
- Reach A—ERM 0.0 to 1.5

Clinch River
- Reference—above CRM 4.5
- Reach B—CRM 3.0 to 4.5
- Reach A—CRM 0.0 to 3.0

Tennessee River
- Reference—above TRM 568
- Reach B—TRM 566 to 568
- Reach A—TRM 550 to 566
Time-Critical Removal Actions

Dredging in Emory River Reaches A & B from May, 2009 to June, 2010

~3.5 million cy of ash and sediment removed from the Emory River

~500,000 cy ash remaining, mostly in Emory River Reaches A & B
HHRA Approach

Examined multiple exposure scenarios

Used real, site-specific data

Followed EPA risk assessment guidance
HHRA Approach

Adult and Child Residents

Surface water
Household use as drinking water, without treatment

Fish Consumption
1 pound per week (fillet)

Adult and Adolescent Swimmers & Beachcombers

Surface water
Swimming 45 days a year
1.4 hours per day

Sediments
Beachcombing 48 days per year
(during winter pool when Watts Bar Reservoir is lowered)
HHRA Results

Confirmed risks from *legacy PCBs & Mercury* in fish tissues

TDEC fish consumption advisory pre-dating the spill

*No unacceptable* risks associated with residual ash

Agrees with 2010 TN DOH Public Health Assessment

Agrees with ORAU/Vanderbilt Medical Screenings
BERA Approach

- Comprehensive Investigation
- Rigorous Analysis
- Defensible, Reasonable Results
Comprehensive Protection of balanced communities or populations of:

- Fishes
- Benthic invertebrates
- Aquatic plants
- Aquatic- or riparian-feeding birds
  - Herbivores (wood duck)
  - Omnivores (mallard; killdeer)
  - Piscivores (osprey; great blue heron)
- Aquatic- or riparian-feeding mammals
  - Herbivores (muskrat)
  - Omnivores (raccoon)
  - Piscivores (mink)
- Aerial-feeding insectivores
  - Birds (tree swallow)
  - Mammals (gray bat)
- Aquatic- or riparian-feeding amphibians
- Aquatic- or riparian-feeding reptiles
Comprehensive

Field Studies (Biosurveys)
- Population and community data
  - Fish community
  - Benthic Invertebrate Community
  - Tree swallow nest box surveys
  - Turtle trapping

Laboratory Studies
- Toxicity tests
  - Surface water
  - Sediment and ash

Toxicity Benchmarks
- Literature-derived effects values
  - Concentrations in water and sediment
  - Concentrations in the receptor (tissue)
  - Concentrations in food items (diet)
Rigorous

Benthic Invertebrate Community Evaluation

- 15 benthic community transects annually
- Substrate characteristics
- % ash, grain size, chemistry
- Geospatial statistical analysis

Results

- Variations primarily due to habitat
- No clear and consistent relationship between community results and concentrations of ash or metals (arsenic)
Rigorous

Sediment Toxicity Tests

Screening
- Short-term, undiluted, 3 test species
- Emory and Clinch Rivers, 8 locations each

Chronic
- Long-term, dilution series, 2 test species
- Emory and Clinch Rivers, 4 locations each

Sediment Chemistry and Characteristics
- Metals, PAHs, PCBs, pesticides
- % ash, grain size, TOC

Multivariate Statistical Analysis
Rigorous

Sediment Toxicity Test Results

- Correlation of sediment toxicity with % ash and with arsenic concentration in sediments

- Minimal or no toxicity observed in sediments with less than about ~40% ash
# BERA Results

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Potential Risk</th>
<th>Risk Mgmt</th>
<th>COECs</th>
<th>Lines of Evidence</th>
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<tbody>
<tr>
<td><strong>Fish</strong></td>
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<td>Community Surveys, Bioassays, Reproductive Studies, Tissue, Biomarkers, Surface Water</td>
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<tr>
<td><strong>Benthic Invertebrates</strong></td>
<td>(ER)</td>
<td>✓</td>
<td>As, Se</td>
<td>Community Surveys, Bioassays, Tissue, Porewater, Sediment</td>
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<td><strong>Birds</strong></td>
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<tr>
<td>Piscivore – Heron, Osprey</td>
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<td>Omnivore – Mallard</td>
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<tr>
<td>Herbivore – Wood Duck</td>
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<tr>
<td>Invertivore – Killdeer</td>
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<td>✓</td>
<td>As, Se</td>
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<tr>
<td>Aerial Insectivore – Tree Swallow</td>
<td>Ø</td>
<td>✓</td>
<td>As, Se</td>
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<tr>
<td><strong>Mammals</strong></td>
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<tr>
<td>Piscivore – Mink</td>
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<tr>
<td>Omnivore – Raccoon</td>
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<tr>
<td>Herbivores – Muskrat</td>
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<tr>
<td>Aerial Insectivore – Gray Bat</td>
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<tr>
<td><strong>Reptiles</strong></td>
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<td>Community Surveys, Tissue, Surface Water, Sediment</td>
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<tr>
<td><strong>Aquatic Plants</strong></td>
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<td></td>
<td>Tissue, Surface Water, Sediment</td>
</tr>
</tbody>
</table>

 Ø = risks are negligible  Ø = risks are low  ☒ = risks are moderate  ● = risks are high  ✓ = risk management is recommended

COECs = constituents of ecological concern; ER = Emory River; CR = Clinch River
Risk Management

Remedial Action Objectives
- Protect invertebrate populations in Watts Bar Reservoir
- Protect shoreline-feeding & aerial-feeding bird populations that consume invertebrates

Risk Drivers
- Ash
- Arsenic and selenium
Risk Management

Remediation Goals (RGs)

- Sediment concentrations protective of benthic invertebrate populations (communities)
- Derived from site-specific sediment toxicity test results
- RG Range based on IC25s for the midge and amphipod
- Where sediment is > 50% ash:
  
  Arsenic = 29 to 41 (mg/kg, dry weight)
  Selenium = 3.0* to 3.2 (mg/kg, dry weight)

Tissue Monitoring Endpoints (TMEs)

- Concentrations in prey items (e.g., mayfly nymphs, adults)
  
  Arsenic = 34 to 81 (mg/kg, dry weight)
  Selenium = 7* (mg/kg, dry weight)

* Background reference concentration
Summary & Conclusions

Comprehensive Investigation

Rigorous Analysis

Defensible, Reasonable Results

Monitored Natural Recovery

Cost Savings:

$22 M vs. in situ capping

$162 M vs. dredging
Imagine the result

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