A Multi-phased Toxicity Study for Evaluating Potential Risks of Kingston Fossil Plant Fly Ash Exposures to Benthic and Aquatic Biota

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ABSTRACT

TVA initiated multi-phase laboratory toxicity studies in March 2009 to evaluate potential risks to biota from exposure to fly ash from the Kingston ash release to the Emory River and subsequent dredging. The overall objective is to evaluate toxicity (survival, growth, reproduction) and metals bioaccumulation elicited by exposure of benthic and aquatic species to whole ash, elutriates, dredge plume water, and ash stilling pond effluent. Various acute and chronic test protocols were used in the first phase with (1) two 3.1-m Vibracore® ash composite samples collected March 17; (2) two 3.1-m Vibracore® ash composite samples collected June 11-12; and, (3) monthly Emory River dredge plume and stilling pond effluent samples collected April – June. Results from the March 17 ash composite samples indicated no appreciable bioaccumulation of metals in *Corbicula fluminea* exposures (28-d) to whole ash nor any toxic effects in *Ceriodaphnia dubia* (96-h), *Pimephales promelas* (96-h), or *Lampsilis siliquoidea* (10-d) exposures to ash elutriates. *Lumbriculus variegatus* exposures (4-d) to whole ash showed no effects on survival, but worms did not burrow so bioaccumulation was not assessed. No effects on survival were noted for *L. siliquoidea* 5-d exposures to whole ash, but 10-d exposures to one of the whole ash samples did result in significant effects on survival relative to laboratory control sediment. *Hyalella azteca* exposures (10-d) to both whole ash samples indicated adverse effects on survival. No effects (survival, reproduction) were observed in 7-day chronic exposures with *C. dubia* to plume or stilling pond effluent samples collected April – June. Results with identical exposures to the April and May samples by *P. promelas* (survival, growth) were invalidated due to confirmed pathogen interference. *P. promelas* chronic tests with Ultraviolet-treated plume and stilling pond effluent samples collected in June resulted in no adverse effects. The second phase of testing (96-h *C. dubia and P. promelas*) involves weekly (August – September) and bimonthly (October – present) monitoring of dredge plume and stilling pond effluent samples in response to increased dredging rates; results through mid October have shown no effects on survival. Test results from the June 11-12 ash composite samples are currently being evaluated. A third phase of this study focusing on the bioavailability of metals in ash and evaluating resin-treatment of ash to provide a suitable reference control is underway.

INTRODUCTION

- Prior to Kingston ash release, virtually no toxicological data existed for aquatic and benthic organism exposures to fly ash in a natural system
- TVA identified exposure-response scenarios that required early laboratory study
- Are benthic animals in direct contact with ash affected, and if so, how?
- Are benthic and aquatic animals affected by dredging, and if so, how?
- Phase 1 — characterize toxicity in the major routes of exposure (whole ash, dredge plume, dredge dewatering and treated water discharge)
- Phase 2 — more intensive monitoring of dredging in response to increasing dredging rates
- Phase 3 — focus on bioavailability of metals in whole ash

OBJECTIVES

Comprehensively evaluate toxicity (survival, growth, reproduction) and metals bioaccumulation from exposure of benthic and aquatic species to:

- Whole ash
- Elutriates
- Dredge plume water
- Ash Stilling Pond effluent

MATERIALS AND METHODS

- Multiple 3.1-m Vibracore® samples collected immediately upstream (Vb.1) and downstream (Vb.2) of dredging on March 17, composited into 2 discrete samples, individually homogenized, placed in 19-L plastic buckets and kept in cold storage (4ºC) until use
- Multiple 3.1-m Vibracore® samples (Vb.3 & Vb.4) collected and composited June 11—12, homogenized, placed in 19-L plastic buckets and kept in cold storage (4ºC) until use
- All whole ash and elutriate exposures conducted with Vibracore® ash composites that required re-homogenization upon each use
- Emory River dredge plumes visually located; Hydrolab used to delineate most turbid depth; peristaltic pump used to collect aqueous plume sample, held at 4ºC until use
- 24-h composite stilling pond effluent samples collected with ISCO sampler, held at 4ºC until use
- Reference control and dilution water collected from unaffected areas of Emory River
- Laboratory control sediment collected from Clinch River mile 189.0

KIF Features
Dredge Turbidity Monitor Locations
Floating Instrument Platform Locations
Stationary Air Monitoring Locations
Entrainment Sampling Locations
Monitoring Well Locations
Surface Water Sample Locations
Date of map: August 21, 2009
Tennessee Valley Authority
Kingston Fossil Plant
Geographic Information Engineering
Source: Image(s) © 2009 Tennessee Valley Authority, Earthstar Geographics SIO, Sites: Aerial Mid Shelby County, 2009/2009 (5.0ft) (5.0ft)
Ash Pond
Ash Pond
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