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Wildlife Dietary Exposure Models

Tennessee Valley Authority
Ash Recovery Project
Kingston, Tennessee

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Table of Contents

1. Introduction 1

2. Exposure Dose Calculations 1

2.1 Data Used to Estimate Concentrations in the Receptor Diet 1

2.1.1 Sediment 2

2.1.2 Surface Water 3

2.1.3 Prey Tissue Concentrations 3

2.1.3.1 Fish 4

2.1.3.2 Invertebrates 4

2.1.3.3 Plants 5

2.1.3.4 Amphibians 5

2.1.4 Exposure Point Concentrations 5

2.2 Wildlife Receptor Exposure Parameters 7

2.2.1 Body Weight 7

2.2.2 Food and Water Ingestion Rates 7

2.2.3 Incidental Sediment Ingestion Rates 8

2.2.4 Dietary Fraction 8

2.2.5 Site Foraging Frequency 8

2.2.6 Bioavailable Fraction 9

2.2.6.1 Sediment 9

2.2.6.2 Food Items 10

3. Toxicity Reference Values 1

3.1 Screening Toxicity Reference Values 1

3.2 Refined Toxicity Reference Values 1

4. Risk Characterization 1

4.1 Risk Characterization Methods 1

4.1.1 Deterministic Risk Characterization 1

4.1.2 Stochastic Risk Characterization 1

4.2 Risk Characterization Results 2

4.2.1 Aquatic- and Riparian-Feeding Birds 3

4.2.1.1 Herbivores (Wood Duck) 3

4.2.1.2 Omnivores (Mallard Duck) 3

4.2.1.3 Insectivores (Killdeer) 3

4.2.1.4 Piscivorous (Heron and Osprey) 5

4.2.2 Aquatic- and Riparian-Feeding Mammals 5

4.2.2.1 Herbivores (Muskrat) 5

4.2.2.2 Omnivores (Raccoon) 5

4.2.2.3 Piscivorous (Mink) 6

4.2.3 Aerial Feeding Wildlife 6

4.2.3.1 Tree Swallow 6

4.2.3.2 Gray Bat 7

5. Uncertainty **1**

5.1 Selection of Receptors of Interest 1

5.2 Data and Exposure Point Concentrations 2

5.2.1 Sample Location and Collection 2

5.2.2 Exposure Point Concentrations 2

5.2.2.1 Sediment 3

5.2.2.2 Surface Water 3

5.2.2.3 Prey Tissue Concentrations 3

5.3 Receptor Exposure Parameter Assumptions 5

5.4 Toxicity References Values 7

5.5 Risk Characterization 9

5.6 Sensitivity Analysis 10

6. References **1**

Tables

1. Data Used for Exposure Point Concentrations in the Dietary Exposure Models
2. Receptor Exposure Assumptions
3. Sediment Bioaccessibility Factors
4. Percentage of Aluminum and Iron in Fish and Larval Gut Content
5. Dietary Uptake Equations
6. Avian Toxicity Reference Values – Screening Evaluation
7. Mammalian Toxicity Reference Values – Screening Evaluation
8. Toxicity Reference Values – Refined Evaluation
9. Toxicity Reference Values – Probabilistic Evaluation
10. Body Weight Ranges for Probabilistic Assessment
11. Screening Deterministic Risk Characterization Results Summary
12. Refined Deterministic Risk Characterization Results Summary
13. Probabilistic Risk Characterization Results Summary

Figures

1. Locations of Exposed Sediment and Surface Water Samples Used in the Dietary Exposure Models
2. Locations of Biota Samples Used in the Dietary Exposure Models
3. Probability Distribution for Exceedance of the Selenium Hazard Quotient for the Mallard–Emory River Reach A
4. Probability Distribution for Exceedance of the Aluminum Hazard Quotient for the Killdeer–Emory River Reach A
5. Probability Distribution for Exceedance of the Arsenic Hazard Quotient for the Killdeer to–Emory River Reach A

6. Probability Distribution for Exceedance of the Selenium Hazard Quotient for the Killdeer– Emory River Reach A
7. Probability Distribution for Exceedance of the Aluminum Hazard Quotient for the Raccoon– Emory River Reach A
8. Probability Distribution for Exceedance of the Aluminum Hazard Quotient for the Mink – Emory River Reach B
9. Probability Distribution for Exceedance of the Selenium Hazard Quotient for the Tree Swallow – Emory River Reach A
10. Probability Distribution for Exceedance of the Selenium Hazard Quotient for the Gray Bat– Emory River Reach A
11. Sensitivity Analysis of Relative Influence of Parameters for Killdeer Aluminum Dietary Dose - Emory River Reach A
12. Sensitivity Analysis of Relative Influence of Parameters for Killdeer Arsenic Dietary Dose - Emory River Reach A
13. Sensitivity Analysis of Relative Influence of Parameters for Killdeer Selenium Dietary Dose - Emory River Reach A
14. Sensitivity Analysis of Relative Influence of Parameters for Raccoon Aluminum Dietary Dose - Emory River Reach A
15. Sensitivity Analysis of Relative Influence of Parameters for Mink Aluminum Dietary Dose - Emory River Reach B
16. Sensitivity Analysis of Relative Influence of Parameters for Tree Swallow Selenium Dietary Dose - Emory River Reach A
17. Sensitivity Analysis of Relative Influence of Parameters for Gray Bat Selenium Dietary Dose - Emory River Reach A

Attachments

1. Concentrations in Depurated versus Non-Depurated Mayfly Nymphs and in Whole Fish Tissue versus Fish Tissue Without Gut
2. Sediment Bioaccessibility Estimates
3. Toxicity Reference Values
4. Screening Deterministic Risk Characterization Models per Reach and Receptor
5. Refined Deterministic Risk Characterization Models per Reach and Receptor
6. Probabilistic Refined Risk Characterization Models Simulations
7. Uncertainty Analysis
8. Response to Comments from USEPA Region 4, on the Wildlife Dietary Exposure Models Methodology Document, dated March 2012

Acronyms

AF	bioavailable fractions
BERA	baseline ecological risk assessment
BTAG	USEPA Biological Technical Assistance Group
COPECs	constituents of potential ecological concern
CR	Clinch River
DDT	dichlorodiphenyltrichloroethane
DDx	dichlorodiphenyltrichloroethane and derivatives
EcoSSL	USEPA Ecological Screening Levels for Soil
EPC	exposure point concentration
ER	Emory River
HQ	hazard quotient
KM	Kaplan-Meier
KM(t)	Kaplan-Meier t-distribution
LOAEL	lowest adverse effect level
mg/kg-day	milligrams per kilogram body weight per day
NOAEL	no adverse effect level
PCBs	polychlorinated biphenyls
ROIs	receptors of interest
RPD	relative percent difference
SEP	sequential extraction procedure
SFF	site foraging frequency
TR	Tennessee River
TRV	toxicity reference value
TVA	Tennessee Valley Authority
UCL	upper confidence limit of the mean
USACHPPM	United States Army Center for Health Promotion and Prevention
USEPA	U.S. Environmental Protection Agency
WTA	Wildlife Toxicity Assessment

Preface

This document presents the assessment of exposure of wildlife through dietary uptake at the Tennessee Valley Authority (TVA), Kingston Fossil Plant Release Site, in Kingston, Tennessee. The methods and assumptions used in the assessment (Sections 1 through 3 and Attachments 1 through 3) were first presented to U.S. Environmental Protection Agency (USEPA) Region 4 in a document titled "Wildlife Dietary Exposure Models Methodology" dated March of 2012 (the Methodology document). Sections 1 through 3 remain the same as in the Methodology document, with a few exceptions where clarifications were included or typographical errors were corrected.

USEPA Region 4 forwarded comments on the Methodology document in a memorandum dated May 8, 2012, prepared by Black & Veatch's. The comments together with TVA's response to them are provided as Attachment 7 of this report. In order to adhere to the schedule of delivery for the Baseline Ecological Risk Assessment (BERA), only minor editorial changes were addressed within the document itself and comments that required further analysis and explanation will be addressed during revision of the BERA this summer in response to comments received during the public review. Sections that were associated with an agency technical comment (as opposed to editorial) are marked with an asterisk (*) to alert the reader that further discussion on the issue is provided in Attachment 7.

1. Introduction

Dietary exposure to constituents of potential ecological concern (COPECs) in the abiotic media and food items is one of the primary lines of evidence used to assess potential risk to wildlife receptors. The models and results presented herein were used in the Baseline Ecological Risk Assessment (BERA) for the River System at the Tennessee Valley Authority (TVA) Kingston Fossil Plant Release Site, in Roane County, Tennessee (the site).

The focus of the BERA is the area impacted by the ash spill within the Emory River (ER), the Clinch River (CR), and the Tennessee River (TR). In order to adequately characterize potential effects of ash-related COPECs on the impacted areas, each river was divided into reaches based on known or expected differences in exposure to ash-related constituents. Reference reaches (i.e., Reach R) were also established for each river to provide an accurate comparison to pre-release conditions. Impacted and reference reaches were defined as follows:

Emory River:

- ER_R: Reference Reach: upstream of ERM 6.0 and/or Little Emory River
- ER_C: Reach C: ERM 3.5 to ERM 6.0
- ER_B: Reach B: ERM 1.5 to ERM 3.5
- ER_A: Reach A: ERM 0.0 to ERM 1.5

Clinch River:

- CR_R: Reference Reach: upstream of CRM 4.5
- CR_B: Reach B: CRM 3.0 to CRM 4.5
- CR_A: Reach A: CRM 0.0 to CRM 3.0

Tennessee River:

- TR_R: Reference Reach: upstream of TRM 568.0
- TR_B: Reach B: TRM 566.0 to TRM 568.0
- TR_A: Reach A: TRM 550.0 to TRM 566.0

The wildlife assessment endpoints and the representative receptors of interest (ROIs) are:

- Aquatic- or riparian-feeding herbivorous bird populations
  – Wood duck (*Aix sponsa*),
- Aquatic- or riparian-feeding insectivorous (omnivorous) bird populations
  – Mallard duck (*Anas platyrhynchos*),
  – Killdeer (*Charadrius vociferous*),

- Aquatic- or riparian-feeding carnivorous (piscivorous) bird populations
  – Great Blue Heron (*Ardea herodias*), and Osprey (*Pandion haliaetus*),
- Aquatic- or riparian-feeding herbivorous mammal populations
  – Muskrat (*Ondatra zibethicus*),
- Aquatic- or riparian-feeding insectivorous (omnivorous) mammal populations
  – Raccoon (*Procyon lotor)*,
- Aquatic- or riparian-feeding carnivorous (piscivorous) mammal populations
  – Mink (*Neovison vison*),
- Aerial-feeding insectivorous (omnivorous) bird populations
  – Tree swallow (*Tachycineta bicolor*), and
- Aerial-feeding insectivorous (omnivorous) mammal populations
  – Gray Bat (*Myotis grisescens*).

The COPECs at the site include inorganics (i.e., metals, metalloids, and naturally occurring radionuclides) associated with ash and legacy (i.e., not associated with ash spill) constituents in the river system. Legacy constituents include the following anthropogenic radionuclides and organic constituents: cesium-137, cobalt-60, pesticides, polychlorinated biphenyls (PCBs), and dichlorodiphenyltrichloroethane (DDT) and derivatives, referred to here as DDx. The dietary exposure models were performed to assess wildlife exposure to the inorganic and organic COPECs. The evaluation of radionuclides was conducted separately and is discussed in Appendix X of the BERA.

Risk through dietary exposure was evaluated by calculating an exposure dose of each COPEC [in milligrams per kilogram per day (mg/kg-day) body weight] using a food chain exposure model for each ash-impacted reach and reference reach and then comparing the dose with a diet-based toxicity reference value (TRV) dose for that COPEC. The TRVs were no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) identified from toxicity studies in the literature. Calculated doses were divided by TRVs to estimate a hazard quotient (HQ) rounded to the nearest whole number. HQs below 1 indicate a low likelihood of risk, while HQs greater than 1 generally indicate a need for further evaluation.

Screening HQs based on NOAEL TRVs were calculated using conservative, non site-specific assumptions for both calculating the dose and identifying TRVs. COPECs whose screening HQs exceeded 1 for a receptor were carried forward into refined analyses. Refinements included using model parameters and TRVs that were adjusted to be more site-specific. This step is an “incremental iteration of exposure, effects, and risk characterization” (USEPA 2001). If the recalculated NOAEL HQ of a COPEC was less than 1 and greater than the NOAEL HQ for the reference reach within the same river, then the COPEC was carried forward for further analysis. If not, the COPEC was not evaluated further. This initial analysis was done using deterministic (fixed input) parameters. For retained COPECs, the variability in the NOAEL and LOAEL HQ estimate and probability of the HQ exceeding 1 was determined via a Monte Carlo stochastic/probabilistic

analysis that accounted for the variability in the parameters of the model and TRVs. Such an analysis helps bound the probability of risk.

Dietary exposure models contained species-specific parameters (e.g., body weights, ingestion rates, and diet compositions) defined in the *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012). The concentrations of COPECs in the sediment and prey items at the site were entered into the deterministic and stochastic models to estimate HQs, which were used as a line of evidence to estimate risk to wildlife.

This document describes the following components of the dietary exposure assessment:

- Exposure Dose Calculations
- Toxicity Reference Values
- Risk Characterization
  - Deterministic Risk Characterization
  - Stochastic Risk Characterization

2. Exposure Dose Calculations

The exposure dose is defined as the amount of a constituent that is taken into the body per day via ingestion. Input parameters used in the dose calculation include measured concentrations of COPECs in site media and diet items, bioavailability of COPECs to the receptor, and receptor-specific exposure parameters (body weight, food, water, and sediment ingestion rate, diet composition, and site use factor). The basic equation used to estimate the dietary exposure for a receptor (modified from USEPA 1999) is shown below:

$$\text{Dose}\left(\frac{\text{mg}}{\text{kg - day}}\right)=\frac{\left(\left[C_{SW}\times IR_{SW}\right]+\left[\left\{\left[C_{SED}\times AF_{SED}\times FIR_{SED}\right]+\left[\sum_{i}\left(C_{i}\times P_{i}\times AF_{i}\right)\right]\right\}\times IR_{FD}\right]\right)\times SFF}{BW}$$

Where:

AF_i	=	Bioavailable fraction of the constituent in the ith food item (unitless)
AF_{SED}	=	Bioavailable fraction of the constituent in the sediment (unitless)
BW	=	Body weight of the organism (kg)
C_i	=	Dry weight concentration of the constituent in the ith food item (mg/kg)
C_{SED}	=	Dry weight concentration of the constituent in the sediment (mg/kg)
C_{SW}	=	Concentration of the constituent in the surface water (milligrams per liter)
FIR_{SED}	=	Fraction of the food ingestion rate that is sediment (unitless)
i	=	Food item (amphibian, fish, nymph or adult mayfly, or vegetation)
IR_{FD}	=	Ingestion rate of dry food (kg/day)
IR_{sw}	=	Ingestion rate of surface water (L/day)
P_i	=	Proportion of the diet comprised of the ith food item (unitless)
SFF	=	Site foraging frequency (unitless; set at 1)

The dietary exposure dose was calculated three times. The first time was a conservative screen, the second a refined more site-specific deterministic analysis, and the third was a probabilistic analysis. The following sections describe the components of the exposure model including the data used to estimate concentrations in diet, methods used to identify the exposure point concentrations (EPCs), and the wildlife receptor exposure parameters used.

2.1 Data Used to Estimate Concentrations in the Receptor Diet

Data collected as part of the Sampling and Analysis Plan were used in the wildlife exposure models. In addition, data collected as part of TVA biological monitoring (i.e., amphibians data) were also used when

available. Surface water and sediment data used in modeling were collected in 2010 and 2011. Fish, benthic invertebrate, and amphibian data were collected in 2010, while aquatic vegetation data were collected in 2011. Exposed sediment and surface water sample locations are presented in Figure 1, while biota sample locations are presented in Figure 2.

Depending on the wildlife receptor, dietary components could include one or more of the following:

- Aquatic invertebrates
- Terrestrial invertebrates
- Small mammals and birds
- Fish
- Vegetation
- Amphibians
- Sediment – via incidental ingestion
- Soil – via incidental ingestion
- Water

To the extent practical, the exposure models used measured concentrations in site-specific food items, rather than estimated concentrations based on literature-derived transfer factors. For the purposes of the BERA, measured concentrations in some dietary items were used as surrogate concentrations for other dietary items, as follows:

- aquatic invertebrates were substituted for terrestrial invertebrates,
- fish were substituted for small mammals and birds, and
- sediment was substituted for soil.

These substitutions conservatively assume all food and exposure is coming from the aquatic environment that was affected by the ash spill, and are detailed in the following subsections.

2.1.1 Sediment

Both seasonally exposed sediment and submerged sediment were sampled in the river system. Submerged sediment samples were collected from locations below the winter pool water elevation (i.e., approximately 735 feet mean sea level). Water depth at winter pool levels range from zero at the shore line to more than 25 feet in the thalweg. Approximately equal numbers of samples were collected from left of the centerline, right of the centerline, and along the centerline each river. Exposed sediment was collected from shallow areas (i.e., water depth less than approximately 5 feet) where the sediment is exposed during winter reservoir drawdown. Wildlife receptors are not expected to be directly exposed to submerged sediment due to water depth; however they could be exposed to submerged sediment ingested by bottom feeding prey items. Seasonally exposed sediment data were used to reflect sediment concentrations that could be

incidentally ingested by wildlife at the site, and submerged sediment was accounted for in the tissue concentrations of prey, which included the gut of the bottom feeding prey items.

2.1.2 Surface Water

Surface water samples consisted of collections from approximately the center of the channel within 0.5 meter (~2.5 feet) of the sediment, as well as from the mid-column depth (approximately 15 feet from the surface). In the event of thermal stratification, an epilimnion (top-most layer of the water column) and hypolimnion (bottom layer below the thermocline) sample were collected in place of a mid-column sample. Mid-column samples were used in the dietary exposure modeling. At locations where both epilimnion and hypolimnion samples were collected, these samples were essentially treated as duplicates, with only one result reported per location using the following selection criteria:

1) if both samples reported positive detects, the higher measured analytical concentration was used;
2) if only one result was a positive detect, that concentration was used; or
3) if both samples reported non-detects, the lower detection/quantitation-limit was used as the proxy concentration.

Surface water samples were analyzed for total and dissolved metals. A review of the data (Appendix A) indicated that concentrations of metals were higher in the unfiltered (total) samples than in the filtered samples (dissolved)[*]. Total metals data were used in the dietary models to reflect drinking water concentrations ingested by wildlife at the site.

2.1.3 Prey Tissue Concentrations

Prey tissue used in the model includes invertebrates, amphibians, fish, and emergent and shoreline vegetation. Data are available for depurated and non-depurated mayfly nymphs and for gizzard shad with the gastrointestinal tract (whole body) and without the gastrointestinal tract (whole body minus guts). A comparison of concentrations of COPECs in depurated versus non-depurated mayfly nymphs and in whole fish tissue versus fish tissue without gut (Attachment 1) showed that, in some cases, the incidental sediment ingestion rate based upon the literature [see *Wildlife Toxicity Profiles Technical Memorandum* (ARCADIS 2012)] may not account for the total COPEC concentration measured in the gut of the prey organism. Therefore, the wildlife exposure models used non-depurated mayfly nymphs and whole body gizzard shad concentrations in addition to the literature-derived incidental sediment ingestion rates.

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[*] See response to agency comments provided in Attachment 8.

Using whole body prey tissue concentrations in addition to incidental sediment ingestion rates is conservative and may overestimate the risk to wildlife. The gut of fish and invertebrates may mostly contain sediment and ash with COPECs, especially for benthic feeding fish and invertebrates (e.g., gizzard shad and burrowing mayflies). Use of whole body tissue concentrations plus incidental sediment ingestion may be double-counting because the sediment in the gut of prey should be accounted for in the incidental ingestion rate in the model, at the rate obtained from studies of scat (Beyer et al. 1994; Beyer et al. 1997). This possible overestimation is further discussed in the uncertainty section. A discussion of the data selected for the model of the data collected for each tissue type is provided below.

2.1.3.1 Fish

Fish data available for the BERA include samples from the following species: black crappie, blue catfish, bluegill, carp, channel catfish, flathead minnow, gizzard shad, largemouth bass, longear sunfish, redear sunfish, spotted bass, and white crappie. Types of fish data available vary by species and may include: whole body, whole body minus gut, fillet, carcass, gut and gut contents, liver, and ovary.

Of the ROIs, mink, raccoon, great blue heron, and osprey have a fish component to their diets. Mink are opportunists and feed on forage and predatory fish and tend to feed on the species that is most abundant. Raccoon, heron, and osprey tend to feed opportunistically as well, but will also forage on bottom-feeding fish, if abundant. A more detailed discussion of foraging habits is presented in the *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012).

Data for gizzard shad, and bluegill were the most abundant with some data for redear sunfish. Whole body concentrations of COPECs in gizzard shad were used in the dietary models to represent the fish dietary component for the ROIs because gizzard shad is one of the most abundant bottom-feeding fish at the site. It maintains a high level of exposure to COPECs in sediment based on its detritus-feeding behavior and is commonly eaten by the higher trophic level receptors. Gizzard shad data were selected over other fish data because the gizzard shad dataset was the most comprehensive and exhibited higher concentrations and was thus more conservative. The uncertainty associated with using one fish species to represent all fish is discussed in the uncertainty section[*].

2.1.3.2 Invertebrates

Samples of snails, and nymph and adult mayflies were collected from impacted and reference areas. Adult mayfly COPEC concentrations were used to represent exposure concentrations for the aerial feeder ROIs (i.e., bats, tree swallows) that feed on adult emergent insects. Of the ROIs, raccoon, mink, wood duck, mallard, killdeer, and great blue heron have an aquatic benthic invertebrate component to their diet. As

[*] See response to agency comments provided in Attachment 8.

noted above, non-depurated (whole body) larval mayfly COPEC concentrations were used to represent the exposure concentration for the aquatic invertebrate component of the ROI diet.. Larval mayfly are closely associated with exposures to ash-related constituents in sediment and were thus considered appropriate to assess effect of ash related COPECs. Larval mayfly data were selected over snail tissue concentrations because the mayfly dataset was the most comprehensive and exhibited higher concentrations for most metals and was thus more conservative. The uncertainty associated with using nymph mayfly to represent all invertebrates is discussed in the uncertainty section*.

2.1.3.3 Plants

Leaves of shoreline and emergent vegetation were collected from the impacted and reference areas at the site. The uncertainty associated with the using data for leaves and not roots is discussed in the uncertainty section*. For the purposes of the BERA, inorganic COPEC data for both types of vegetation (i.e., shoreline and emergent) were combined for each evaluated reach to represent vegetation concentrations at that reach. Of the ROIs, muskrat, raccoon, mink, wood duck, and mallard have a vegetation component to their diet.

2.1.3.4 Amphibians

Two species of frog (spring peeper, upland chorus frog) and one species of toad (American toad) were collected in the West Embayment, North Embayment, and the un-impacted wetlands that feed into the North Embayment. Since many animals generally prefer frog over toad due to the apparent bad taste of toad skin secretions (Duellman and Trueb 1986), data for only the two species of frogs were combined and used to represent amphibian concentrations for the impacted river reaches.

Even though amphibian concentrations were only collected in the embayments, the data were assumed to represent amphibian tissue concentrations at all potentially impacted reaches. This is conservative, because the sampling locations were in impoundments containing large volumes of released ash, which is likely to overestimate exposures in the unconfined, flowing river reaches. Those reaches also provide relatively little habitat suitable for substantial populations of amphibians, with that habitat being restricted primarily to shallow coves away from the most significant ash deposits. Amphibian data from reference locations were used to represent reference amphibian tissue concentrations for all reference reaches.

2.1.4 Exposure Point Concentrations

The EPC is the representative concentration of a constituent in an environmental medium that is potentially contacted by the receptor (USEPA 1989). The EPC is defined as “the arithmetic average of the

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* See response to agency comments provided in Attachment 8.

concentration that is contacted over the exposure period" (USEPA 1989). To ensure that the estimate of the average (or mean) is conservative and not underestimated, USEPA (1989, 2002) recommends using an upper confidence limit of the mean (UCL) as an estimate for the EPC (e.g., the 95% UCL). The UCL is a statistical number calculated to represent the mean concentration with a high percent confidence that the true arithmetic mean concentration for a site will be less than the UCL. The high level of confidence (e.g., 95%) is used to compensate for the uncertainty involved in representing site conditions with a finite number of samples.

EPCs in both abiotic and biotic dietary components were based on measured concentrations. EPCs for all relevant media were identified for each reach. In a few instances where data for a reach were not available, data from another reach with similar properties were used. If the missing data were from an upstream reference reach, then available data from another upstream reference reach were used since downstream reaches of the rivers have been shown to be less impacted than upstream reaches a fact supported by both sampling and sediment transport modeling (Jacobs 2011)[*]. If the missing data were from an impacted reach, then available data from a more impacted reach (based on sediment concentrations) were used. Table 1 summarizes the data sources that were used to identify EPCs for each reach.

The following rules were applied to the available data when identifying EPCs:

- Duplicate results were treated as follows: The greater result of the parent and duplicate sample was used if a constituent was detected in both samples. The detected value was used when the constituent was detected in only one of the paired samples. The lower of the two detection limits was used if the constituent was not detected in either the parent sample or the duplicate sample.
- EPCs for the deterministic risk assessment were set at the maximum or the UCL, whichever was lowest. The standard deviation and mean of the data applied to a lognormal distribution were used to randomly select the EPCs for the probabilistic risk assessment (see Section 4.1.2).
- The most current version of the U.S. Environmental Protection Agency's (USEPA) ProUCL software - version 4.1 (USEPA 2011) was used to the calculate UCLs where enough data were available (a minimum of five detections and eight samples). In most cases, the UCL recommended by the software was used. In a few cases, the number of samples was sufficient and ProUCL recommended several UCLs rather than one. In those cases the following stepwise process was used to select the UCL for the exposure model:
  - The relative percent difference (RPD) for the two values was calculated as the ratio of the absolute difference in UCLs divided by the mean of the UCLs.
  - Where the RPD was < 5%, the higher of the two UCLs was conservatively used as the EPC.

[*] See response to agency comments provided in Attachment 8.

- Where the RPD was higher than 5%, ProUCL generally recommended the Kaplan-Meier (KM) estimate using the percentile bootstrap method [KM(% bootstrap)] and the KM estimate using the Student's t-distribution cutoff value [KM(t)]. In those cases, the KM(t) UCL was selected over the KM(% bootstrap) UCL for two reasons: 1) bootstrap methods are typically not reliable when the number of unique values is small (USEPA sets a lower limit of five unique values); and 2) USEPA's decision rules for left-censored data state that with a high degree of censoring, KM(t) is preferred.

2.2 Wildlife Receptor Exposure Parameters

The *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012) provides a detailed exposure profile for each wildlife indicator species including a general description, a discussion of the species distribution in the United States and Tennessee, a description of the species preferred habitat, information regarding the species reproduction patterns, and lastly information regarding the species preferred diet. Receptor exposure parameters such as body weight, ingestion rates, home range, and foraging range are also presented. A brief discussion of the types of parameters and their use in the models is summarized below.

2.2.1 Body Weight

The *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012) presents a compendium of studies that report body weights identified through an extensive literature search for the wildlife ROI. The exception is the raccoon, for which body weight values were based on measured site-specific values (Souza 2010). From the body weights reported in the literature, an average adult body weight was calculated for each species for use in the deterministic risk assessment. For the probabilistic models, a standard deviation was also calculated, where possible. That standard deviation for the compendium of studies was calculated by calculating a set of coefficient of variations for each of the reported means. Then, the median of those coefficients of variation was selected and back-converted to a standard deviation. Average adult body weights for the ROIs are summarized with all other receptor exposure parameters in Table 2.

2.2.2 Food and Water Ingestion Rates

The *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012) presents various food ingestion rates for the wildlife ROIs. The document concludes that for consistency, ingestion rates for the ROIs should be based on allometric equations; thus only these allometrically-derived "All Mammals" and "All Birds" ingestion rates (Nagy 2011) were used in the model.

Water ingestion rates were calculated using allometric relationships for mammals and birds from USEPA's *Wildlife Exposure Factors Handbook* (USEPA 1993). Average food and water ingestion rates based on average body weights for the ROIs are summarized in Table 2.

2.2.3 Incidental Sediment Ingestion Rates

Some receptors also incidentally ingest ambient media (i.e., sediment) during foraging and preening. Sediment ingestion rates used in the wildlife dietary exposure models were based on those presented in the *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012). No studies have been conducted on the ROIs to determine sediment ingestion rates, but Beyer et al. (1994), Beyer et al. (1997), and Fair et al. (1995) evaluated the proportion of soil in diet in a number of species. The incidental ingestion rate of sediment selected for each ROI was based on that for the tested species that was most similar in feeding habits to the ROI. The estimate of sediment ingested incidentally during foraging and preening is equal to the receptor-specific proportion of sediment in diet multiplied by the food ingestion rate. The osprey is expected to have no incidental sediment ingestion other than that in the gut of its prey, which is taken into account by using the whole body of fish. Sediment ingestion rates used in the dietary exposure models are summarized in Table 2.

2.2.4 Dietary Fraction

The proportion of the total diet for an ROI made up by each prey item is known as the dietary fraction. The estimates of dietary fraction used in this BERA are based on values found within the literature and compiled in the *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012). When more than one literature source of dietary information was available, the dietary fraction estimates were based on either an average of all relevant literature sources or the values most relevant to eastern Tennessee. As mentioned earlier, the diet component identified as “terrestrial invertebrates” is assessed using measured tissue data for aquatic invertebrates; the diet component referred to as “small mammals and birds” is represented by measured fish tissue data. This approach focuses the assessment on the potential effect of the ash spill in the aquatic environment. Dietary fractions used in the dietary exposure models are summarized in Table 2.

2.2.5 Site Foraging Frequency

SFF is a term used to describe the ratio of the exposure area to the average home range for the representative species, because the degree of an organism’s exposure is greatly influenced by its home range. An organism with a home range entirely within the affected area will likely have a greater potential of exposure than an organism with only a portion of its home range overlapping the affected area. However, in some instances it is possible for organisms with large home ranges to, at times, remain within a smaller area provided that area offers adequate food and cover. In these instances, using the full home range may underestimate the exposure of that organism to COPECs. Home ranges for the ROIs are discussed in the *Wildlife Exposure Profiles Technical Memorandum* (ARCADIS 2012).

For several of the receptors (e.g., wood duck), the typical home range may be larger than the areas evaluated for each river reach, but they may have reduced home ranges during the breeding season. For other receptors (e.g., killdeer), their foraging ranges are smaller than the typical size of a reach for the site. For the

purposes of the BERA, SFFs were all conservatively assumed to be 1 (i.e., 100% of individual's diet comes from within the reach).

2.2.6 Bioavailable Fraction

Bioavailability describes the fraction of a chemical that desorbs from its matrix (e.g., sediment) in the gastrointestinal tract and is absorbed and transferred into the circulatory system (ITRC 2011). Bioaccessibility is the fraction of chemical available after desorbing from its matrix but before being absorbed into the circulatory system. Most toxicity studies from which TRVs are derived evaluate COPEC toxicity in a highly bioavailable form. Therefore, if a COPEC in the diet item or sediment is not similarly as bioavailable as the form used in the TRV study, the comparison of the calculated dose to the exposure dose will be incorrect. For this reason, the refined assessment incorporated a bioavailable fraction in the dietary dose equation. In the screening dietary exposure models, bioavailability of the COPECs from both sediment and food items was assumed to be 100%. Measures of bioavailability were incorporated into the refined and probabilistic models for each COPEC that was retained following initial screening. These COPECs included five metals (aluminum, iron, lead, manganese, and vanadium) and two metalloids (arsenic and selenium). Metals and metalloids have different properties that affect bioavailability and were treated differently. Bioavailable fractions were estimated using bioaccessible fractions for ingested sediment and food items.

2.2.6.1 Sediment

Sediment bioaccessible fractions for the metals were estimated using chemical extractions that extract the metal expected to be liberated in the gastrointestinal tract using data from a sequential extraction procedure (SEP) based on that established by Querol et al. (1996).* Aluminum, iron, lead, manganese, and vanadium are naturally occurring in sediment in insoluble chemical species (e.g., natural minerals) that are of limited mobility. These metals in the sediment can be partitioned into the following forms likely bioaccessible to wildlife: water-soluble fraction, exchangeable fraction, acid-soluble fraction, and easily-reducible fraction (Karadas and Kara 2012). These fractions were quantified for sediment samples at the site using the sequential metal extraction procedure and were used to calculate the bioaccessible fraction (Attachment 2). To be conservative, the bioavailable fractions of these metals in sediment in the exposure models were assumed to equal their sediment bioaccessible fractions. Sediment bioavailable fractions for metals used in the refined and probabilistic models were 1.2, 6.2, 4.7, 75, and 2.5% for aluminum, iron, lead, manganese, and vanadium, respectively (Table 3).

In contrast, sediment bioavailability of metalloids could not be estimated using the sequentially extracted metals data because organic matter is predominantly digested by enzymes in the digestive tract, but enzymes were not used in the sequential extraction process. Organic selenium represented about 80% (Emory River) to 85% (Clinch and Tennessee Rivers) of the forms of selenium in the sediment, while organic arsenic ranged from 0 to 32% of the species in the sediment (see speciation data in Baseline Risk Assessment Data). As such, sediment bioavailable fractions for metals were assumed equal to the sediment bioaccessible fractions, while sediment bioavailable fractions for metalloids were assumed equal to their total

concentration in the sediment (i.e., bioavailability was assumed to be 100%) since organic metalloids are considered highly bioavailable.

2.2.6.2 Food Items

Bioavailability in food items was treated differently for metals and metalloids in the refined assessment. Amongst the metals, the bioavailable fraction in food was also handled differently depending on the metal.

Bioavailability in food items for lead, manganese, and vanadium was assumed 100%. Such an assumption is conservative, but the degree of conservatisms cannot be explicitly quantified. For example, COPECs can be complexed in less digestible parts of food items (bones, exoskeletons) (Stafford and McGrath 1986, Beyer 1994, Aranaz et al. 2009), and thus are not 100% bioavailable; and the bioavailability of manganese in vegetation is probably not 100% because less than 70% of the manganese in vegetables was bioavailable in the human stomach (Dean 2007), although analogous data are not available for wildlife.

Bioavailable fractions in food for aluminum and iron were treated differently from the other metals because aluminum and iron are expected to be most associated with sediment, whether incidentally ingested or in the gut of ingested food, rather than in food tissue. Aluminum was present in very high proportions in fish and invertebrate guts compared to the tissue (Section 2.1.3). Aluminum in gut ranged between 75 to 91% of total aluminum in whole fish and 79 to 96% of total aluminum in adult mayflies (Table 4). Likewise, the percentage of iron that is in the gut versus the whole organism ranged between 70 to 94% in whole fish and 67 to 83% in mayfly nymphs (Table 4).

Aluminum is a major component of sediment, but not a major component of animal tissue and vegetation. Therefore, it was assumed that the fraction of aluminum in the gut of fish was most likely in sediment form, and as such the bioavailability of aluminum in the gut of fish could be approximated by the bioavailability of aluminum in the sediment. Thus, 70% [conservative estimate that is lower than the lower end of the range of 75 to 91%] of the whole body fish aluminum concentration and 80% [conservative estimate within range of 79 to 96%] of the undepurated mayfly aluminum concentration was adjusted using the bioavailability of aluminum in the sediment. The remaining aluminum in the tissue was unchanged (assumed 100% bioavailable).

Iron, like aluminum, is also a major component of sediment. Therefore, it was assumed that the fraction of iron in the gut of fish was most likely in sediment form as well, and as such the bioavailability of iron in the gut of fish could be approximated by the bioavailability of iron in the sediment. Thus, 70% [conservative estimate that is low end of the range of 70 to 94%] of the whole body fish iron concentration was adjusted using the bioavailable fraction for the sediment. The remaining iron in the fish tissue was unchanged (assumed 100% bioavailable). At high exposure concentrations, most of the iron accumulated by invertebrates is not incorporated into the organism itself, but mostly resides on the exoskeleton encrusted as iron oxides (Vuori 1995). Therefore, unlike the fish, the entire concentration in mayfly was adjusted with a bioavailability factor set equal to the sediment bioaccessibility factor, effectively assuming that the

bioavailability of iron oxides on invertebrates to be the same as the bioavailability of iron in the sediment. The bioavailability of iron in plants was conservatively set at 20% because absorption of non-heme iron in plant foods ranges from 2 to 20% (USNIH 2012). The bioavailability of iron in amphibian (assumed heme iron) was also assumed to be 100%. Table 5 presents the equation used to estimate dietary dose in both the screening and refined assessment and shows the model equations for aluminum and iron in detail.

For the metalloid selenium, the majority of the dose came from the tissue of the food items, not from the sediment or the gut contents of the prey food items. Concentrations of selenium in sediment were very low, below detection limits in one dataset used in the dietary exposure models. Using the speciation dataset, selenium concentrations averaged 1.0 to 1.6 mg/kg in the Emory River Reaches A and B, 0.85 to 0.88 mg/kg in the Clinch River, and below those concentrations (below detection limits) in Emory River Reach C and the Emory reference reach. Tissue concentrations of selenium were much higher in these reaches (>6 mg/kg) as would be expected for bioaccumulating metalloids. The selenium in the gut of prey items was most likely in the periphyton in the gut, not the sediment, in the gut. Organic forms of selenium are highly bioavailable and toxic and were the forms used in the TRV studies (Attachment 3). Thus, bioavailability of the selenium in the ingested material is expected to be near 100% and is expected to be similar to the bioavailability of the forms used in the TRV studies.

For the metalloid arsenic, like selenium, most of the dietary contribution dose was in the food (i.e., not from incidentally ingested sediment). However, unlike selenium, a majority of the ingested arsenic was in the gut contents of the prey item (Attachment 1), and it was conservatively assumed the arsenic in the gut was inorganic. Because the bioavailability of arsenic from prey gut could not be estimated, bioavailability was best captured in the TRV by evaluating toxicity studies that used different forms of arsenic, including inorganic arsenic and organic arsenic as part of prey tissue. The TRVs from those studies were weighted by organic and inorganic percentages contributing to total dose (Attachment 3). The TRVs from such studies were incorporated into the TRVs used in the deterministic analysis, as well as into the TRV distribution in the Monte Carlo probability analysis to represent TRV uncertainty of such a mixture of arsenic forms (Attachment 3). Because adjustments for bioavailability were made in the TRV, not in the calculated dose, the bioavailability of the arsenic in the ingested material was set at 100%.*

* See response to agency comments provided in Attachment 8.

3. Toxicity Reference Values

TRVs are used to estimate the potential effects of dietary exposure to the ROIs. TRVs represent a daily exposure dose that is designed to be protective of that wildlife species. For the most part, TRVs are typically based on studies using laboratory test species easy to raise (e.g., mice, rat, chicken, quail, duck), whereas toxicological studies have not been conducted on most wildlife species. TRVs are typically reported as NOAELs and LOAELs.

3.1 Screening Toxicity Reference Values

In the screening deterministic evaluation, TRVs based on NOAELs were used to calculate risk. TRVs were identified from the following sources in order of preference:

- USEPA Ecological Screening Levels for Soil (EcoSSL) documents (USEPA 2012). Where TRVs were not identified in the EcoSSL documents,
- Oak Ridge National Laboratory (Sample et al. 1996),
- United States Army Center for Health Promotion and Prevention (USACHPPM) Wildlife Toxicity Assessment (WTA) program (USACHPPM 2012), and
- USEPA Region IX Biological Technical Assistance Group (BTAG) (USEPA 2009),
- TRVs were based on toxicological studies referenced in the open literature.

TRVs for most COPECs had already been identified in the *Toxicity Profiles Technical Memorandum* (ARCADIS 2011). The NOAELs in that document were used to calculate the HQs in the screening step. The Toxicity Profiles document (ARCADIS 2011) did not identify TRVs for some elements, specifically: antimony, beryllium, iron, and strontium TRVs for birds and iron and strontium TRVs for mammals. However, some studies have since been identified for those COPECs; therefore, TRVs were identified for them using literature sources. The derivation of those TRVs is discussed in Attachment 3. Further, the mammalian TRV for beryllium was used as the avian TRV because of lack of avian studies. TRVs based on NOAELs used in the screening deterministic evaluation, together with their sources, are presented in Tables 6 and 7, for avian and mammalian endpoints, respectively.

3.2 Refined Toxicity Reference Values

TRVs were refined for select COPECs with screening HQs that exceeded 1. Refined TRVs for the deterministic and probabilistic models include both a NOAEL and LOAEL and are discussed in Attachment 3. TRVs used in the refined deterministic HQ calculations are summarized in Table 8. TRV means, standard deviations, and distributions used for the probabilistic dietary exposure analysis are summarized in Table 9.

4. Risk Characterization

In order to characterize potential ecological effects within the river system adjacent to the site, the effects of constituent concentrations (or stressors) on a receptor must be identified and linked to an assessment endpoint. The ecological effect of an exposure is a function of the amount of the constituent within the cells or organs of a receptor that causes a toxicological effect. The HQ helps predict the likelihood for adverse toxicological effects, if any, from dietary exposure modeling evaluation (USEPA 1999, 2000). The HQs were calculated by dividing the estimated ingestion doses by the established TRVs. An HQ value of 1 (rounded to one significant figure) is considered the threshold value for adverse effects. An HQ equal to or less than a value of 1 (to nearest whole number) indicates that adverse (or "ecologically significant") impacts to ecological receptors are considered unlikely (USEPA 2001).

4.1 Risk Characterization Methods

4.1.1 Deterministic Risk Characterization

Screening NOAEL HQs were calculated using conservative assumptions for both calculating the dose and identifying TRVs. COPECs that had screening HQs that exceeded 1 for some receptors were carried forward into a second stage where refined HQs were calculated using more refined site-specific assumptions and refined TRVs. Where the refined deterministic NOAEL HQs in impacted reaches were greater than 1 and were greater than the HQs in the reference reach of same river, the variability in the HQ estimate was determined via a stochastic analysis.

4.1.2 Stochastic Risk Characterization

For specific COPECs and ROIs, where refined NOAEL HQs were greater than 1 and also greater than HQs for the reference reach of same river, a probability distribution of the HQ was generated to perform a Monte Carlo probabilistic analysis (USEPA 1997b). Parameters that were varied stochastically included: the driver EPCs (Ci, Cs), sediment bioavailability of COPECs (AF_{SED}), receptor body weight (and consequently allometrically-calculated ingestion rates), and TRVs. Proportions of food items in diet (Pi) was not varied because the variability would be observed mostly in species with a diversity of food items that also feed on the terrestrial invertebrates, birds, and mammals, but no data were available for such non-aquatic food items.

Stochastic risk distributions were generated from means and standard deviations of the parameters with Monte Carlo simulations using the @risk® software; using the following approach:

- Body weights of wildlife receptors are in general normally distributed and therefore, the probabilistic analysis assumed normal distribution for body weight.
- COPEC concentrations in biotic and abiotic media are typically skewed right characterized by a lognormal distribution and therefore, the probabilistic analysis assumed lognormal distribution for EPCs

and bioavailable fractions*. A preliminary sensitivity analysis conducted showed that the assumption of lognormality for the biotic and abiotic data was conservative compared to a normal distribution.

- Most TRVs were assigned a normal distribution because distributions on the often limited datasets of TRVs did not suggest otherwise, with the exception of two TRVs, the arsenic TRV for birds and the selenium TRV for mammals. The ranges of the NOAEL and LOAEL for the arsenic avian toxicity studies were very wide and overlapped. Thus, a triangular distribution on the range was selected for the arsenic avian TRV. Likewise, the ranges of the NAOEL and LOAEL for the selenium mammalian toxicity studies were wide and thus, triangular distributions were assigned for the selenium mammalian TRV ranges. All distributions were truncated at 0 to avoid negative numbers. The data used to generate the TRV distributions are presented in the Toxicity Reference Value Attachment (Attachment 3).

The TRV ranges used in the probabilistic assessment are summarized in Table 9. Likewise, the ranges of body weights used in the probabilistic assessment are presented in Table 10.

The output of the probabilistic assessment for each endpoint were a joint probability distribution that combined the dose and the TRV to produce a plot of probability of exceeding HQs and a table of the probabilities of exceeding an HQ of 1. Stochastic risk estimates were not modeled for reaches missing data needed for the dietary model. The probability analyses provide alternative estimates of risk because they evaluate the variability in the EPC of abiotic and biotic media, as compared to the deterministic risk estimates that are based on a conservative UCL or maximum concentration as the EPC. Further, the probability analyses also consider the variability of in the TRV across many species, not just the most sensitive species tested. The variability in the calculated dose (and resultant probability of exceeding HQ of 1) in the probabilistic model mostly captures measured variability in the parameters used to calculate dose, whereas the variability in the TRV captures uncertainty in the TRV.

Additionally, a sensitivity analysis was conducted by constructing a tornado diagram that indicate which parameters in the model most influence the results, which helps evaluate the uncertainty of the dietary exposure model. The tornado diagrams produce bar lengths proportional to the model's sensitivity to each parameter. These analyses were conducted by reach and because sample size of EPCs was small for reaches, also by river.

4.2 Risk Characterization Results

Predictions of the likelihood for adverse effects, if any, from the food chain modeling evaluation are based on HQs and probability of an HQ exceeding 1 (USEPA 1997a,b, 2000). The HQs of the screening dietary exposure models by reach and receptor are presented in Attachment 4 and summarized by receptor in

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* See response to agency comments provided in Attachment 8.

Tables 11-1 through 11-11. Where the NOAEL HQs were greater than 1, the COPECs were carried forward into a refined assessment. The refined dietary exposure models by reach and receptor are presented in Attachment 5 and summarized by receptor in Tables 12-1 through 12-11. Upon completion of the refined risk characterization, stochastic risk analysis was conducted for a receptor and reach if the refined NOAEL HQ was greater than 1 and greater than the HQ developed for the associated reference reach. The stochastic risk estimates are presented in Attachment 6 and the probability of an HQ exceeding 1 are summarized per receptor and reach in Tables 13-1 through 13-6. Probability distributions for HQ exceedances were also plotted. Example probability distributions plots are presented in Figures 3 through 10 for select endpoints. Sensitivity analysis of the relative influence of model input parameters were also conducted from same scenarios and are presented in Figures 11 through 17. A summary of the HQs and their meaning relative to the likelihood for adverse impacts is provided and discussed in the following sections by receptor group.

4.2.1 Aquatic- and Riparian-Feeding Birds

The results of the refined dietary models for aquatic- and riparian feeding birds are presented by assessment endpoint below. Probabilistic model results are also presented if HQs from the refined analysis exceeded 1 and the reference reach of the same river.

4.2.1.1 Herbivores (Wood Duck)

In the screening risk characterization, NOAEL HQs were all below 1 except for aluminum, iron, and vanadium (Table 11-1). In the refined analysis, none of the HQs exceeded 1 (Table 12-1).

4.2.1.2 Omnivores (Mallard Duck)

In the screening risk characterization, NOAEL HQs were all below 1 except for aluminum, arsenic, iron, selenium, and vanadium (Table 11-2). The HQs in the refined analysis were all equal to or less than 1 with the exception of selenium in ER_A (Table 12-2). The selenium HQ for ER_A ranged from 0.8 to 2 based on the LOAEL to the NOAEL TRV, respectively. The probability of the selenium LOAEL and NOAEL HQs to exceed 1 was extremely low, around 0.2% (0.002) and 2% (0.02), respectively (Table 13-1). The probability of the HQ exceeding a range of thresholds in ER_A is depicted in Figure 3, showing negligible probability of risk exceeding an HQ of 2.

4.2.1.3 Insectivores (Killdeer)

In the screening risk characterization, NOAEL HQs were all below 1 except for aluminum, arsenic, iron, lead, selenium, and vanadium (Table 11-3). The HQs of iron, lead, and vanadium in the refined analysis were all equal to or less than 1 (Table 12-3). Refined NOAEL HQs for aluminum, arsenic, and selenium marginally exceeded 1 in the Emory River and aluminum and selenium HQs marginally exceeded 1 in the Clinch River and Tennessee River. The NOAEL HQs for aluminum and selenium also exceeded 1 in the reference reaches. However, none of the LOAELs exceeded 1. NOAEL HQs that exceeded 1 and the

corresponding LOAEL HQs are presented in Exhibit 1. NOAEL HQs that exceeded 1 and the corresponding LOAEL HQs are presented in Exhibit 1.

Exhibit 1. Hazard Quotients Greater than 1 – Killdeer

Constituent	ER_R	ER_A	ER_B	ER_C	CR_R	CR_A	CR_B	TR_R	TR_A	TR_B
Aluminum (LOAEL/NOAEL)	<1 - 2	<1 - 3	< 1 - 3	<1 - 2	<1 - 2	<1 - 3	<1 - 3	<1 - 3	<1 - 3	<1 - 3
Arsenic (LOAEL/NOAEL)	–	1 - 3	–	–	–	–	–	–	–	–
Selenium (LOAEL/NOAEL)	<1 - 2	2 - 5	1 - 3	<1 - 2	<1 - 2	1 - 3	1 - 3	<1 - 2	1 - 2	1 - 2

Note: LOAEL HQ - NOAEL HQ

The Monte Carlo simulation modeling shows a wide range (0-1) for the probability of the aluminum HQ exceeding 1 for reaches where the HQ was greater than that in the reference reach in the same river (Table 13-2). However, simulations showed that the probability of an aluminum HQ exceeding 1 for a given reach overlapped with the probability of the HQ exceeding 1 in the reference reach in the same river, indicating the effect from the ash appears to be small. The probability of the aluminum HQ exceeding a range of thresholds for the killdeer in ER_A, is provided in Figure 4, which shows negligible probability of the NOAEL exceeding 4 for insectivorous birds. The probabilities are most influenced by the TRV uncertainty, and secondly by the variability in invertebrate (larval mayfly) EPCs (Figure 11).

Compared to aluminum, arsenic has a much lower probability of the HQ exceeding 1 in ER_A, which is 0.05 for the LOAEL HQ and 0.1 for the NOAEL HQ (Table 13-2). The probability distribution for exceedances of the arsenic HQ for the killdeer in ER_A (Figure 5) shows negligible probability of the NOAEL exceeding 2, and thus risk appears to be minimal for arsenic to insectivorous birds. The probabilities are most influenced by the TRV uncertainty, and secondly by the variability in invertebrate (larval mayfly) EPCs (Figure 12).

The probability of the selenium HQ for the killdeer exceeding an HQ of 1 ranged from 10% (LOAEL) to 30% (NOAEL) in the Emory and Clinch Rivers, and 4% to 10% in the Tennessee River (Table 13-2). The probability of the selenium HQ exceeding a range of thresholds for the killdeer in ER_A is provided in Figure 6. The probability of an HQ great than 1 was at most 24% in ER_A and much less in the other reaches. The probabilities are most influenced by the TRV uncertainty, and secondly by the variability in invertebrate (larval mayfly) EPCs (Figure 13).

4.2.1.4 Piscivorous (Heron and Osprey)

In the screening risk characterization, NOAEL HQs were all below 1 except for aluminum, iron, and PCBs (Tables 11-4 and 11-5 for inorganics and Table 11-11 for PCBs). The HQs in the refined analysis were all equal to or less than 1 (Tables 12-4 and 12-5 for inorganics and Table 12-11 for PCBs).

4.2.2 Aquatic- and Riparian-Feeding Mammals

The results of the refined dietary models are presented by receptor below.

4.2.2.1 Herbivores (Muskrat)

In the screening risk characterization, NOAEL HQs were all below 1 except for aluminum, iron, and manganese (Table 11-6). Results of the refined dietary models for the muskrat are presented in Table 12-6. Refined HQs for iron and manganese selenium are all equal to or less than 1.

The aluminum NOAEL HQ for CR_A slightly exceeds 1 (i.e., 2), however the LOAEL HQ fell to below 1 (0.1). The aluminum HQs for all three reference reaches (ER_R, CR_R, and TR_R) exceeded 1 and is equal to that of impacted reaches.

4.2.2.2 Omnivores (Raccoon)

Results of the screening risk characterization indicate that NOAEL HQs were all below 1 except for aluminum and iron (Table 11-7). Results of the refined dietary models for the raccoon are presented in Table 12-7. Refined HQs for iron were all equal to or less than 1.

The aluminum NOAEL HQs for every reach are slightly above 1 (i.e., ranging from 2 to 3), however the LOAEL HQs all fell to below 1. The aluminum NOAEL HQs for all three reference reaches (ER_R, CR_R, and TR_R) exceeded 1. NOAEL HQs that exceeded 1 and the corresponding LOAEL HQs are presented in Exhibit 2.

Exhibit 2. Hazard Quotients Greater than 1 – Raccoon

Constituent	ER_R	ER_A	ER_B	ER_C	CR_R	CR_A	CR_B	TR_R	TR_A	TR_B
Aluminum (LOAEL-NOAEL)	<1 - 2	<1 - 2	<1 - 2	<1 - 2	<1 - 2	<1 - 3	<1 - 2	<1 - 1	<1 - 3	<1 - 2

Note: LOAEL HQ - NOAEL HQ.

Monte Carlo simulation modeling to evaluate risk from aluminum for the raccoon for reaches where the HQ also exceeded the reference reach in same river (i.e., CR_A and TR_A). The probability of the HQ exceeding 1 was calculated to get a better understanding of the HQ. The Monte Carlo simulation modeling shows that

the probability of the aluminum HQ exceeding 1 ranged between 0.06 and 0.7 (Table 13-3). The probability distribution for exceedances of target aluminum HQs for the raccoon in ER_A is depicted in Figure 7, as an example. The probabilities are most influenced by the TRV uncertainty, and secondly by the variability in invertebrate (larval mayfly) EPCs (Figure 14).

4.2.2.3 Piscivorous (Mink)

Results of the screening risk characterization indicate that NOAEL HQs were all below 1 except for aluminum and iron of the inorganic COPECs (Table 11-8) and PCBs from the organics COPECs (Table 11-11). Results of the refined dietary models for the mink are presented in Table 12-8 for the inorganics and Table 12-11 for the organics. Refined HQs of PCBs were below 1. HQs for iron were slightly above 1 at 2, but iron HQs in impacted reaches were equal to HQs in reference reaches in same river. The aluminum NOAEL HQs for reaches ER_B, CR_A, CR_B for the mink are slightly above 1 (i.e., ranging from 2 to 3), however the LOAEL HQs all fell below 1. The aluminum HQ for reference reach ER_R exceeds 1. The range of aluminum HQs (LOAEL – NOAEL) per reach are presented in Exhibit 3.

Exhibit 3. Hazard Quotients Greater than 1 – Mink

Constituent	ER_R	ER_A	ER_B	CR_R	CR_A	CR_B
Aluminum (LOAEL-NOAEL)	<1 - 2	<1 - 2	<1 - 3	<1 - 1	<1 - 3	<1 - 2

Note: LOAEL HQ - NOAEL HQ.

Monte Carlo simulation modeling was conducted for the aluminum HQ for the mink for reaches where the HQ also exceeded the reference reach in same river (i.e., ER_B). Results are summarized in Table 13-4. The probability distribution for exceedances of the aluminum HQ for the mink in ER_B is depicted in Figure 8, as an example. The probabilities are most influenced by the TRV uncertainty, and secondly by the variability in fish EPCs (Figure 15).

4.2.3 Aerial Feeding Wildlife

4.2.3.1 Tree Swallow

The COPECs whose NOAEL HQs exceeded 1 in the screening evaluation for the tree swallow were copper and selenium (Table 11-9). Results of the refined dietary models for the tree swallow are presented in Table 12-9.

Copper NOAEL HQs for ER_C, CR_A, and TR_A are slightly above 1 (i.e., 2), however the LOAEL HQs all fell to below 1. The copper HQs for all three reference reaches (ER_R, CR_R and TR_R) exceeded 1. Further, the copper NOAEL HQs in impacted reaches were equal to those in the reference reaches.

Selenium NOAEL HQs exceeded 1 at all reaches and range from 2 to 5. The selenium NOAEL HQs for the Emory River and Clinch River reference reaches (ER_R and CR_R) also exceeded 1. Selenium LOAEL HQs exceeded 1 at reaches ER_A, ER_B, ER_C, CR_A and CR_B. NOAEL HQs that exceeded 1 and the corresponding LOAEL HQs are presented in Exhibit 4.

Exhibit 4. Hazard Quotients Greater than 1 – Tree Swallow

Constituent	ER_R	ER_A	ER_B	ER_C	CR_R	CR_A	CR_B	TR_R	TR_A	TR_B
Copper (LOAEL-NOAEL)	<1 - 1	–	–	<1 - 2	<1 - 2	<1 - 2	–	<1 - 2	<1 - 2	–
Selenium (LOAEL-NOAEL)	3 - 3	2 - 5	2 - 5	2 - 5	1 - 3	2 - 4	2 - 4	<1 - 1	1 - 2	1 - 3

Note: LOAEL HQ - NOAEL HQ.

Monte Carlo simulation modeling was conducted for the selenium HQ for the tree swallow. The probability of the HQ exceeding 1 was calculated to get a better understanding of the HQ. The Monte Carlo simulation results for reaches where the HQ also exceeded the reference reach in same river are summarized in Table 13-5. The tree swallow HQs for selenium have a relatively low probability of exceeding 1. The probability of selenium HQ exceeding 1 ranges from 10% (LOAEL) to 30% (NOAEL) in the Emory and Clinch Rivers, and 4 percent to 10% in the Tennessee River (Table 13-5). The probability distribution for the selenium HQ exceedances for the tree swallow in ER_A is depicted in Figure 9, as an example. These probabilities are most influenced by the TRV uncertainty, and secondly by the variability in insect concentrations (Figure 16).

4.2.3.2 Gray Bat

Results of the refined dietary models for the gray bat are presented in Table 12-10. Refined HQs for aluminum and iron manganese are all equal to or less than 1.

Selenium NOAEL HQs exceeded 1 at all reaches and range from 3 to 10. The selenium NOAEL HQs for all reference reaches (ER_R, CR_R, and TR_R) also exceeded 1. Selenium LOAEL HQs exceeded 1 at all reaches. NOAEL HQs that exceeded 1 and the corresponding LOAEL HQs are presented in Exhibit 5.

Exhibit 5. Hazard Quotients Greater than 1 – Gray Bat

Constituent	ER_R	ER_A	ER_B	ER_C	CR_R	CR_A	CR_B	TR_R	TR_A	TR_B
Selenium (LOAEL-NOAEL)	3 - 5	6 - 9	7 - 10	6 - 10	3 - 5	6 - 9	5 - 8	2 - 2	3 - 5	3 - 5

Note: LOAEL HQ - NOAEL HQ.

The gray bat HQs for selenium from the refined analysis are very conservative, based on reduced growth of laboratory animals. As discussed in detail in Attachment 3, field studies do not support adverse effects to small mammal populations from selenium at places known to have elevated selenium such as Kesterson

National Wildlife Refuge. Incorporating population-level TRVs into the range of uncertainty for TRVs, the probability of selenium HQs exceeding 1 for gray bats is near 0% (Table 13-6). The probability distribution for the selenium HQ exceedances for the gray bat in ER_A is depicted in Figure 10, as an example. These probabilities are most influenced by the TRV uncertainty, and secondly by the variability in insect concentrations (Figure 17).

5. Uncertainty

Uncertainty is "the imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution," (USEPA 1997b). Uncertainties that may lead to either an overestimate or underestimate of risk are associated with each stage of risk assessment. Uncertainty is inherent to BERA, in part, because the sciences of ecology and ecotoxicology are relatively young and not yet fully developed (Kapustka and Landis 1998; Newman 1998; Emlen and Springman 2007; Kapustka 2008; Suter and Cormier 2008).

The risk estimates presented in the BERA are conservative estimates of potential risks to the ROIs associated with exposure to the COPECs. Each of the three basic building blocks for risk assessment (data evaluation, receptor exposure assumptions, and toxicity measures) contributes uncertainties. Each of the uncertainties is accounted for by using conservative assumptions wherever specific data are unavailable. Uncertainties existed in the selection of ROIs, selection of data and identification of EPCs, receptor exposure parameter assumptions used, identification of TRVs, and risk characterization. Some of these parameters were subjected to a sensitivity analysis to clarify which of them most affects the model results. Of variables tested in a sensitivity analysis, the results are generally most sensitive to the literature-derived TRVs selected and secondly to the measured tissue concentrations (EPCs) of the food item. In contrast, variability in body weight, the only other parameter varied in the probabilistic models, had a smaller effect on the results. The uncertainties are discussed below:

5.1 Selection of Receptors of Interest

One source of uncertainty relates to the ROI selection. Indicator species were selected based on several criteria, including:

- The organism must first be in a habitat in which there is potential risk of exposure to adverse effects due to chemical contaminants.
- The receptors must be able to provide measurable responses or adequate analytical samples.

Species were selected to represent a feeding guild or group of organisms with similar feedings modes and diets. These species may or may not accurately reflect risks to observed or unknown species at a given site. Exposures may be lower or higher for species not evaluated compared to receptor species. Some species not evaluated may be more or less sensitive than those receptors for which toxicity data were available (see Section 5.4 discussing TRV uncertainty). Therefore, risks may be either overestimated or underestimated. Even the probability analysis is limited to distributions of studied species.

Most receptor species chosen were present and many common at the site before the ash spill. The results may not differ much if a different ROI for a trophic level that met such criteria was selected because the

TRVs, often based on species unrelated to the ROI, most strongly influences model results (see Section 5.6 for a discussion of the sensitivity analysis results).

5.2 Data and Exposure Point Concentrations

The sampling design (sample location and methods used to collect data), the species selected as food items, the assumptions about diet components, and the methods used to estimate the EPC can lead to uncertainty in the risk estimates as discussed below.

5.2.1 Sample Location and Collection

A well-designed sampling plan, use of appropriate sampling techniques, and implementation of laboratory data validation and quality assurance and quality control can reduce uncertainty associated with sample locations and collection methods, and such measures were instituted as best as possible given real-world practicalities. As with all such assessments, this risk assessment is based on the assumption that the available monitoring data adequately describe the occurrence of constituents in media at the site. However in reality, environmental sampling itself introduces uncertainty. Frequently, there are only a limited number of samples, and sometimes they are collected close to each other. This type of sampling typically has reduced statistical power and may not fully represent the concentrations in the environment in which wildlife exposure occurs.

Tissue sample collection was often clustered and limited in each reach (Figure 2) and hence good representation of reach exposure concentrations and their distribution is uncertain. Hotspots may have been missed or data may only have hit hotspots. Calculation of probabilities of HQs exceeding 1 were not very different when samples were pooled by reach than by river, which suggests sample design may have been adequate, despite some clustering.

The timing of sample collections varied. The vegetation data were collected in 2011, the sediment data were collected at the end of 2010, while most other data were collected in 2010. Amphibian, mayfly, and fish data collections started towards the end of the dredging period with some overlap. The 2011 adult mayfly data recently obtained, unavailable at the time of the dietary exposure modeling, show similar or higher concentrations of selenium than in 2010 and 2009. The results for aerial feeding birds and mammals would not be that different if 2011 data were used, and thus timing may not be a major concern.

5.2.2 Exposure Point Concentrations

In the deterministic evaluation, the EPCs used in the dietary exposure model were conservative, biasing the dose high. They were set at the maximum concentration where less than five detected concentrations and eight total samples, otherwise they were set at the UCL. There is some uncertainty regarding the true UCL concentration measurements for the media. The UCL is used because of uncertainty in calculating the mean and becomes less useful, the smaller the sample size. The Monte Carlo probabilistic analysis

addresses this uncertainty in a different and more accurate way than using the UCL, by evaluating variability of the data around the mean and its effects on the output.

5.2.2.1 Sediment

Exposure through direct incidental sediment ingestion was estimated using seasonally exposed sediment data whereas indirect exposure to submerged sediment was accounted for in the tissue concentrations of prey, which included sediment in the gut of the bottom feeding prey items. This approach of including the gut contents of prey is conservative for two reasons: 1) using sediment ingestion rates in conjunction with whole body fish and larval data that include sediment in the gut can be double counting and introduces uncertainty in the dose estimates, and 2) we assumed that receptors are exposed to seasonally exposed sediment year round when in fact, exposure is most likely 6 months (mid October to mid April). These uncertainties in sediment concentrations and use of the UCL overestimate risk.

5.2.2.2 Surface Water

Total metals in surface water were used in the dietary exposure models. A review of the dissolved versus total metal in surface water data indicated that concentrations of metals were higher in the unfiltered (total) samples than in the filtered samples (Attachment 7 - Table 7-1)[*]. ROI are expected to be exposed to unfiltered water therefore this assumption is acceptable for the risk assessment and is not expected to cause uncertainty.

5.2.2.3 Prey Tissue Concentrations

Prey tissue EPCs were obtained from tissues of one or a few species or plant parts that may not represent the full set of food items of an ROI well. Data from one species (e.g., gizzard shad versus bluegill sunfish) or one type of data (e.g., leaves versus roots of plants) were used in the dietary models. These substitutions could bias risk low or high depending on the constituents; however they are not expected to cause a difference in the conclusions of the wildlife assessment. Specific tissue datasets used are discussed in the following sections.

Whole body concentrations of COPECs in gizzard shad were used in the dietary models to represent the fish dietary component for the ROIs. Gizzard shad is one of the most abundant bottom-feeding fish at the site and bottom-feeding fish, if abundant, are a main diet item of piscivorous herons feeding in shallow water and osprey in lakes in the southeast (Poole et al. 2002; Vennesland and Butler 2011). Gizzard shad maintains a high level of exposure to COPECs in sediment based on its detritus-feeding behavior (Torres and Vanni 2007) and is commonly eaten by the higher trophic level receptors. A review of whole body

[*] See response to agency comments provided in Attachment 8.

gizzard shad data versus whole body bluegill sunfish data shows that gizzard shad exhibited higher concentrations for most constituents (e.g., aluminum, arsenic, chromium, copper, iron, lead, nickel, vanadium) than bluegill sunfish (Attachment 7 - Table 7-2). The constituents of silver, beryllium, zinc, and cadmium were higher in bluegill sunfish than shad but HQs were so low, they nevertheless would not be in the refined analysis, even if bluegill sunfish tissue were used. However, selenium was also higher in bluegill sunfish and would cause mink HQ to increase to 2 in the screening and refined analysis, and selenium would be identified as a COPEC with low magnitude of risk with low confidence for the mink. Selenium is already identified as a COPEC for birds and thus, this uncertainty for the mink is not of great concern. Concentrations of the two constituents that were carried forward to the refined analysis for piscivorous receptors (i.e., aluminum and iron) were higher in gizzard shad. Overall, using only one prey item when animals feed on many creates uncertainty in results.

Similarly, whole body COPEC concentrations in larval mayfly data were used in the dietary models over snail tissue concentrations. Larval mayfly are closely associated with exposures to ash-related constituents in sediment and were thus considered appropriate to assess effect of ash related COPECs. Like gizzard shad, larval mayfly data exhibited higher concentrations for most constituents than snail data (Attachment 7 - Table 7-3); and specifically those that were carried forward into the refined analysis for invertebrate-eating ROI (e.g., aluminum, arsenic iron, lead, selenium, and vanadium for killdeer, mallards, raccoons). While data for a few metals (i.e., cadmium, cobalt, nickel, silver, thallium, and zinc) were slightly higher in the snail than in the larval mayfly, they were not high enough that if used in the screening models, HQs would be greater than 1. Copper was the only constituent that had a higher concentration in snail than larval mayfly which would have resulted in HQs greater than 1 in screening evaluation. However copper would not have been carried into refined analysis because HQs in impacted reaches would have been equal to references reaches. Overall, using larval mayfly data to represent benthic invertebrates at TVA is expected to conservatively bias risk results high, although using only one prey item creates uncertainty in results.

As to vegetation data used as input into the models, data from the leaves of emergent and shoreline vegetation were used, even though many receptors (e.g., ducks and muskrats) feed on the roots of emergent vegetation. However, while risk to herbivorous birds could be biased low due to the exclusion of roots, it is likely not enough that if corrected for roots, it would increase HQs to above the target of 1.

Likewise, amphibian data used in the dietary model for the mink are conservative. Amphibian data used were collected from amphibians found in the embayment impoundments containing large volumes of released ash, and therefore are expected to be higher than what would be expected in the unconfined, flowing river reaches. Using frog data from the embayments to represent the river system is expected to conservatively bias risk results high. In addition to using prey tissue data from one species, uncertainty exists from the complete substitutions for food groups. For example, the diet component identified as “terrestrial invertebrates” was assessed using tissue data for aquatic invertebrates. Likewise, the diet component referred to as “small mammals and birds” was represented solely by fish tissue data, and incidental sediment ingestion substituted for all incidental ingestion of soil and sediment. The substitutions were intentional to capture the effect of the ash spill in the aquatic environment, and likely overestimate the

exposure of the receptor. For example, a mink's diet consists of small mammals, birds, fish, and other items. Although the river system provides abundant foraging, mink are opportunistic and likely do not get their entire diet from the river. Since impacts associated with the TVA release are contained generally in and around the river system, prey obtained from terrestrial areas would be less impacted and mink would have less exposure to COPECs than estimated in the BERA.

Whole body tissue concentrations for fish and mayfly larvae were used to derive EPCs used in the exposure calculation. Using whole body prey tissue concentrations in addition to incorporating incidental sediment ingestion rates calculated based on gut contents (Beyer et al. 1994, Beyer et al. 1997) is a conservative approach and may slightly overestimate the risk to wildlife.

5.3 Receptor Exposure Parameter Assumptions

The exposure assessment contributes uncertainty to the risk assessment as well. Receptor exposure assumptions used in the dose modeling such as assumption regarding diet composition, receptor body weights, ingestion rates, site foraging frequencies, and bioavailability fractions of COPECs in sediment all contribute uncertainty to the risk estimates. In addition, the results are applied to many species in an assessment endpoint of a receptor group. Species differ with respect to water and food ingestion rates, absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical (Sample et al. 1996). Such uncertainties may slightly under or overestimate exposure but are not expected to be as important as TRV uncertainty.

Diet components for ROIs were based on studies in Tennessee, on studies with comparable habitats to the site, or on averages reported in the literature, depending on what information was available. All the diet value percentages have some inherent uncertainty since data are not available for an entire population nor for all ages and all seasons. Further, as discussed above (Section 5.2), many substations and assumptions about the diet components were made when identifying the EPCs, which also add to the uncertainty in the dose estimates. Ignoring the substitutions, the diet component percentages that were used are reasonable but exclude diet components representing small fractions of the diet. For example, killdeer and tree swallows are assumed to feed 100% on invertebrates, but they do feed on seeds or berries in small amounts, but such omissions likely have minimal influence on the model results.

All the receptor body weights, with the exception of raccoon, were from the literature and have some inherent uncertainty since data are not available for an entire population nor available for all ages and all seasons. As such, estimated food and water ingestion rates based on the body weight also have a level of uncertainty based on the models themselves and also on the body weights input into them.

Incidental ingestion rates of sediment or soil are highly uncertain because studies have not been conducted on the ROIs. Even those studies conducted on other species (Beyer et al. 1994, Beyer et al. 1997.) have high uncertainties because digestibility used to calculate percent ingestion of soil is estimated from the literature. However, the range of possible soil ingestion rates is not large and such uncertainty may not have

a large effect on the model results. Further, studies on incidental sediment ingestion rates use gut contents to estimate the sediment portion in diet. Using sediment ingestion rates in conjunction with whole body fish and larval data can in fact sometimes be double counting and introduces uncertainty in the dose estimates. However guts could not be excluded because in some instances, the COEPCs in guts could be in periphyton form. For COPECs who are a major component of sediment (i.e., aluminum and iron), this uncertainty was reduced by incorporating the sediment bioavailable fraction for the gut contents.

In the dietary exposure models, the site foraging frequencies were conservatively assumed to be 1 for all receptors, regardless of their home range. Organisms will spend varying amounts of time in different habitats, which ultimately affect their exposures. Assuming that receptors spend 100% of their time during a critical period (e.g., breeding season) in an impacted reach is slightly conservative for some receptors (e.g., tree swallows).

The sediment bioavailability fraction used in the models to adjust for bioavailability of some COPECs (aluminum, iron, copper, lead, manganese, and vanadium) in incidentally ingested sediment and the bioavailability of aluminum and iron in guts of fish and in invertebrates can also introduce uncertainty in the dose estimates. Average sediment bioavailablity factors were used in the deterministic models, while mean and standard deviation of the sediment bioavailability factors were used in the probabilistic models.

Sediment bioavailability factors were conservatively set to equal sediment bioaccessibility factors. The bioavailable fraction is the fraction of metal that actually interacts with the organism's contact surface (e.g., membrane) and is absorbed onto, or into, and across that membrane; while the bioaccessible fraction is that fraction that dissolves or desorbs from its matrix (e.g., sediment) in the gastrointestinal tract and is available for absorption (USEPA 2007, ITRC 2011). Therefore, by definition, the bioavailable fraction has to be smaller than the bioaccessible fraction. As such, using bioaccessibility factors to estimate bioavailability will likely overestimate potential dose and risk.

There is inherent uncertainty with estimating bioaccessibility in general. Here, sediment bioaccessibility fractions for the metals were estimated using chemical extractions using data from an SEP procedure based on that established by Querol et al. (1996). While there is uncertainty in estimating bioaccessibility using SEP data; this particular SEP procedure minimized some of that uncertainty (Attachment 2). Major limitations of some SEP procedures are associated with the non-selectivity of extractants and trace element redistribution among phases during the extraction procedure (Zimmerman and Weindorf, 2010, Filguieras et al. 2002). In our application of the steps of the Querol SEP method (up to their step 4a) to sediments to estimate bioavailability, the bioaccessibility factors were estimated using the total cumulative metal extracted from the first four steps that extracted water-soluble, exchangeable, carbonate-bound, and manganese-iron oxide bound fractions. Redistribution of metals can occur for each individual step but summing the four steps with the last step ending at a pH of 1.5 reduces redistribution (low pH limits re-adsorption). Moreover, the last step was for a long period of 15 hours at 95ºC, increasing the likelihood of liberating more metals and increasing bioavailability estimates. The SEP procedure's fourth step may overestimate bioaccessibility since some metals extracted in step 4 are at a pH lower than some animal stomachs (e.g., bird stomachs

are typically at a pH of 2 to 3) and might not be bioaccessible in the gastrointestinal tract. However, the fifth step in Querol et al. (1996) of extracting some organic-bound metals was not incorporated into bioaccessibility estimates, and the gastrointestinal tract has enzymes that can release some of this fraction. Therefore, the SEP method may only approximate bioaccessibility, and it is unknown if it underestimates bioaccessibility. Karadas and Kara's (2012) data suggest the SEP method used for TVA (similar to steps 1 and 2 of the Community Bureau of Reference method in Karadas and Kara 2008) produces results approximately similar to in vitro bioavailability tests simulating human gastrointestinal fluids for many metals with some exceptions (chromium and to some extent copper). They did not test many of the metals used in the dietary exposure models (vanadium, iron, aluminum) and it is possible bioavailability is underestimated. However, if bioavailability in models is increased by 35%, HQs do not change (within rounding error) in the refined models.

Further, because vanadium bioavailability showed a correlation with percent ash in the sample, an analysis of using the maximum vanadium bioavailability from the laboratory tests versus the mean in the deterministic models was conducted. Results indicated that while the estimates HQs do go up one integer in a few reaches (e.g., from 0.07 to 0.08), they remain under 1 and thus do not affect the conclusions of the dietary models.

The sensitivity analysis conducted on the probabilistic models showed that the probabilistic models were not very sensitive to the variability in sediment bioavailability factors (Section 5.6), and are not sensitive to increasing bioavailability by one-third.

5.4 Toxicity References Values

The toxicity values and other toxicological information used in the BERA likewise are associated with the most significant uncertainty (Newman 1998; Lovett Doust et al. 1993; Dale et al. 2008, see Section 5.6 for the sensitivity analysis discussion). Toxicity data are only available for a limited number of species (most of them laboratory test species) under a strictly defined set of test conditions that deviate from natural conditions (Sample et al. 1996, Suter 1996). Avian TRVs for antimony, beryllium, iron, and strontium and a mammalian TRV for iron were not available from the primary TRV sources available. Therefore, TRVs were based on toxicological studies referenced in the open literature, except beryllium; for which the mammalian TRV was applied to birds. Some of the studies on which TRVs were based are not of the quality desired, but were used because no other studies were available (i.e., antimony). While there is a large uncertainty associated with some of these TRVs, they were used for lack other values.

In current practice, more than 95% of the resources in toxicology are focused toward the study of single chemicals (Cassee et al. 1998), while wildlife exposures rarely occur on a chemical-specific basis. Simplistic extrapolations from laboratory species to wildlife species and testing conditions to field conditions are not likely accurate, and are rarely, if ever, validated against natural conditions (Power 1996; Tannenbaum 2003).

Tolerance and adaptation of the receptors are not considered directly in the BERA and provide another source of uncertainty (Millward and Klerks 2002; Grant 2002). Furthermore, the white rat used often in toxicological testing is bred to minimize differences between lab animals, thereby diminishing the genetic variability that gives wildlife some capability for adaptation and tolerance (Tannenbaum 2003).

Finally, there are relatively few studies that actually evaluate the effects of toxicity at the population scale that integrate reproduction and survival endpoints or incorporate concepts of carrying capacity, intraspecific competition, density-dependence, or dispersal (metapopulation dynamics). Nor do these studies evaluate toxicity effects at the community scale incorporating predator-prey interactions, and interspecific competition for scarce resources (Atchison et al. 1996; Kapustka and Landis 1998). Communities are complex and simplistic models such as the individual-based dietary exposure model are not representations of reality, but rather tools that assist with reasonable science-based decision-making and provide one line of evidence to use in the risk assessment.

There is uncertainty regarding which forms of the metal COPECs are actually present in the food and sediment ingested by wildlife receptors at the site. This is an important consideration because those chemical forms might be different than those upon which the TRVs were derived. For example, the TRVs for lead for avian and mammal receptors were derived from laboratory studies using lead acetate in the dosing media (Edens and Garlich 1983; Kimmel et al. 1980). Lead acetate is considerably more bioavailable and more toxic than the inorganic forms of lead that normally occur in soil and sediment (e.g., lead carbonate, lead sulfide, lead-bearing iron oxide minerals) (National Research Council 2003; Schoof 2003; Suedel et al. 2006, Agency for Toxic Substances and Disease Registry 2007; USEPA 2008). It is unlikely that the form of lead (and potentially other metal COPECs) in the food and sediment ingested by wildlife at the site is exactly the same as the chemical forms that were used to derive the TRVs. The bioavailable fraction or TRV can be adjusted to account for these differences between the TRV form of the COPEC and the site form, but there is much uncertainty on the adjustment.

The uncertainty in the TRVs used in the BERA was reduced in the refined risk characterization step, but only for COPECs identified as possible risk drivers after the initial the screening analysis. However in some cases, the refined TRV was still based on the most sensitive species, not necessarily the most appropriate species for the site. More details about the refined TRVs are provided in the Attachment 3. Nevertheless, toxicity data are only available for a limited number of species, mostly laboratory test species, under a strictly defined set of test conditions that deviate from natural conditions (Sample et al. 1996; Suter 1996). Tolerance and adaptation of the receptors are not considered for laboratory studies (Millward and Klerks 2002; Grant 2002) but do play a role in field studies included in some of the Monte Carlo probabilistic models for selenium. Relatively few studies evaluate the effects of toxicity at the population scale that integrate reproduction and survival endpoints or incorporate concepts of carrying capacity, intraspecific competition, density-dependence, or dispersal and none were available to evaluate selenium effects on population size and growth. The probability analysis captures some uncertainty in the HQ estimates, but does not separate natural variability of the parameters from uncertainty. Most of the uncertainty lies in the TRV distribution. But uncertainty exists for the mean, standard deviation, and selection of the distribution for

all the parameters, which were derived from the range of values in the field or literature. Greater uncertainty is associated with those from the literature.

Avian TRVs for aluminum and arsenic were very uncertain and likewise avian selenium TRVs for all birds other than the mallard were also uncertain. TRVs for selenium are best established for the mallard, and hence the confidence in the risk assessment for omnivorous birds such as the mallard is highest and lower for the other assessment endpoints. Likewise the mammalian aluminum TRV also was highly uncertain as the aluminum studies relied upon and discussed by Sample et al. (1996) and used to refine TRVs were poorly conducted or documented. The studies relied on growth endpoint while other studies showed that reproduction effects occur at much higher levels (Carson 2002, Bernuzzi et al. 1989).

5.5 Risk Characterization

An HQ less than or equal to a value of 1 indicates that adverse impacts to wildlife are considered unlikely (USEPA 2000). However, there is no clear guidance for interpreting the HQs that exceed a value of 1, except that this point of departure indicates that adverse effects of some kind may have occurred or may occur in the future. Although HQ values much greater than one might be assumed to describe risks that are more severe than those associated with HQs that slightly exceed 1, HQ values should not be interpreted literally or as probabilities. For example, an HQ of 0.5 does not reflect a 50% probability of population decline or a 50% reduction in the population and an HQ of 4 does not necessarily indicate adverse effects to the population two times greater than those associated with an HQ of 2. Nevertheless, USEPA (USEPA 1997a) guidance on ERA states effects should be evaluated at the population scale, but this simple modeling approach cannot provide that information. Other information collected for the BERA, such as tree swallow fledglings produced per nest, provide population-level information on potential adverse effects. HQs are based on the types of impacts that could occur to individuals, and they completely fail to address ecological exposure and risk at spatial scale of populations (Tannenbaum 2003; Durda and Preziosi 1999).

To put the results of the deterministic risk analysis in perspective, a stochastic analysis was conducted. For the deterministic analysis, the EPCs used in the dietary exposure model were conservative, biasing the dose high, because the EPCs were the 95 UCL or maximum concentration for a reach, rather than the average. The probability analysis used the entire range of possible EPCs (by using the average and standard deviation), which is more representative of the full range of possible EPCs.

Many of the datasets used in the probabilistic analysis were not of adequate size to distinguish data distribution. The datasets with sufficient sample size (selenium in adult mayfly, aluminum and arsenic in sediment) were either normally distributed, gamma distributed, or did not follow a discernible distribution, based on the reach-level analysis using USEPA ProUCL software. Therefore, a sensitivity analysis was conducted to determine a suitable assumption for data distribution. The sensitivity analysis involved conducting the probabilistic analysis twice, first assuming the data was lognormal and then a second time assuming the data was normally distributed. A comparison of the probability of the HQ exceeding the target of 1 for each assumption demonstrated that there was a very slight difference (at most 1% change in

probability for selenium and aluminum, and 2% for arsenic) between the two assumptions when evaluated by reach, with the assumption of normally distributed data being less conservative for selenium. Given the distribution is unknown in most cases, the probabilistic analysis assumed lognormal distribution for all exposure concentration datasets, which was conservative for the constituent of most concern in the dietary exposure models, selenium. Tables 7-4 and 7-5 (Attachment 7), present the probabilities of the HQ exceeding the target of 1 for both the killdeer and the tree swallow, respectively, assuming both a normal and lognormal distribution for the EPC.

Moreover, since risk can depend on spatial relationships in the concentrations, particularly when clustering of high concentrations exists, further sensitivity analysis was conducted to evaluate whether EPCs stratified at the reach level using lognormal distributions gave results much different than point-scale reach maximums or conservative UCLs of the mean. The probabilistic analysis was conducted holding the EPC at a single value using a conservative point value of the 95 to 97% UCL of the mean or maximum value for the reach (if UCL was incalculable due to sample size and/or frequency of detection). The results indicated that the difference in the probability of the HQ exceeding 1 between the lognormal distribution and a conservative single value approach for killdeer and tree swallow was relatively small in impacted reaches, -1 to 6% probability increase for selenium (e.g., 6% increase from 24 to 30%). There was a 2 to 16% difference for aluminum and 16% for the one reach affected by arsenic (from 11 to 27%). If evaluated at the river scale, the differences are much larger, likely due to high variation in EPCs among reaches. Thus, evaluating exposure at the reach level to reduce within-river variation appears to sufficiently stratify EPCs spatially and almost approximates risk estimated with overly conservative point estimates. Tables 7-4 and 7-5 (Attachment 7), present the probabilities of the HQ exceeding the target of 1 for both the killdeer and the tree swallow, respectively, under three assumption: holding the EPC constant, assuming a normal distribution and finally assuming a lognormal distribution for the EPC.

5.6 Sensitivity Analysis

A sensitivity analysis was conducted on the models by constructing tornado diagrams that produce bar lengths proportional to the model's sensitivity to each parameter. The bar lengths are a measure of the change in the probability of the HQ exceeding 1 if the standard deviation of a parameter is changed by 1 unit. Tornado diagrams for COPEC and ROIs carried into the stochastic analysis are presented in Figures 11 through 17 for ER_A as an example. The tornado diagrams indicate that the TRV is the most sensitive parameter in the dietary exposure risk characterization model for aluminum in the killdeer, raccoon, and mink, and for selenium in the killdeer, tree swallow, and gray bat (Figures 11 and 14 through 17). On the other hand, the EPC in the larval mayfly was the most sensitive parameter in the dietary exposure risk characterization model for arsenic in the killdeer (Figure 12). After the TRV, the EPC of invertebrate and/or fish were the most sensitive variables. The model was relatively insensitive to model concentrations. Thus, uncertainties in not only the TRVs, but concentrations of food items potentially biased by of maximum concentrations and substitutions of aquatic food items for terrestrial items likely strongly impact the results. Incidental ingestion rate and bioavailability (in gut or sediment) uncertainty is less influential. That is not to be interpreted as saying changing from 100% bioavailable fractions in sediment to

<10% is not very important in affecting results. However, no dataset for the site supports 100% bioavailability in sediment for those metals. Thus, the uncertainty is from the variability of the measured data, which is relatively small.

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Table 1
Data Used for Exposure Point Concentrations in Dietary Exposure Models
Kingston Fossil Plant
Tennesse Valley Authority

	Biota Dataset Used Per Areas									
	Emory River (ER)				**Clinch River (CR)**			**Tennessee River (TR)**		
Dataset	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Larval Mayfly WB	ER_Reach A	ER_Reach B	ER_Reach C	ER_Reach R	CR_Reach A	CR_Reach B	CR_Reach R	TR_Reach A	TR_Reach B	TR_Reach R
Adult Mayfly	ER_Reach A	ER_Reach B	**ERM 2.8**	**CR_Reach R**	CR_Reach A	CR_Reach B	CR_Reach R	TR_Reach A	TR_Reach B	TR_Reach R
Vegetation	ER_Reach A	ER_Reach B	ER_Reach C	ER_Reach R	CR_Reach A	CR_Reach B	CR_Reach R	TR_Reach A	TR_Reach B	**CR_Reach R**
Gizzard Shad WB	ER_Reach A	ER_Reach B	ER_Reach C	ER_Reach R	CR_Reach A	CR_Reach B	CR_Reach R	**CR_Reach A**	**CR_Reach A**	**CR_Reach R**
Amphibian	Embayments	Embayments	Embayments	Reference	Embayments	Embayments	Reference	Embayments	Embayments	Reference
Exposed Sediment	ER_Reach A	ER_Reach B	ER_Reach C	ER_Reach R	CR_Reach A	CR_Reach B	**ER_Reach R**	**CR_Reach A**	**CR_Reach A**	**ER_Reach R**
Surface Water	ER_Reach A	ER_Reach B	ER_Reach C	ER_Reach R	CR_Reach A	CR_Reach B	CR_Reach R	**TRM 566**	**TRM 566**	TR_Reach R

Where possible reach specific data were used, otherwise data from the closest reach (in bold) were used.

WB Whole Body

Table 2
Receptor Exposure Assumptions
Kingston Fossil Plant
Tennesse Valley Authority

			Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian-Feeding Mammals			Aerial Insectivores	
Exposure Parameter	**Acronym**	**Units**	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Body Weight (BW) [a]	BW	kg	0.668	1.158	0.095	2.254	1.66	1.177	5.44	1.11	0.0205	0.0095
Proportion of Diet (P) [b]	P	unitless										
Invertebrates		%	33%	75%	100%	2%	–	–	39%	10%	100%	100%
Terrestrial Invertebrates		%	–	–	80%	–	–	–	10%	–	–	100%
Aquatic Invertebrates		%	33%	75%	20%	2%	–	–	29%	10%	100%	–
Vegetation		%	67%	25%	–	–	–	100%	58%	9%	–	–
Fish (and small mammals)		%	–	–	–	98%	100%	–	3%	79%	–	–
Fish		%	–	–	–	98%	100%	–	1%	73%	–	–
Small Mammals and Birds		%	–	–	–	–	–	–	2%	6%	–	–
Amphibians		%	–	–	–	–	–	–	–	2.5%	–	–
Food Ingestion Rate - dry weight (IRdf) [c]	IRf_d	kg/day	0.055	0.080	0.014	0.126	0.103	0.062	0.194	0.060	0.005	0.0017
Fraction of ingestion rate that is sediment [b]	IR	%	2.0%	3.3%	10.4%	1.0%	0.0%	9.4%	9.4%	2.0%	0.0%	0.0%
Sediment Ingestion Rate (IRs)	IRs	kg/day	0.00110	0.00264	0.00150	0.00126	0	0.00585	0.01828	0.00119	0	0
Water Ingestion Rate (IRw) [d]	IRw	L/day	0.045	0.065	0.012	0.102	0.083	0.115	0.455	0.109	0.0044	0.0015

kg kilogram.
L Liter

a Average receptor body weight from the Wildlife Receptors Profiles document.
b Diet proportions (including incidentally ingested sediment) are presented in the Wildlife Receptors Profiles document.
c IRd were calculated based on equations for all birds and all mammals provided by Nagy (2001).
d IRw was calculated based on equations provided by USEPA (1993).

Table 3
Sediment Bioaccessibility Factors
Kingston Fossil Plant
Tennesse Valley Authority

Media/Constituent	Bioaccessibility Factors [a]
Aluminum	1.2%
Iron	6.2%
Lead	4.7%
Manganese	75%
Vanadium	2.5%

a Derivation presented in Attachment 2.

Table 4

Percentage of Aluminum and Iron in Fish and Larval Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Media/Constituent	Fraction In Larval Gut					Fraction In Fish Gut				
	Range				Average	Range				Average
Aluminum	79%	to	96%		88%	75%	to	91%		84%
Iron	70%	to	94%		85%	67%	to	83%		77%

a Derivation presented in Attachment 1.

Table 5
Dietary Exposure Equations
Kingston Fossil Plant
Tennessee Valley Authority

The following model was used to calculate the screening and refined dietary intake dose for each indicator receptor, except for the refined dietary intake of Aluminum and Iron (see next page):

$$\text{Dose}\left(\frac{\text{mg}}{\text{kg - day}}\right)=\frac{\left(\left[C_{SW}\times IR_{SW}\right]+\left[\left\{\left[C_{SED}\times AF_{SED}\times FIR_{SED}\right]+\left[\sum_{i}\left(C_{i}\times P_{i}\times AF_{i}\right)\right]\right\}\times IR_{FD}\right]\right)\times SFF}{BW}$$

Where:

AF_i	=	Bioavailability fraction of the constituent in the ith food item (unitless; set at 100%)
AF_{SED}	=	Bioavailability fraction of the constituent in the sediment (unitless) –
		In screening assessment, assumed 100% for all constituents.
		In refined assessment, set at 100% for all constituents except aluminum, copper, iron, lead, manganese, and vanadium.
BW	=	Body weight of the organism (kg)
C_i	=	Dry weight concentration of the constituent in the ith food item (mg/kg)
C_{SED}	=	Dry weight concentration of the constituent in the sediment (mg/kg)
C_{SW}	=	Concentration of the constituent in the surface water (mg/L)
FIR_{SED}	=	Fraction of the food ingestion rate that is sediment (unitless)
i	=	Food item (amphibian, fish, nymph mayfly, or vegetation)
IR_{FD}	=	Ingestion rate of dry food (kg/day)
IR_{sw}	=	Ingestion rate of surface water (L/day)
P_i	=	Proportion of the diet comprised of the ith food item (unitless)
SFF	=	Site Foraging Frequency (unitless; set at 1)

Table 5
Dietary Exposure Equations
Kingston Fossil Plant
Tennessee Valley Authority

The following model was used to calculate the refined dietary intake dose for Aluminum and Iron for each indicator receptor:

$$\text{Dose}\left(\frac{\text{mg}}{\text{kg - day}}\right)=\frac{\left(\left[C_{SW}\times IR_{SW}\right]+\left[\left\{\left[C_{SED}\times AF_{SED}\times FIR_{SED}\right]+\left[\sum_{i=A,V}\left(C_i\times P_i\times AF_i\right)\right]+\left[\sum_{j=F,N}\left(C_j\times P_j\times F_{tiss,\,j}\times AF_{tiss,\,j}+C_j\times P_j\times F_{gut,\,j}\times AF_{SED}\right)\right]\right\}\times IR_{FD}\right]\right)\times SFF}{BW}$$

Where:

AF_i	=	Bioavailability fraction of the constituent in the ith food item, either amphibian (A; unitless set at 100%) or vegetation (V; unitless; set at 100% for Aluminum and 20% for Iron)
AF_{SED}	=	Bioavailability fraction of the constituent in the sediment (unitless)
$AF_{tiss,\,j}$	=	Bioavailability fraction of the constituent in the tissue of the jth food item, either fish (F) or nymph mayfly (N) (unitless; set at 100%)
BW	=	Body weight of the organism (kg)
C_{SED}	=	Dry weight concentration of the constituent in the sediment (mg/kg)
C_{SW}	=	Concentration of the constituent in the surface water (mg/L)
C_i	=	Dry weight concentration of the constituent in the ith food item, either amphibian (A) or vegetation (V) (mg/kg)
C_j	=	Dry weight concentration of the constituent in the jth food item, either fish (F) or nymph mayfly (N) (mg/kg)
$F_{gut,\,j}$	=	Fraction of the constituent in the gut of the jth food item, either fish (F) or nymph mayfly (N) (unitless) For aluminum, it was 70% for fish and 80% for nymph mayfly; for iron, it was 70% for fish and 0% for nymph mayfly
$F_{tiss,\,j}$	=	Fraction of the constituent in the jth food item, either fish tissue (F) or whole nymph mayfly (N) (unitless) For aluminum, it was 30% for fish and 20% for nymph mayfly; for iron, it was 30% for fish and 100% for nymph mayfly
FIR_{SED}	=	Fraction of the food ingestion rate that is sediment (unitless)
IR_{FD}	=	Ingestion rate of dry food (kg/day)
IR_{sw}	=	Ingestion rate of surface water (L/day)
P_i	=	Proportion of the diet comprised of the ith food item, either amphibian (A) or vegetation (V) (unitless)
P_j	=	Proportion of the diet comprised of the jth food item, either fish (F) or nymph mayfly (N) (unitless)
SFF	=	Site Foraging Frequency (unitless; set at 1)

Table 6

Avian Toxicity Reference Values - Screening Evaluation
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Toxicity Reference Values (TRV) [a] (mg/kg BW-day) NOAEL	Test Species	Effect	Reference
Inorganics				
Aluminum	109.7	ring doves	REP, GRO	[a]
Antimony	18	bobwhite quail	GRO, MOR	Damron 1975 [a]
Arsenic	2.24	multiple	REP, GRO	USEPA 2005
Barium	20.8	chicken	MOR	Sample et al. 1996
Beryllium	0.532	multiple mammals	REP, GRO	USEPA 2005
Boron	28	mallard duck	REP	Sample et al. 1996
Cadmium	1.47	multiple	REP, GRO	USEPA 2005
Chromium	2.66	multiple	REP, GRO	USEPA 2007
Cobalt	7.61	multiple	REP, GRO	USEPA 2005
Copper	4.05	chicken	REP	USEPA 2007
Iron	109.3	--	--	[a]
Lead	1.63	chicken	REP	USEPA 2007
Manganese	179	multiple	REP, GRO	USEPA 2007
Mercury	0.45	japanese quail	REP	Sample et. al 1996
Molybdenum	3.5	chicken	REP	Sample et al. 1996
Nickel	6.71	multiple	REP, GRO	USEPA 2007
Selenium	0.29	chicken	MOR	USEPA 2007
Silver	2.02	turkey	GRO	USEPA 2006
Strontium	312	chicken	REP	Mraz et al 1967 [a]
Thallium	0.35	starling	MOR	Schafer 1972
Vanadium	0.344	chicken	GRO	USEPA 2005
Zinc	66.1	multiple	REP, GRO	USEPA 2007
Organic Compounds				
Total Chlordane	2.14	red-winged blackbird	MOR	Sample et al. 1996
Total PCBs	0.09	chicken	REP	USEPA 2009
Total DDx	0.227	chicken	GRO	USEPA 2007
Dieldrin	0.0709	multiple	REP	USEPA 2007
Heptachlor Epoxide	NA	NA	NA	Sample et al. 1996

REP	Reproduction.	MOR	Mortality.
GRO	Growth.	NA	Not available.
mg/kg-BW-day	Milligrams per kilogram of body weight per day.	NOAEL	No Observed Adverse Effect Level.

a Please refer to Attachment 3 for a detailed discussion.

Table 7

Mammalian Toxicity Reference Values - Screening Evaluation
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Toxicity Reference Values (TRV) [a] (mg/kg BW-day) NOAEL	Test Species	Effect	Reference
Inorganics				
Aluminum	1.93	mouse	REP	Sample et al. 1996
Antimony	0.059	multiple	REP, GRO	USEPA 2005
Arsenic	1.04	multiple	GRO	USEPA 2005
Barium	51.8	multiple	REP, GRO	USEPA 2005
Beryllium	0.532	multiple	REP, GRO	USEPA 2005
Boron	28.8	rat	REP	Sample et al. 1996
Cadmium	0.77	multiple	GRO	USEPA 2005
Chromium	2.4	multiple	REP, GRO	USEPA 2008
Cobalt	7.33	multiple	REP, GRO	USEPA 2007
Copper	5.6	multiple	REP, GRO	USEPA 2007
Iron	22.8	--	--	[a]
Lead	4.7	multiple	REP, GRO	USEPA 2005
Manganese	51.5	multiple	REP, GRO	USEPA 2007
Mercury	1	mink	REP	Sample et. al 1996
Molybdenum	0.26	multiple	REP	Sample et al. 1996
Nickel	1.7	multiple	REP	USEPA 2007
Selenium	0.143	multiple	GRO	USEPA 2007
Silver	6.02	multiple	REP, GRO	USEPA 2006
Strontium	263	rat	BW, BN	Sample et al. 1996
Thallium	0.015	rat	REP	USACHPPM 2007
Vanadium	4.16	mouse	SUR	USEPA 2005
Zinc	75.4	multiple	REP, GRO	USEPA 2007
Organic Compounds				
Total Chlordane	4.58	mouse	REP	Sample et al. 1996
Total PCBs	0.36	mouse	REP	USEPA 2009
Total DDx	0.147	rat	REP	USEPA 2007
Dieldrin	0.015	multiple	REP, GRO	USEPA 2007
Heptachlor Epoxide	0.1	mink	REP	Sample et al. 1996

REP	Reproduction.	mg/kg-BW-day	Milligrams per kilogram of body weight per day.
BW	Body weight.	MOR	Mortality.
GRO	Growth.	NOAEL	No Observed Adverse Effect Level.
BN	Bone effects.	SUR	Survival.

a Please refer to Attachment 3 for a detailed discussion.

Table 8
Toxicity Reference Values - Refined Evaluation
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Toxicity Reference Values (TRV) (mg/kg BW-day) NOAEL	LOAEL	
Avian			
Aluminum	110	386.5	Sample et al. 1996
Arsenic	5	13	[a]
Copper	4.05	12.1	USEPA 2007
Iron	109	790.5	[a]
Lead	1.63	3.3	USEPA 2007
Selenium	0.4	0.7	[a]
Vanadium	8	13	[a]
PCBs	0.41	7	[a]
Mammalian			
Aluminum	17	212.6	[a]
Iron	22.8	31.6	[a]
Manganese	162	271	[a]
Selenium	0.14	0.215	USEPA 2007

LOAEL Lowest Observed Adverse Effect Level.
mg/kg-BW-day Milligrams per kilogram of body weight per day.
NOAEL No Observed Adverse Effect Level.

a Derivation presented in Attachment 3.

Table 9

Toxicity Reference Values - Stochastic Evaluation
Kingston Fossil Plant
Tennesse Valley Authority

	Toxicity Reference Values (TRV) Ranges [a]									
	NOAEL					LOAEL				
	Distribution of Input Variables					Distribution of Input Variables				
Constituent	min	max	mean	stdev	Distribution	min	max	mean	stdev	Distribution
Avian										
Aluminum	--	--	137	39	Normal	--	--	386.5	110	Normal
Arsenic	2	24	--	--	Triangular	2	37	--	--	Triangular
Selenium	--	--	1.69	1.11	Normal	--	--	3.03	1.71	Normal
Mallard										
Selenium	0.40	1.00	--	--	Triangular	0.70	1.20	--	--	Triangular
Mammalian										
Aluminum	--	--	16	10	Normal	--	--	96	103	Normal
Selenium	0.11	13	--	--	Triangular	0.16	14	--	--	Triangular

LOAEL	Lowest Observed Adverse Effect Level.	min	minimum.
mg/kg-BW-day	Milligrams per kilogram of body weight per day.	max	maximum.
NOAEL	No Observed Adverse Effect Level.	stdev	standard deviation.

a Derivation presented in Attachment 3.

Table 10
Body Weight Ranges for Probabilistic Assessment
Kingston Fossil Plant
Tennesse Valley Authority

	Body Weight Range (kg)		
Receptor	**mean**	**Standrd Deviation**	**Distribution**
Killdeer	0.095	0.017	normal
Mallard	1.158	0.112	normal
Raccoon	5.440	1.363	normal
Mink	1.110	0.165	normal
Tree swallow	0.0205	0.0006	normal
Bat	0.0095	0.0021	normal

kg = kilogram.

Receptor body weight ranges from the Wildlife Receptors Profiles document.

Table 11-1
Screening Risk Characterization Results Summary
Wood Duck
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	**3**	**3**	**2**	**2**	**4**	**3**	**2**	**4**	**4**	**3**
Antimony	0.001	0.0005	0.0002	0.0001	0.0006	0.0005	0.0001	0.0005	0.0005	0.0002
Arsenic	1	0.3	0.1	0.07	0.2	0.2	0.08	0.2	0.2	0.09
Barium	0.3	0.3	0.3	0.4	0.3	0.3	0.2	0.7	0.3	0.2
Beryllium	0.05	0.05	0.03	0.02	0.05	0.04	0.02	0.04	0.04	0.02
Boron	0.1	0.06	0.1	0.1	0.1	0.1	0.1	0.1	0.04	0.1
Cadmium	0.02	0.02	0.02	0.06	0.04	0.02	0.02	0.03	0.04	0.03
Chromium	0.2	0.2	0.08	0.1	0.2	0.2	0.1	0.2	0.2	0.1
Cobalt	0.04	0.04	0.03	0.04	0.04	0.03	0.03	0.04	0.04	0.03
Copper	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.5	0.3
Iron	**4**	**3**	**3**	**3**	**4**	**3**	**3**	**4**	**4**	**3**
Lead	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Manganese	0.2	0.4	0.6	0.4	0.3	0.3	0.3	0.4	0.5	0.4
Mercury	0.009	0.005	0.004	0.004	0.02	0.02	0.07	0.01	0.009	0.004
Molybdenum	0.04	0.03	0.03	0.02	0.04	0.08	0.03	0.05	0.04	0.03
Nickel	0.08	0.08	0.06	0.06	0.08	0.08	0.09	0.07	0.1	0.08
Selenium	1	0.7	0.5	0.4	0.8	0.8	0.4	0.6	0.6	0.4
Silver	--	0.0006	--	0.004	0.001	0.001	--	0.001	0.0009	--
Strontium	0.02	0.009	0.01	0.01	0.01	0.009	0.01	0.01	0.009	0.01
Thallium	0.04	0.02	0.009	--	--	0.01	--	0.01	0.01	--
Vanadium	**2**	**2**	1	1	**2**	**2**	1	**2**	**2**	1
Zinc	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2

Hazard quotients greater than one are in bold

Table 11-2
Screening Risk Characterization Results Summary
Mallard Duck
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	**5**	**5**	**3**	**3**	**7**	**5**	**4**	**7**	**7**	**5**
Antimony	0.002	0.0009	0.0003	0.0002	0.001	0.0009	0.0003	0.0008	0.0008	0.0003
Arsenic	**2**	0.4	0.2	0.1	0.4	0.4	0.1	0.3	0.3	0.1
Barium	0.4	0.3	0.2	0.3	0.3	0.3	0.2	0.4	0.3	0.3
Beryllium	0.1	0.09	0.05	0.03	0.09	0.08	0.04	0.08	0.07	0.04
Boron	0.06	0.03	0.04	0.04	0.06	0.05	0.05	0.05	0.03	0.04
Cadmium	0.04	0.03	0.01	0.09	0.07	0.04	0.04	0.06	0.06	0.05
Chromium	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.2
Cobalt	0.06	0.07	0.05	0.06	0.06	0.06	0.05	0.06	0.06	0.05
Copper	0.3	0.3	0.2	0.2	0.4	0.3	0.3	0.3	0.4	0.2
Iron	**6**	**6**	**5**	**5**	**7**	**5**	**5**	**7**	**7**	**6**
Lead	0.4	0.4	0.2	0.2	0.4	0.3	0.3	0.4	0.4	0.4
Manganese	0.2	0.3	0.3	0.5	0.3	0.3	0.3	0.5	0.5	0.5
Mercury	0.02	0.009	0.008	0.008	0.04	0.04	0.1	0.02	0.02	0.008
Molybdenum	0.05	0.03	0.02	0.02	0.03	0.05	0.02	0.03	0.03	0.02
Nickel	0.1	0.1	0.08	0.07	0.1	0.1	0.1	0.1	0.1	0.08
Selenium	**2**	1	0.9	0.8	1	1	0.8	1	1	0.9
Silver	--	0.001	--	0.005	0.002	0.002	--	0.002	0.001	--
Strontium	0.01	0.007	0.005	0.004	0.008	0.007	0.005	0.007	0.006	0.005
Thallium	0.08	0.04	0.003	--	--	0.02	--	0.02	0.03	--
Vanadium	**4**	**3**	**2**	**2**	**4**	**3**	**2**	**3**	**3**	**3**
Zinc	0.1	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.2

Hazard quotients greater than one are in bold

Table 11-3
Screening Risk Characterization Results Summary
Killdeer
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	**18**	**17**	**11**	**11**	**25**	**18**	**13**	**25**	**25**	**15**
Antimony	0.006	0.004	0.001	0.0007	0.004	0.004	0.0008	0.004	0.004	0.0008
Arsenic	**7**	1	0.6	0.3	1	1	0.4	0.9	0.9	0.4
Barium	1	0.8	0.6	0.5	0.9	0.8	0.5	0.7	0.7	0.7
Beryllium	0.3	0.3	0.2	0.1	0.3	0.3	0.1	0.3	0.3	0.1
Boron	0.07	0.04	0.02	0.02	0.08	0.06	0.04	0.06	0.07	0.02
Cadmium	0.1	0.07	0.03	0.2	0.2	0.1	0.1	0.2	0.2	0.1
Chromium	1	0.9	0.5	0.5	1	1	0.6	1	1	0.7
Cobalt	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.1
Copper	0.9	0.8	0.5	0.5	1	0.9	0.8	1	0.9	0.6
Iron	**22**	**20**	**15**	**14**	**24**	**18**	**16**	**24**	**23**	**19**
Lead	**2**	1	0.7	0.7	1	1	1	1	1	1
Manganese	0.6	0.6	0.5	1	0.9	0.8	0.9	1	1	1
Mercury	0.05	0.03	0.02	0.02	0.1	0.1	0.4	0.06	0.05	0.02
Molybdenum	0.1	0.06	0.03	0.03	0.07	0.07	0.03	0.04	0.06	0.03
Nickel	0.4	0.4	0.2	0.2	0.4	0.3	0.3	0.4	0.3	0.2
Selenium	**6**	**4**	**3**	**2**	**3**	**4**	**2**	**3**	**3**	**3**
Silver	--	0.004	--	0.01	0.006	0.005	--	0.006	0.003	--
Strontium	0.03	0.02	0.007	0.004	0.02	0.02	0.005	0.01	0.01	0.005
Thallium	0.2	0.1	--	--	--	0.1	--	0.07	0.08	--
Vanadium	**14**	**11**	**6**	**5**	**13**	**11**	**6**	**12**	**12**	**8**
Zinc	0.4	0.4	0.5	0.7	0.5	0.4	0.5	0.7	0.6	0.5

Hazard quotients greater than one are in bold

Table 11-4
Screening Risk Characterization Results Summary
Heron
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	1	**2**	0.4	1	**2**	1	0.5	**2**	**2**	0.5
Antimony	0.00009	0.0005	0.000007	0.000005	0.0004	0.0003	0.000006	0.0004	0.0004	6E-06
Arsenic	0.1	0.1	0.05	0.04	0.1	0.09	0.06	0.1	0.1	0.06
Barium	0.1	0.1	0.05	0.1	0.1	0.08	0.06	0.1	0.1	0.06
Beryllium	0.004	0.03	0.002	0.001	0.03	0.02	0.002	0.03	0.03	0.002
Boron	0.005	0.005	0.0004	0.0002	0.006	0.001	0.0003	0.006	0.006	0.0002
Cadmium	0.0008	0.005	0.002	0.01	0.005	0.004	0.003	0.005	0.005	0.003
Chromium	0.1	0.09	0.05	0.1	0.1	0.1	0.05	0.1	0.1	0.05
Cobalt	0.02	0.02	0.006	0.02	0.02	0.01	0.006	0.02	0.02	0.006
Copper	0.09	0.1	0.1	0.5	0.2	0.1	0.1	0.2	0.2	0.1
Iron	1	**2**	0.5	**2**	1	1	0.5	1	1	0.6
Lead	0.1	0.1	0.03	0.1	0.1	0.1	0.05	0.1	0.1	0.05
Manganese	0.05	0.07	0.05	0.1	0.1	0.08	0.07	0.1	0.1	0.07
Mercury	0.01	0.01	0.007	0.01	0.02	0.02	0.02	0.02	0.02	0.01
Molybdenum	0.0009	0.005	0.0003	0.0002	0.003	0.004	0.0003	0.003	0.003	0.0002
Nickel	0.02	0.06	0.01	0.3	0.1	0.05	0.04	0.1	0.1	0.04
Selenium	0.6	0.8	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7
Silver	--	0.0007	0.0003	0.0005	0.001	0.0005	0.0004	0.001	0.001	0.0004
Strontium	0.01	0.009	0.006	0.008	0.008	0.008	0.01	0.008	0.008	0.01
Thallium	0.002	0.0008	--	--	--	--	--	0.0005	0.0006	--
Vanadium	0.7	1	0.2	0.7	1	0.7	0.3	1	1	0.3
Zinc	0.08	0.1	0.08	0.08	0.1	0.1	0.09	0.1	0.1	0.09

Hazard quotients greater than one are in bold

Table 11-5
Screening Risk Characterization Results Summary
Osprey
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	1	1	0.3	1	**2**	0.9	0.4	**2**	**2**	0.4
Antimony	0.000001	0.0004	--	--	0.0004	0.0003	--	0.0004	0.0004	--
Arsenic	0.06	0.1	0.05	0.04	0.1	0.09	0.06	0.1	0.1	0.06
Barium	0.1	0.1	0.05	0.1	0.1	0.08	0.06	0.1	0.1	0.06
Beryllium	--	0.03	--	--	0.03	0.02	--	0.03	0.03	--
Boron	0.004	0.005	0.00004	0.00003	0.005	0.00003	0.00003	0.005	0.005	0.00003
Cadmium	--	0.005	0.002	0.01	0.004	0.004	0.003	0.004	0.004	0.003
Chromium	0.1	0.09	0.05	0.2	0.1	0.1	0.05	0.1	0.1	0.05
Cobalt	0.01	0.02	0.005	0.02	0.02	0.01	0.005	0.02	0.02	0.005
Copper	0.09	0.1	0.1	0.6	0.2	0.1	0.2	0.2	0.2	0.2
Iron	1	1	0.4	**2**	0.8	1	0.4	0.8	0.8	0.4
Lead	0.08	0.1	0.03	0.1	0.1	0.1	0.04	0.1	0.1	0.04
Manganese	0.05	0.08	0.05	0.2	0.1	0.08	0.07	0.1	0.1	0.07
Mercury	0.01	0.01	0.008	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Molybdenum	0.00002	0.005	0.00001	0.00001	0.003	0.003	0.00001	0.003	0.003	8E-06
Nickel	0.02	0.06	0.009	0.3	0.1	0.05	0.04	0.1	0.1	0.04
Selenium	0.6	0.8	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7
Silver	--	0.0007	0.0004	0.0005	0.001	0.0005	0.0004	0.001	0.001	0.0004
Strontium	0.01	0.009	0.007	0.009	0.009	0.008	0.01	0.009	0.009	0.01
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	0.6	1	0.2	0.7	1	0.7	0.3	1	1	0.3
Zinc	0.09	0.1	0.09	0.09	0.1	0.1	0.1	0.1	0.1	0.1

Hazard quotients greater than one are in bold

Table 11-6
Screening Risk Characterization Results Summary
Muskrat
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	**110**	**61**	**54**	**64**	**190**	**93**	**52**	**190**	**190**	**52**
Antimony	0.2	0.2	--	--	0.2	0.1	--	0.2	0.2	--
Arsenic	0.09	0.2	0.03	0.05	0.2	0.2	0.05	0.2	0.1	0.05
Barium	0.06	0.07	0.1	0.1	0.06	0.06	0.05	0.2	0.06	0.05
Beryllium	0.01	0.01	0.01	0.007	0.02	0.01	0.007	0.02	0.02	0.007
Boron	0.1	0.06	0.09	0.1	0.1	0.1	0.1	0.1	0.04	0.1
Cadmium	--	0.02	0.03	0.03	0.004	0.005	0.009	--	0.009	0.009
Chromium	0.1	0.07	0.03	0.06	0.2	0.1	0.03	0.1	0.2	0.03
Cobalt	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.01
Copper	0.1	0.08	0.08	0.1	0.1	0.1	0.1	0.1	0.3	0.1
Iron	**9**	**6**	**4**	**7**	**12**	**8**	**5**	**12**	**12**	**5**
Lead	0.07	0.04	0.02	0.02	0.06	0.05	0.02	0.06	0.06	0.02
Manganese	0.5	1	**2**	0.6	0.5	0.8	0.5	0.5	1	0.5
Mercury	0.0004	0.0004	--	0.00002	0.001	0.003	--	0.001	0.001	--
Molybdenum	0.3	0.3	0.3	0.2	0.3	0.9	0.3	0.6	0.4	0.3
Nickel	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.3	0.2
Selenium	0.3	0.1	--	0.0003	0.3	0.2	0.0003	--	--	0.0003
Silver	--	--	--	0.0007	--	0.0002	--	--	0.0001	--
Strontium	0.02	0.01	0.01	0.01	0.01	0.008	0.01	0.01	0.008	0.01
Thallium	--	--	0.2	--	--	1	--	--	--	--
Vanadium	0.07	0.05	0.03	0.05	0.1	0.06	0.04	0.1	0.1	0.04
Zinc	0.03	0.04	0.04	0.06	0.06	0.03	0.06	0.07	0.06	0.06

Hazard quotients greater than one are in bold

Table 11-7
Screening Risk Characterization Results Summary
Raccoon
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	**140**	**120**	**79**	**83**	**210**	**130**	**87**	**210**	**200**	**100**
Antimony	0.2	0.2	0.03	0.02	0.2	0.2	0.02	0.2	0.2	0.02
Arsenic	1	0.4	0.1	0.09	0.3	0.4	0.1	0.3	0.2	0.1
Barium	0.07	0.06	0.06	0.07	0.06	0.05	0.04	0.1	0.05	0.05
Beryllium	0.03	0.03	0.02	0.01	0.04	0.03	0.01	0.03	0.03	0.02
Boron	0.05	0.03	0.04	0.04	0.06	0.04	0.04	0.05	0.02	0.04
Cadmium	0.02	0.02	0.01	0.05	0.04	0.02	0.02	0.03	0.03	0.03
Chromium	0.1	0.1	0.07	0.07	0.2	0.1	0.08	0.2	0.2	0.08
Cobalt	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Copper	0.1	0.09	0.07	0.09	0.1	0.1	0.1	0.1	0.2	0.09
Iron	**13**	**11**	**8**	**9**	**15**	**11**	**9**	**15**	**15**	**11**
Lead	0.08	0.05	0.03	0.03	0.07	0.06	0.04	0.07	0.07	0.05
Manganese	0.4	0.6	0.8	0.6	0.5	0.6	0.5	0.6	0.8	0.6
Mercury	0.002	0.001	0.001	0.001	0.005	0.007	0.02	0.003	0.003	0.001
Molybdenum	0.3	0.2	0.2	0.1	0.2	0.4	0.2	0.3	0.2	0.2
Nickel	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Selenium	1	0.8	0.5	0.4	0.8	0.8	0.5	0.6	0.6	0.5
Silver	--	0.0001	0.000002	0.0006	0.0002	0.0002	0.000003	0.0002	0.0001	3E-06
Strontium	0.01	0.006	0.005	0.005	0.007	0.005	0.006	0.006	0.005	0.006
Thallium	0.5	0.2	0.08	--	--	0.7	--	0.1	0.2	--
Vanadium	0.1	0.1	0.06	0.06	0.1	0.1	0.07	0.1	0.1	0.08
Zinc	0.04	0.05	0.06	0.08	0.07	0.05	0.06	0.09	0.08	0.07

Hazard quotients greater than one are in bold

Table 11-8
Screening Risk Characterization Results Summary
Mink
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	**90**	**98**	**40**	**71**	**140**	**79**	**45**	**140**	**140**	**50**
Antimony	0.08	0.1	0.01	0.008	0.1	0.1	0.009	0.1	0.1	0.009
Arsenic	0.6	0.3	0.1	0.09	0.3	0.3	0.1	0.3	0.3	0.1
Barium	0.05	0.06	0.03	0.06	0.06	0.04	0.03	0.07	0.05	0.03
Beryllium	0.01	0.03	0.007	0.004	0.03	0.02	0.005	0.03	0.03	0.006
Boron	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01
Cadmium	0.008	0.01	0.008	0.04	0.02	0.01	0.01	0.02	0.02	0.01
Chromium	0.2	0.1	0.06	0.2	0.1	0.1	0.08	0.1	0.1	0.08
Cobalt	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.01
Copper	0.08	0.1	0.08	0.3	0.2	0.1	0.1	0.2	0.2	0.1
Iron	**8**	**9**	**4**	**9**	**8**	**7**	**4**	**8**	**8**	**5**
Lead	0.05	0.04	0.02	0.05	0.05	0.05	0.03	0.05	0.05	0.03
Manganese	0.2	0.3	0.3	0.6	0.4	0.4	0.3	0.5	0.5	0.4
Mercury	0.005	0.005	0.003	0.004	0.008	0.007	0.01	0.008	0.007	0.005
Molybdenum	0.09	0.1	0.05	0.03	0.1	0.1	0.05	0.1	0.09	0.04
Nickel	0.1	0.2	0.07	0.8	0.4	0.2	0.2	0.4	0.4	0.2
Selenium	1	1	1	0.9	1	1	1	1	1	1
Silver	0.000008	0.0002	0.00009	0.0003	0.0004	0.0002	0.0001	0.0003	0.0003	0.0001
Strontium	0.01	0.01	0.007	0.009	0.01	0.009	0.01	0.009	0.009	0.01
Thallium	0.2	0.1	0.05	--	0.03	0.3	--	0.09	0.1	--
Vanadium	0.08	0.1	0.03	0.06	0.1	0.08	0.04	0.1	0.1	0.04
Zinc	0.07	0.1	0.08	0.08	0.1	0.08	0.08	0.1	0.1	0.08

Hazard quotients greater than one are in bold

Table 11-9
Screening Risk Characterization Results Summary
Tree Swallow
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	0.02	0.02	0.06	0.01	0.0003	0.0002	0.01	0.0003	0.0003	0.02
Antimony	0.0002	0.0006	--	--	--	--	--	--	--	0.0003
Arsenic	0.03	0.06	0.06	0.02	0.03	0.03	0.02	0.02	0.02	0.02
Barium	0.02	0.02	0.02	0.009	0.009	0.01	0.008	0.01	0.009	0.01
Beryllium	--	--	--	--	--	--	--	0.0002	0.0002	--
Boron	0.01	0.01	0.01	0.007	0.007	0.009	0.007	0.01	0.006	0.01
Cadmium	0.03	0.02	0.009	0.07	0.1	0.06	0.07	0.09	0.05	0.06
Chromium	0.02	0.02	0.02	1	0.03	0.02	1	0.03	0.02	0.02
Cobalt	0.03	0.02	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Copper	1	1	**2**	**2**	**2**	1	**2**	**2**	1	**2**
Iron	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Lead	0.00005	0.00005	0.00008	--	0.00005	--	0.00004	0.00006	0.00006	0.02
Manganese	0.005	0.005	0.007	0.004	0.005	0.004	0.004	0.006	0.005	0.007
Mercury	0.03	0.02	0.02	0.07	0.03	0.04	0.07	0.03	0.03	0.02
Molybdenum	0.05	0.06	0.04	0.03	0.04	0.04	0.03	0.04	0.04	0.03
Nickel	0.004	0.00002	0.00002	0.00002	0.00002	0.01	0.00002	0.00004	0.00004	0.006
Selenium	**6**	**7**	**6**	**3**	**6**	**5**	**3**	**3**	**3**	**2**
Silver	0.002	0.001	0.002	0.003	0.001	0.002	0.003	0.004	0.002	0.007
Strontium	0.0008	0.0009	0.001	0.0007	0.0007	0.0007	0.0007	0.0008	0.0007	0.0009
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.09
Zinc	0.6	0.7	0.9	0.4	0.8	0.7	0.4	0.6	0.6	0.6

Hazard quotients greater than one are in bold

Table 11-10
Screening Risk Characterization Results Summary
Gray Bat
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotients (HQs) based on No Adverse Effect Levels (NOAELs)									
	Emory River				Clinch River			Tennessee River		
Constituent	**Reach A**	**Reach B**	**Reach C**	**Reach R**	**Reach A**	**Reach B**	**Reach R**	**Reach A**	**Reach B**	**Reach R**
Aluminum	0.6	0.9	**3**	0.5	0.01	0.01	0.5	0.01	0.01	0.7
Antimony	0.05	0.1	--	--	--	--	--	--	--	0.08
Arsenic	0.05	0.09	0.09	0.02	0.05	0.04	0.02	0.03	0.03	0.04
Barium	0.005	0.005	0.006	0.003	0.003	0.003	0.002	0.003	0.003	0.004
Beryllium	--	--	--	--	--	--	--	0.0001	0.0001	--
Boron	0.009	0.01	0.008	0.005	0.005	0.006	0.005	0.008	0.004	0.007
Cadmium	0.04	0.02	0.01	0.09	0.2	0.08	0.09	0.1	0.07	0.09
Chromium	0.02	0.01	0.01	1	0.02	0.02	1	0.03	0.02	0.02
Cobalt	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Copper	0.7	0.7	0.9	0.9	0.9	0.8	0.9	0.8	0.7	0.8
Iron	1	1	**2**	1	1	1	1	1	1	1
Lead	0.00001	0.00001	0.00002	--	0.00001	--	0.00001	0.00002	0.00002	0.004
Manganese	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.02
Mercury	0.01	0.006	0.007	0.02	0.01	0.01	0.02	0.009	0.008	0.006
Molybdenum	0.5	0.6	0.4	0.3	0.3	0.4	0.3	0.4	0.4	0.3
Nickel	0.01	0.00006	0.00006	0.00006	0.00005	0.04	0.00006	0.0001	0.0001	0.02
Selenium	**9**	**10**	**10**	**5**	**9**	**8**	**5**	**5**	**5**	**2**
Silver	0.0004	0.0004	0.0005	0.0008	0.0003	0.0004	0.0008	0.001	0.0005	0.002
Strontium	0.0007	0.0008	0.001	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0008
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	0.007	0.009	0.007	0.006	0.01	0.01	0.006	0.008	0.007	0.005
Zinc	0.4	0.4	0.6	0.2	0.5	0.5	0.2	0.4	0.4	0.4

Hazard quotients greater than one are in bold

Table 11-11
Summary of Screening Risk Characterization Results
Legacy Organics Food Web Modeling
Kingston Fossil Plant
Tennesse Valley Authority

	NOAEL Hazard Quotients		
Constituent	**Mink**	**Great Blue Heron**	**Osprey**
Whole System			
Dieldrin	0.08	0.02	0.02
Heptachlor Epoxide	0.009	--	--
Total Chlordane	0.0005	0.001	0.001
Total Detects Chlordane	0.0005	0.001	0.001
Total DDX	0.03	0.02	0.02
Total Detects DDX	0.009	0.006	0.007
Total PCBs	0.4	**2**	**2**
Total detects PCBs	0.09	0.4	0.4

DDX Dichlorodiphenyltrichloroethane (DDT) and derivatives.
NOAEL No Observed Adverse Effects Level.
PCB Polychlorinated Biphenyl.

Table 12-1
Refined Risks
Wood Duck
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.2	0.6	0.2	0.6	0.2	0.6	0.2	0.8
Iron	0.03	0.2	0.03	0.2	0.03	0.2	0.04	0.3
Vanadium	0.05	0.09	0.04	0.07	0.03	0.04	0.03	0.04

Table 12-1
Refined Risks
Wood Duck
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.2	0.8	0.2	0.6	0.2	0.7	0.2	0.8	0.2	0.7	0.2	0.7
Iron	0.04	0.3	0.03	0.2	0.03	0.2	0.04	0.3	0.03	0.2	0.03	0.3
Vanadium	0.05	0.08	0.04	0.07	0.03	0.05	0.04	0.07	0.04	0.07	0.04	0.06

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-2
Refined Risks
Mallard Duck
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.3	0.9	0.3	1	0.2	0.7	0.2	0.8
Arsenic	0.4	1	0.08	0.2	0.03	0.09	0.02	0.05
Iron	0.06	0.4	0.05	0.4	0.04	0.3	0.04	0.3
Selenium	0.8	**2**	0.5	1	0.3	0.6	0.3	0.5
Vanadium	0.1	0.2	0.08	0.1	0.04	0.07	0.04	0.06

Table 12-2
Refined Risks
Mallard Duck
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.3	1	0.3	0.9	0.2	0.8	0.3	1	0.3	1	0.3	1
Arsenic	0.06	0.2	0.07	0.2	0.02	0.06	0.05	0.1	0.05	0.1	0.03	0.07
Iron	0.06	0.4	0.05	0.3	0.04	0.3	0.06	0.4	0.06	0.4	0.05	0.4
Selenium	0.4	0.9	0.5	1	0.3	0.6	0.4	0.8	0.4	0.8	0.3	0.6
Vanadium	0.08	0.1	0.08	0.1	0.05	0.08	0.07	0.1	0.07	0.1	0.06	0.1

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-3
Refined Risks
Killdeer
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.7	**3**	0.9	**3**	0.5	**2**	0.5	**2**
Arsenic	1	**3**	0.2	0.6	0.1	0.3	0.06	0.2
Iron	0.2	1	0.2	1	0.1	0.9	0.1	0.9
Lead	0.5	1	0.5	0.9	0.3	0.6	0.3	0.6
Selenium	**2**	**5**	1	**3**	0.9	**2**	0.8	**2**
Vanadium	0.3	0.5	0.2	0.4	0.1	0.2	0.1	0.2

Table 12-3
Refined Risks
Killdeer
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.9	**3**	0.8	**3**	0.6	**2**	0.9	**3**	0.9	**3**	0.8	**3**
Arsenic	0.2	0.5	0.2	0.6	0.07	0.2	0.2	0.4	0.2	0.4	0.08	0.2
Iron	0.2	1	0.2	1	0.1	1	0.2	1	0.2	1	0.2	1
Lead	0.5	1	0.4	0.8	0.5	0.9	0.5	1	0.5	1	0.6	1
Selenium	1	**3**	1	**3**	0.9	**2**	1	**2**	1	**2**	0.9	**2**
Vanadium	0.2	0.4	0.2	0.4	0.1	0.2	0.2	0.4	0.2	0.4	0.2	0.3

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-4
Refined Risks
Heron
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.09	0.3	0.1	0.4	0.03	0.1	0.09	0.3
Iron	0.05	0.4	0.06	0.4	0.02	0.1	0.07	0.5

Table 12-4
Refined Risks
Heron
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.1	0.5	0.07	0.3	0.03	0.1	0.1	0.5	0.1	0.5	0.03	0.1
Iron	0.04	0.3	0.05	0.3	0.02	0.1	0.04	0.3	0.04	0.3	0.02	0.1

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-5
Refined Risks
Osprey
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.1	0.3	0.1	0.4	0.03	0.1	0.1	0.3
Iron	0.05	0.4	0.07	0.5	0.02	0.1	0.08	0.6

Table 12-5
Refined Risks
Osprey
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.2	0.5	0.08	0.3	0.03	0.1	0.2	0.5	0.2	0.5	0.03	0.1
Iron	0.04	0.3	0.05	0.4	0.02	0.1	0.04	0.3	0.04	0.3	0.02	0.1

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-6
Refined Risks
Muskrat
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.06	0.8	0.05	0.6	0.1	1	0.2	**3**
Iron	0.5	0.7	0.3	0.5	0.3	0.5	0.5	0.8
Manganese	0.09	0.1	0.2	0.3	0.3	0.6	0.1	0.2

Table 12-6
Refined Risks
Muskrat
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.1	**2**	0.05	0.6	0.1	**2**	0.1	1	0.07	0.9	0.1	**2**
Iron	0.7	0.9	0.4	0.5	0.3	0.5	0.6	0.9	0.6	0.8	0.3	0.5
Manganese	0.09	0.1	0.1	0.2	0.09	0.1	0.09	0.2	0.2	0.3	0.09	0.1

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-7
Refined Risks
Raccoon
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.1	**2**	0.2	**2**	0.1	**2**	0.2	**2**
Iron	0.6	0.9	0.5	0.8	0.4	0.6	0.5	0.7

Table 12-7
Refined Risks
Raccoon
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.2	**3**	0.1	**2**	0.2	**2**	0.2	**3**	0.2	**2**	0.2	**2**
Iron	0.7	1	0.5	0.7	0.4	0.6	0.7	1	0.7	1	0.5	0.7

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-8
Refined Risks
Mink
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.2	**2**	0.2	**3**	0.08	1	0.2	**2**
Iron	1	**2**	1	**2**	0.5	0.7	**2**	**2**

Table 12-8
Refined Risks
Mink
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.3	**3**	0.1	**2**	0.09	1	0.3	**3**	0.3	**3**	0.1	1
Iron	0.9	1	1	1	0.5	0.7	0.9	1	0.9	1	0.5	0.7

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-9
Refined Risks
Tree Swallow
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Copper	0.4	1	0.4	1	0.6	**2**	0.6	**2**
Selenium	**2**	**5**	**2**	**5**	**2**	**5**	1	**3**

Table 12-9
Refined Risks
Tree Swallow
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Copper	0.6	**2**	0.5	1	0.6	**2**	0.5	**2**	0.5	1	0.5	**2**
Selenium	**2**	**4**	**2**	**4**	1	**3**	1	**2**	1	**3**	0.6	1

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-10
Refined Risks
Gray Bat
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River							
	Reach A		Reach B		Reach C		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.001	0.02	0.002	0.02	0.005	0.06	0.0009	0.01
Copper	0.4	0.7	0.4	0.7	0.5	0.9	0.5	0.9
Selenium	**6**	**9**	**7**	**10**	**6**	**10**	**3**	**5**

Table 12-10
Refined Risks
Gray Bat
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River						Tennessee River					
	Reach A		Reach B		Reach R		Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**
Aluminum	0.0001	0.001	0.00009	0.001	0.001	0.01	0.0001	0.002	0.0001	0.002	0.001	0.02
Copper	0.5	0.9	0.5	0.8	0.5	0.9	0.5	0.8	0.4	0.7	0.5	0.8
Selenium	**6**	**9**	**5**	**8**	**3**	**5**	**3**	**5**	**3**	**5**	**2**	**2**

Hazard quotients greater than one are in bold.
LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 12-11
Summary of Refined Risk Characterization Results
Legacy Organics Food Web Modeling
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Great Blue Heron Hazard Quotient		Osprey Hazard Quotient	
	LOAEL	NOAEL	LOAEL	NOAEL
Whole System				
Total PCBs	0.02	0.3	0.02	0.4
Total detects PCBs	0.005	0.08	0.005	0.09

LOAEL Lowest Observed Adverse Effect Level.
NOAEL No Observed Adverse Effect Level.
PCB Polychlorinated Biphenyl.

Table 13-1
Probabilistic Risk Characterization Results Summary- Probability of Hazard Quotient to Exceed 1
Mallard
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River			
	Reach A		Reach R	
	Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL[a]	NOAEL[a]	LOAEL[a]
Selenium	0.02	0	0	0

Notes
[a] - 0 indicates a probability of exceeding of less than 0.001
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Table 13-2
Probabilistic Risk Characterization Results Summary- Probability of Hazard Quotient to Exceed 1
Killdeer
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River									
	Reach A		Reach B		Reach C		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL[a]	LOAEL[a]	NOAEL	LOAEL
Aluminum	1	0.03	1	0.05	--	--	0.2	0.00	0.5	0.03
Arsenic	0.1	0.05	--	--	--	--	0	0	--	--
Selenium	0.2	0.1	0.1	0.06	--	--	0.05	0.02	0.11	0.05

	Clinch River							
	Reach A		Reach B		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	1	0.0	1	0.04	0.7	0.02	1	0.04
Selenium	0.1	0.05	0.1	0.05	0.08	0.03	0.1	0.04

Notes
[a] - 0 indicates a probability of exceeding of less than 0.001
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Table 13-3
Probabilistic Risk Characterization Results Summary- Probability of Hazard Quotient to Exceed 1
Raccoon
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River					
	Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	0.6	0.07	--	--	0.5	0.06

	Tennessee River					
	Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	0.7	0.07	--	--	0.6	0.06

Notes
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Table 13-4
Probabilistic Risk Characterization Results Summary- Probability of Hazard Quotient to Exceed 1
Mink
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River									
	Reach A		Reach B		Reach C		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	--	--	0.4	0.05	--	--	0.5	0.06	--	--

	Clinch River					
	Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	0.6	0.07	0.4	0.05	0.2	0.03

	Tennessee River					
	Reach A		Reach B		Reach R	
	Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	0.6	0.07	0.6	0.08	0.2	0.03

Notes
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Table 13-5
Probabilistic Risk Characterization Results Summary- Probability of Hazard Quotient to Exceed 1
Tree Swallow
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River									
	Reach A		Reach B		Reach C		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Selenium	0.3	0.1	0.3	0.1	0.3	0.1	0.1	0.05	0.3	0.1

	Clinch River							
	Reach A		Reach B		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Selenium	0.2	0.1	0.2	0.1	0.1	0.05	0.2	0.1

	Tennessee River							
	Reach A		Reach B		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Selenium	0.1	0.04	0.1	0.05	0.04	0.02	0.1	0.04

Notes
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Table 13-6
Probabilistic Risk Characterization Results Summary- Probability of Hazard Quotient to Exceed 1
Gray Bat
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River									
	Reach A		Reach B		Reach C		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL[a]	NOAEL	LOAEL
Selenium	0.009	0.007	0.010	0.007	0.008	0.006	0.002	0	0.007	0.006

	Clinch River							
	Reach A		Reach B		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL[a]	LOAEL[a]	NOAEL	LOAEL
Selenium	0.005	0.003	0.005	0.005	0	0	0.006	0.003

	Tennessee River							
	Reach A		Reach B		Reach R		All Reaches	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	NOAEL	LOAEL[a]	NOAEL[a]	LOAEL[a]	NOAEL[a]	LOAEL[a]	NOAEL	LOAEL[a]
Selenium	0.002	0	0	0	0	0	0.001	0

Notes
[a] - 0 indicates a probability of exceeding of less than 0.001
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level

Label	Reach (river mile)	Miles
CR-A	Clinch A (0 - 3.0)	3.0
CR-B	Clinch B (3.0 - 4.5)	1.5
CR-R	Clinch Reference (4.5 - 8.0)	3.5
ER-A	Emory A (0 - 1.5)	1.5
ER-B	Emory B (1.5 - 3.5)	2.0
ER-C	Emory C (3.5 - 6.0)	2.5
ER-R	Emory Reference (6.0 - 12.2)	6.2
	Little Emory Reference (0 - 3.0)	3.0
TR-A	Tennessee A (550 - 566)	16.0
TR-B	Tennessee B (566 - 568)	2.0
TR-R	Tennessee Reference (568 - 573)	5.0

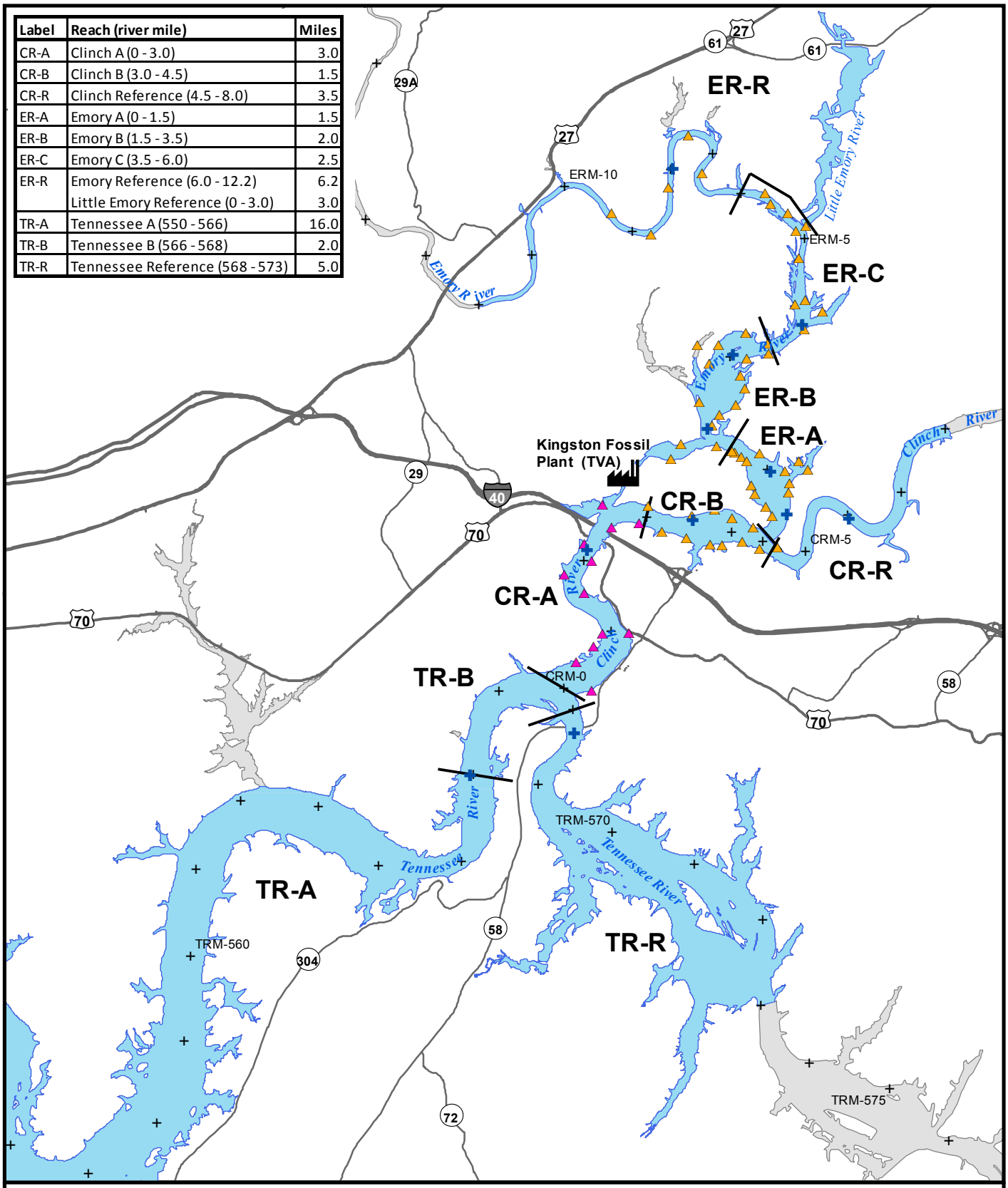


Figure 1 - Surface Water and Sediment Data Collected in 2010 and 2011

Kingston Ash Recovery Project

N

0 1 2 Miles

Seasonally-Exposed Sediment (2010)

Seasonally-Exposed Sediment (2011)

Surface Water Sampling (2010)

Map compiled:
03 Feb 2012

Tennessee Valley Authority
Geographic Information & Engineering

ARCADIS_SurfaceH2O_SESed_20120202_8x11_Fig1.mxd

Label	Reach (river mile)	Miles
CR-A	Clinch A (0 - 3.0)	3.0
CR-B	Clinch B (3.0 - 4.5)	1.5
CR-R	Clinch Reference (4.5 - 8.0)	3.5
ER-A	Emory A (0 - 1.5)	1.5
ER-B	Emory B (1.5 - 3.5)	2.0
ER-C	Emory C (3.5 - 6.0)	2.5
ER-R	Emory Reference (6.0 - 12.2)	6.2
	Little Emory Reference (0 - 3.0)	3.0
TR-A	Tennessee A (550 - 566)	16.0
TR-B	Tennessee B (566 - 568)	2.0
TR-R	Tennessee Reference (568 - 573)	5.0

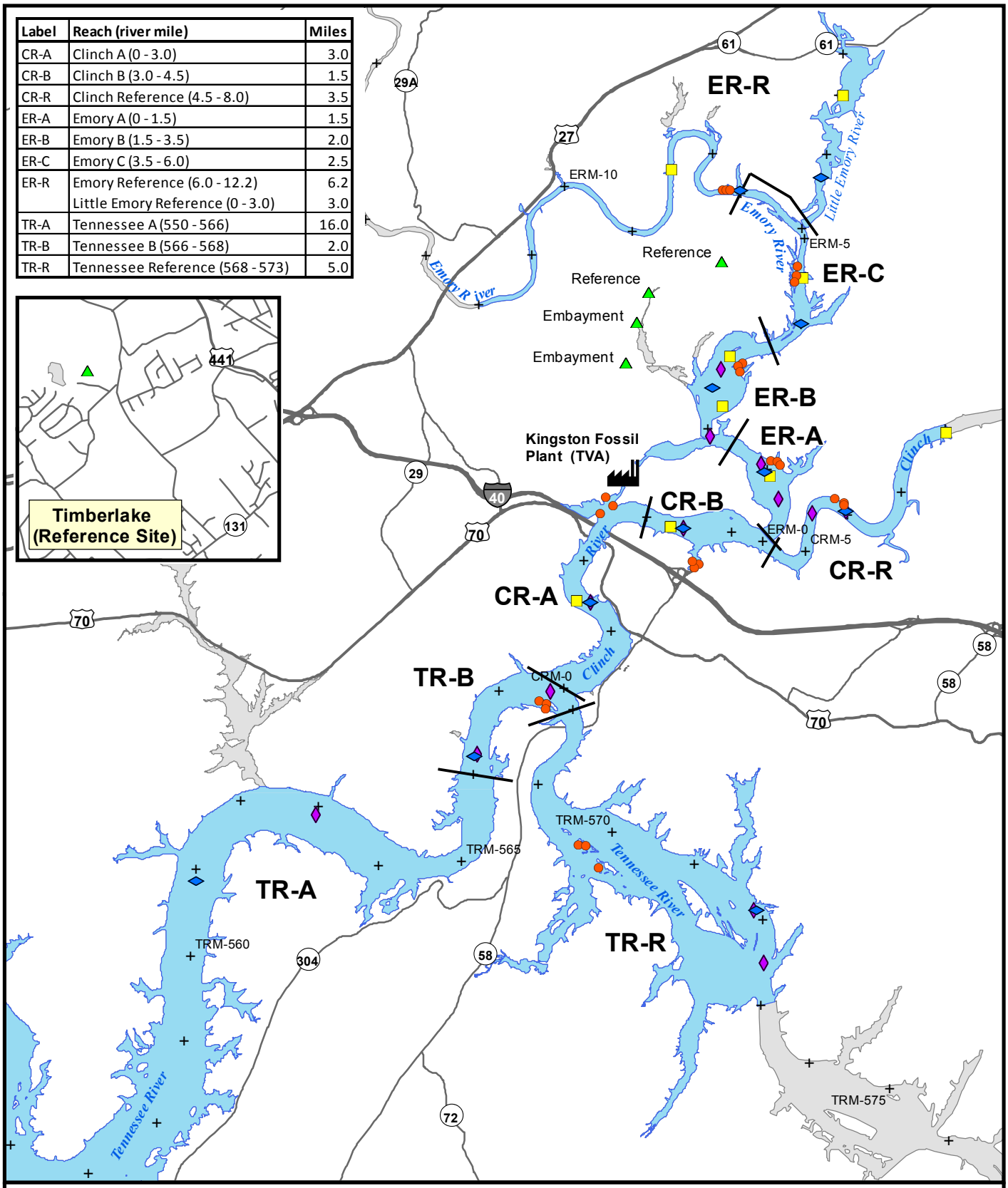


Figure 2 - Locations of Biota Samples Used in Dietary Exposure Models

Kingston Ash Recovery Project

N

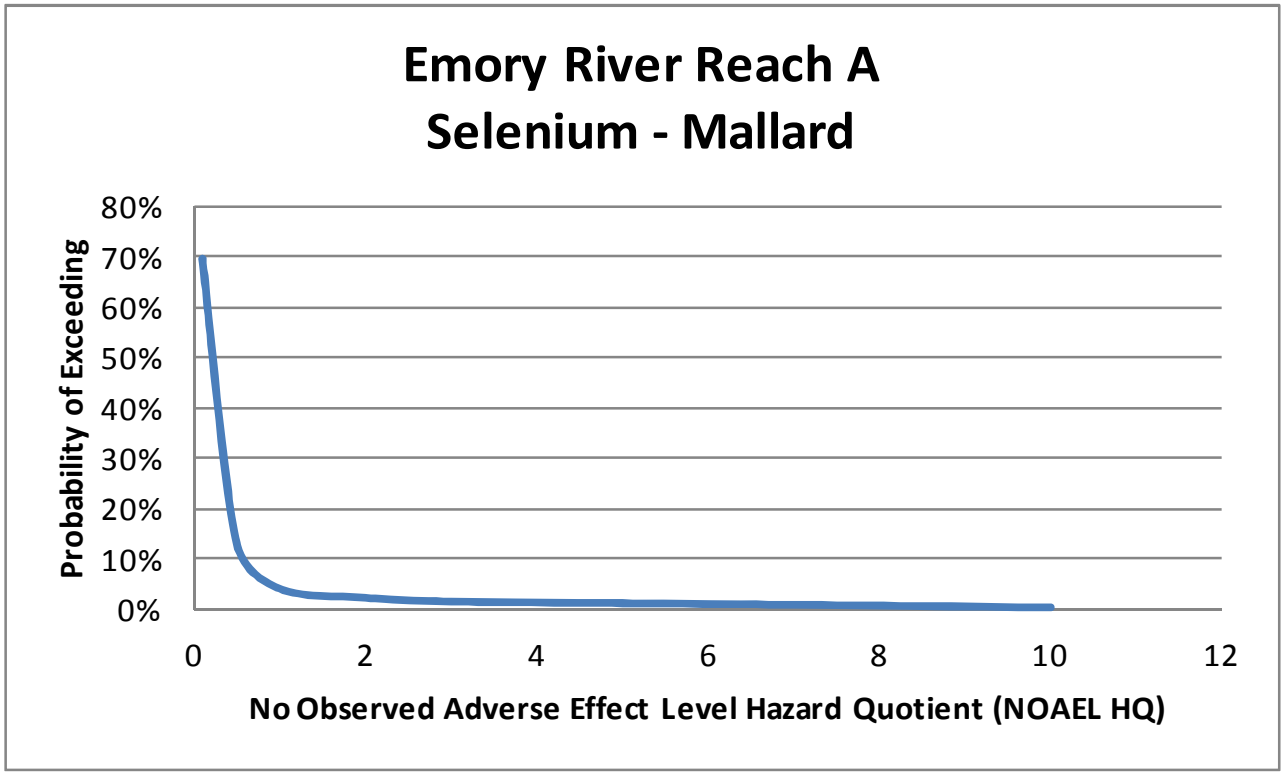
0 1 2 Miles

- Amphibians (2010)
- Larval Mayfly (whole body) (2011)
- Adult Mayfly (whole body) (2011)
- Aquatic Vegetation (2011)
- Gizzard Shad (whole body) (2011)

Map compiled:
03 Feb 2012

Tennessee Valley Authority
Geographic Information & Engineering

ARCADIS_BIOTA_Samples_20120202_8x11_Fig2.mxd



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT. TENNESSEE
EMORY RIVER REACH A
PROBABILITY DISTRIBUTION

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE SELENIUM HAZARD QUOTIENT FOR MALLARD

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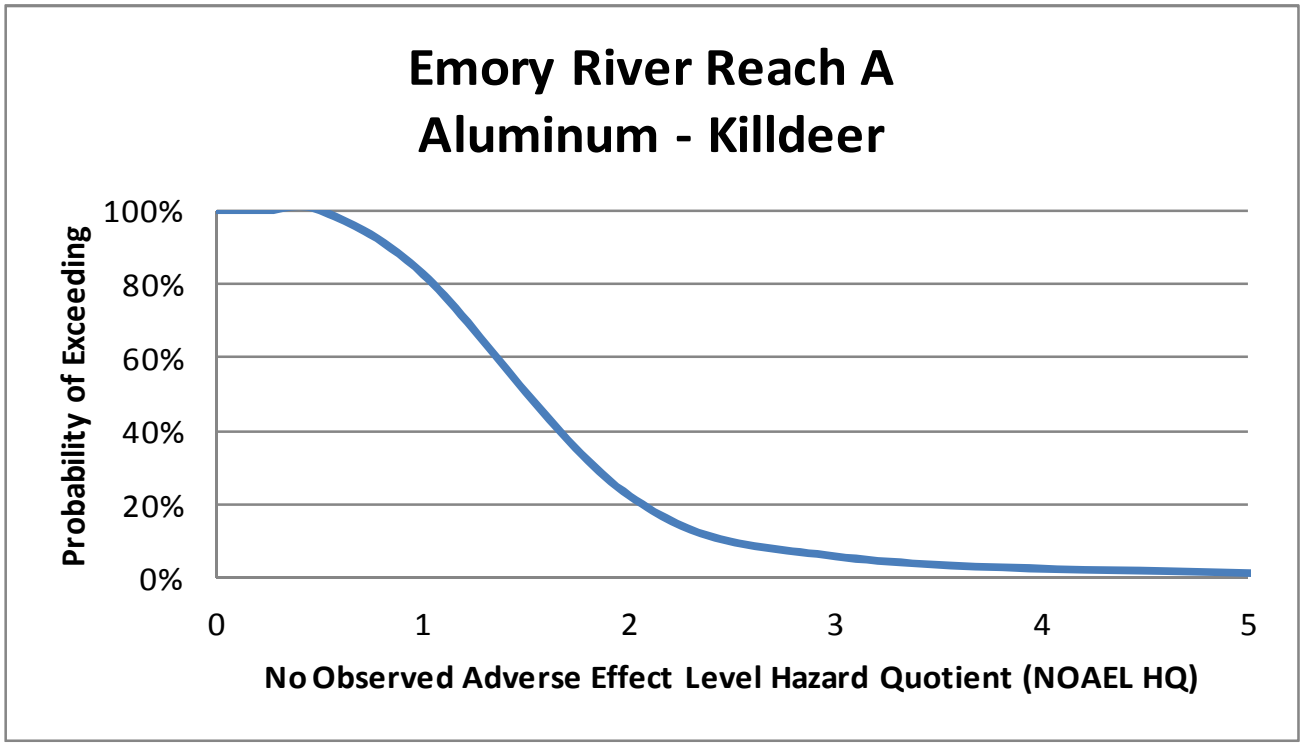
FIGURE
3



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EMORY RIVER REACH A
PROBABILITY DISTRIBUTION

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE ALUMINUM HAZARD QUOTIENT FOR KILLDEER

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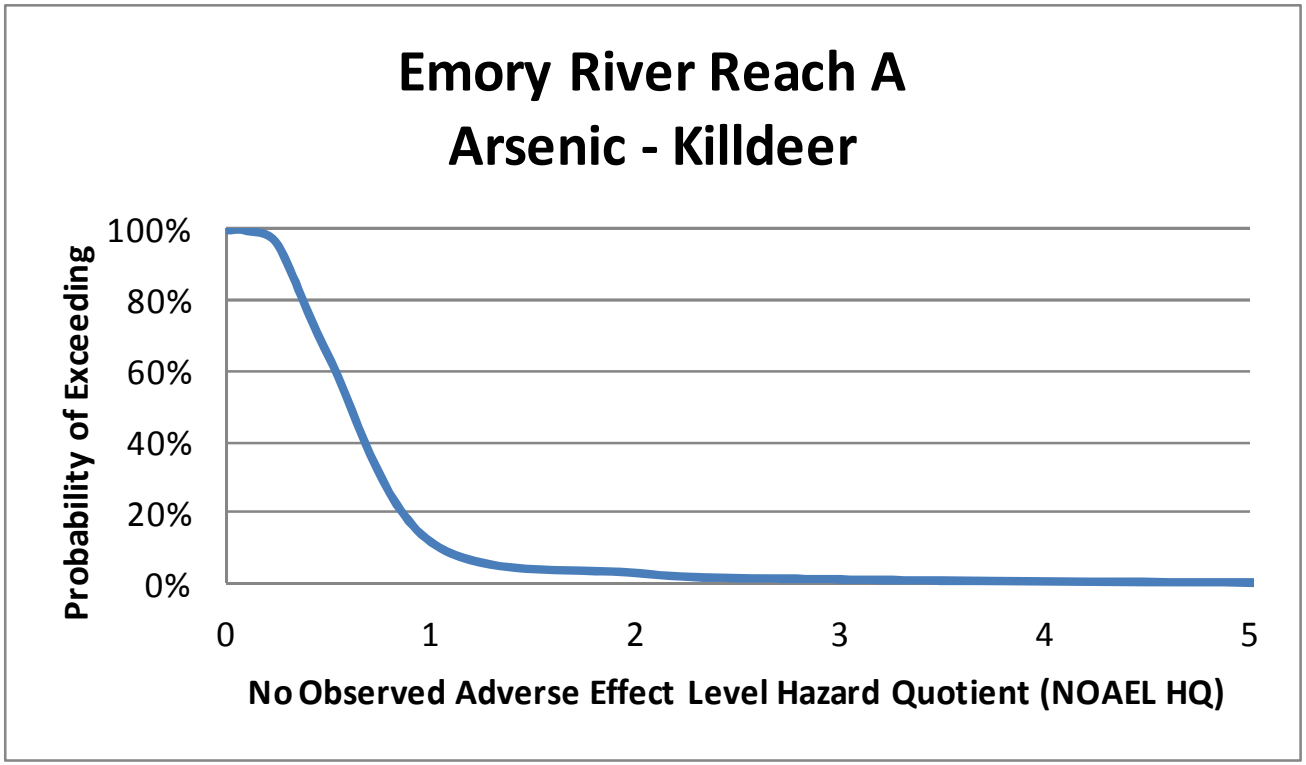
FIGURE
4



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EMORY RIVER REACH A

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE ARSENIC HAZARD QUOTIENT FOR KILLDEER

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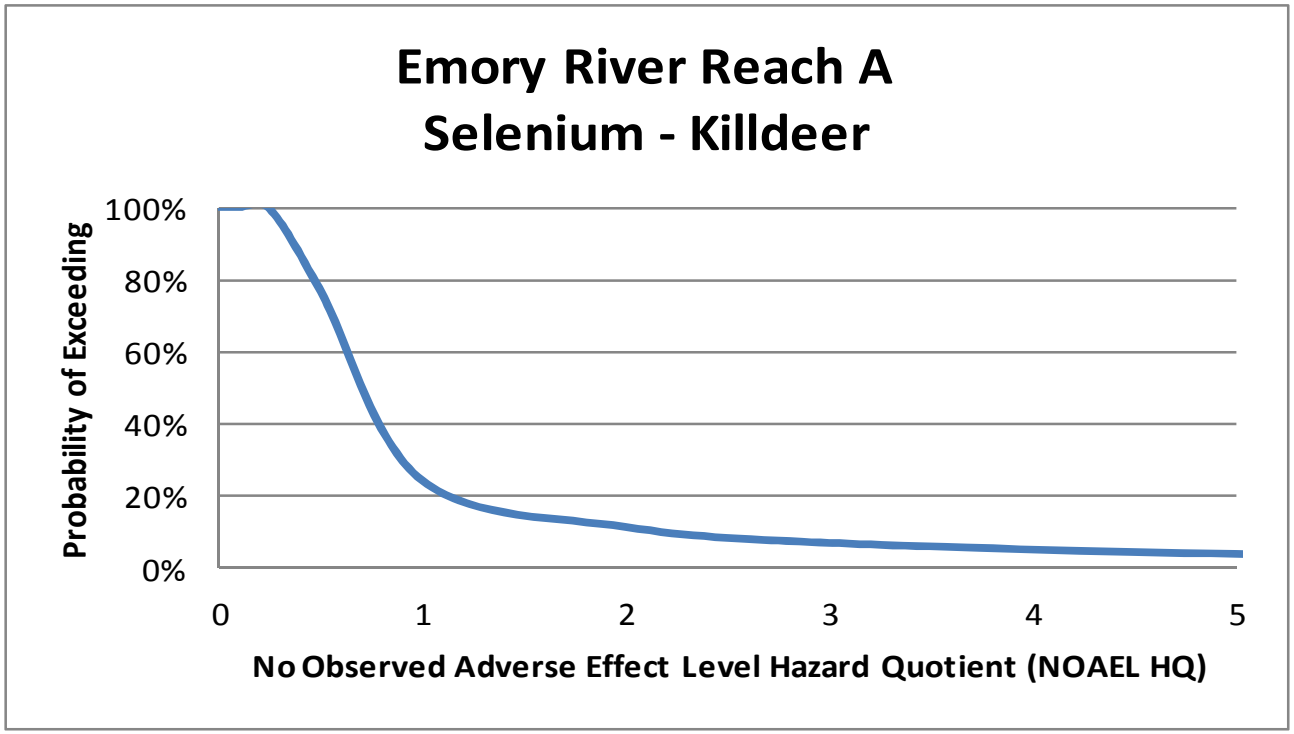
FIGURE
5



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KINGSTON ASH RECOVERY PROJECT, TENNESSEE

EMORY RIVER REACH A
PROBABILITY DISTRIBUTION

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE SELENIUM HAZARD QUOTIENT FOR KILLDEER

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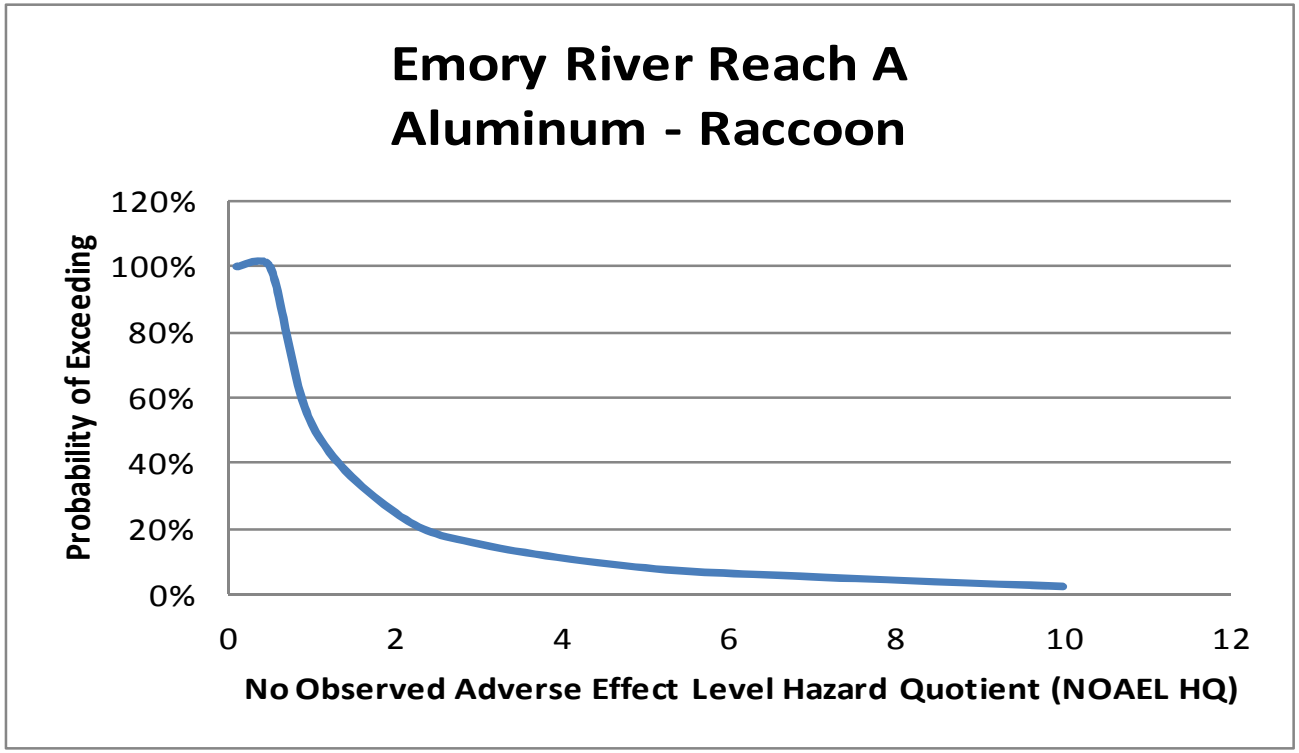
FIGURE
6



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KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE ALUMINUM HAZARD QUOTIENT FOR RACCOON

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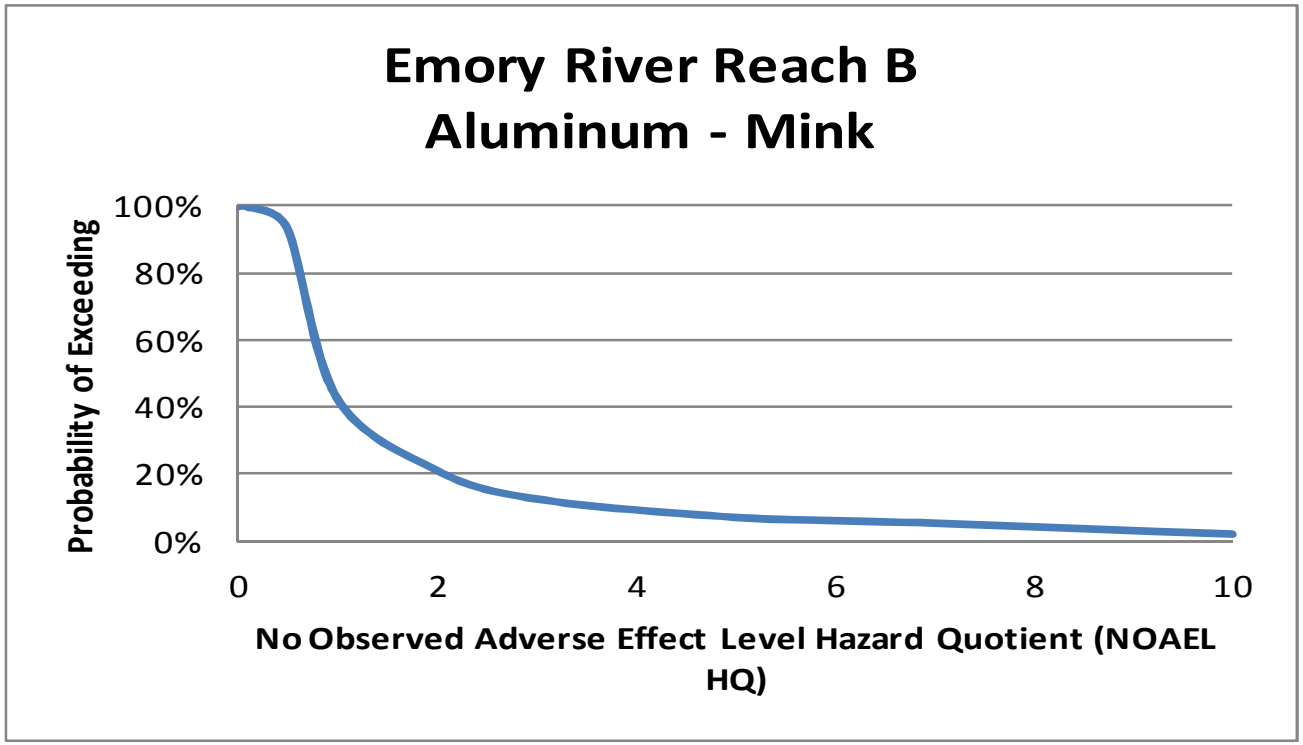
FIGURE
7



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KINGSTON ASH RECOVERY PROJECT, TENNESSEE

EMORY RIVER REACH B
PROBABILITY DISTRIBUTION

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE ALUMINUM HAZARD QUOTIENT FOR MINK

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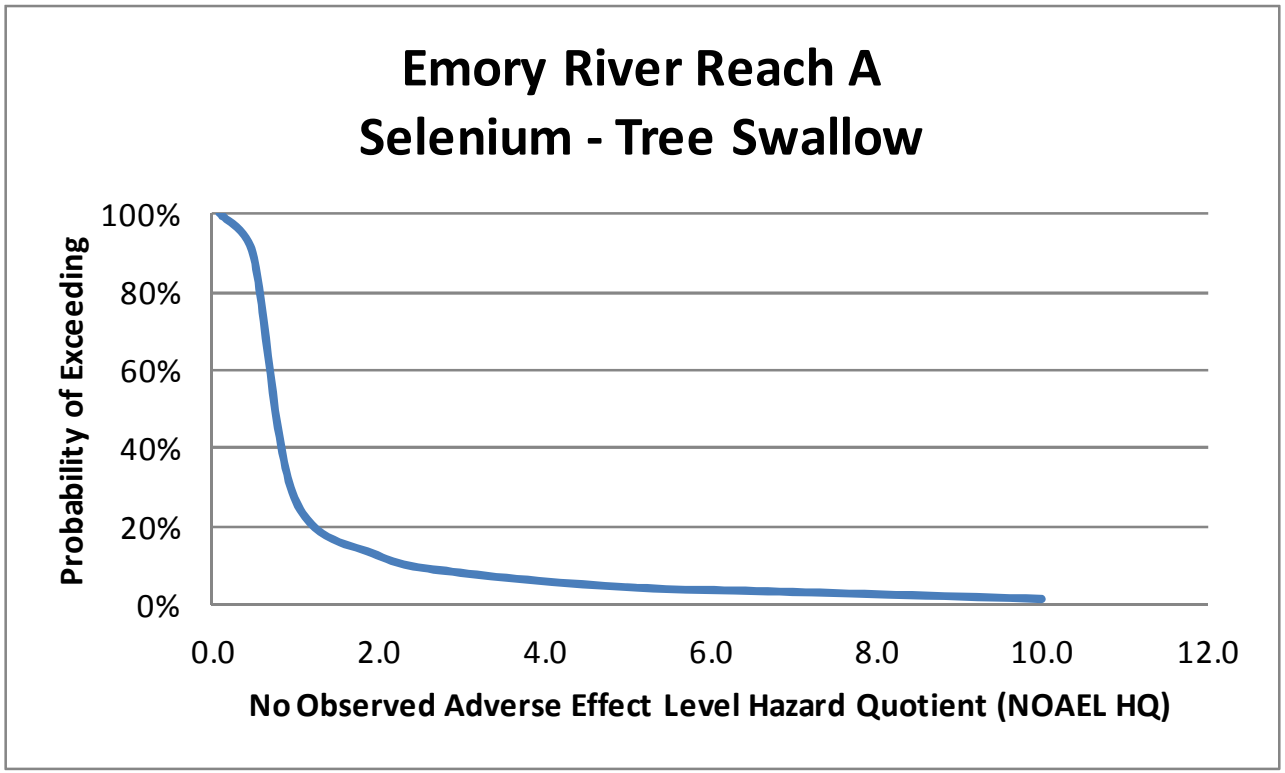
FIGURE
8



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KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A
PROBABILITY DISTRIBUTION

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE SELENIUM HAZARD QUOTIENT FOR TREE SWALLOW

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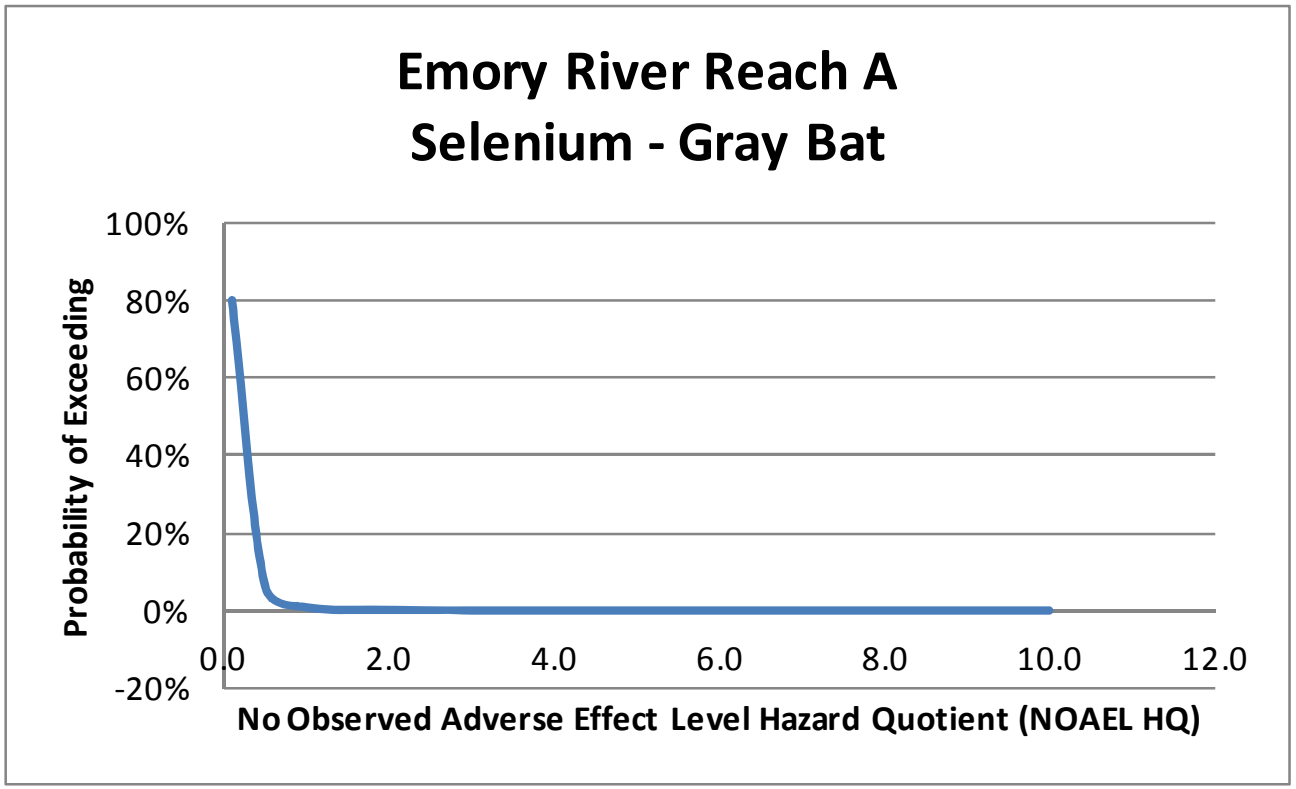
FIGURE
9



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EMORY RIVER REACH A
PROBABILITY DISTRIBUTION

PROBABILITY DISTRIBUTION FOR EXCEEDANCE OF THE SELENIUM HAZARD QUOTIENT FOR GRAY BAT

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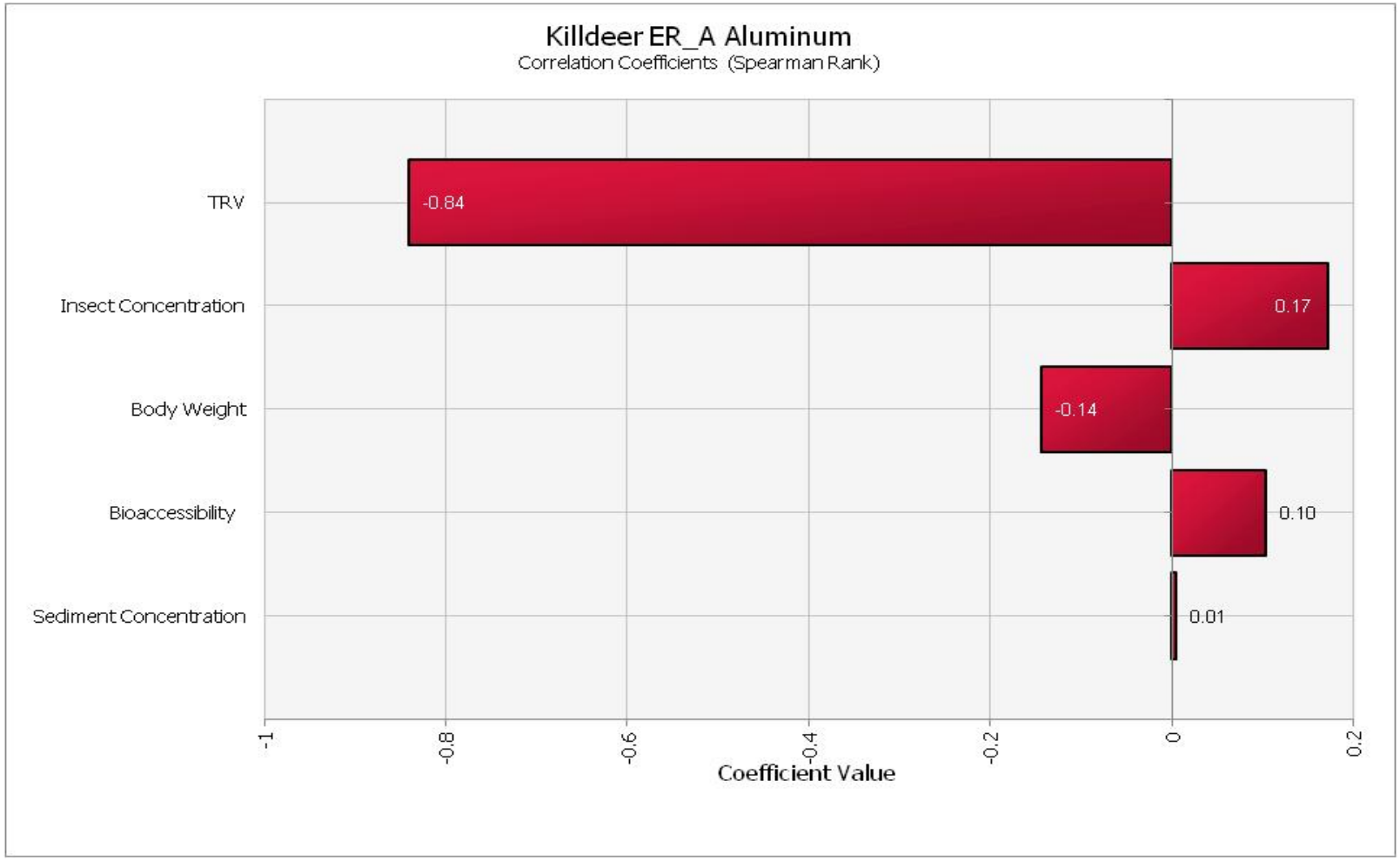
FIGURE
10



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A

Sensitivity Analysis of Relative Influence of Parameters for Killdeer Aluminum Dietary Dose - Emory River Reach A (ER_A)

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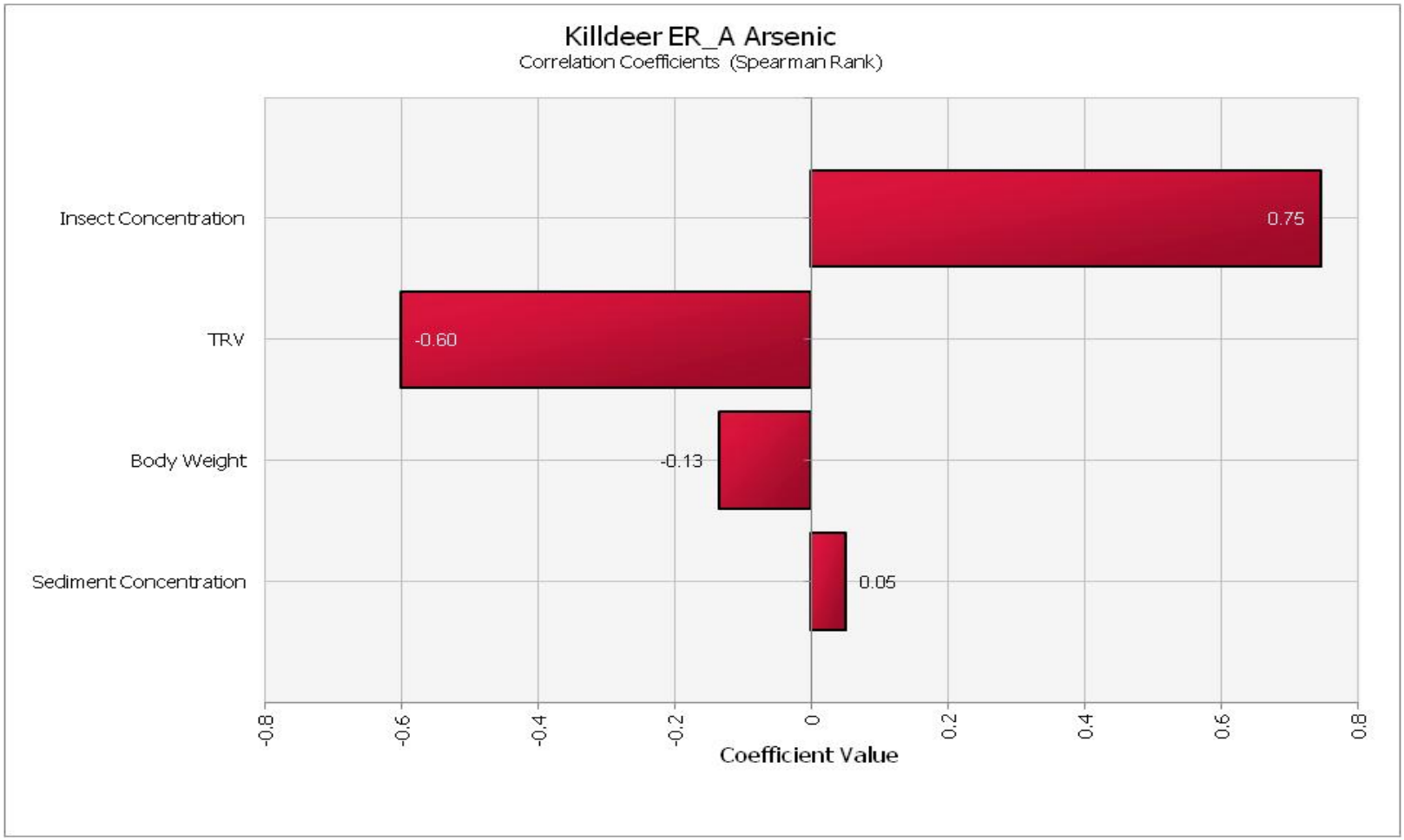
FIGURE
11



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A

Sensitivity Analysis of Relative Influence of Parameters for Killdeer Arsenic Dietary Dose - Emory River Reach A (ER_A)

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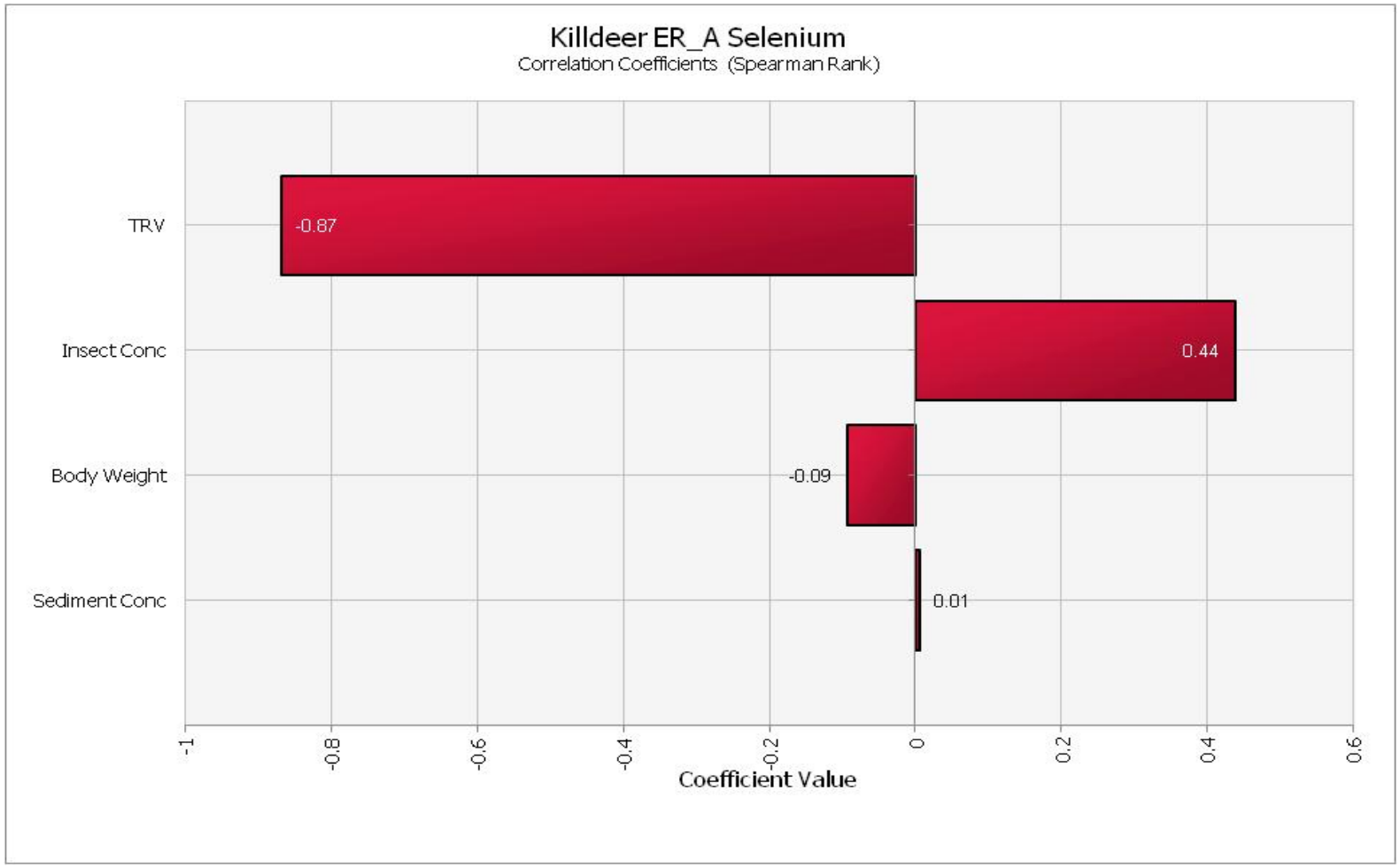
FIGURE
12



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A

Sensitivity Analysis of Relative Influence of Parameters for Killdeer Selenium Dietary Dose - Emory River Reach A (ER_A)

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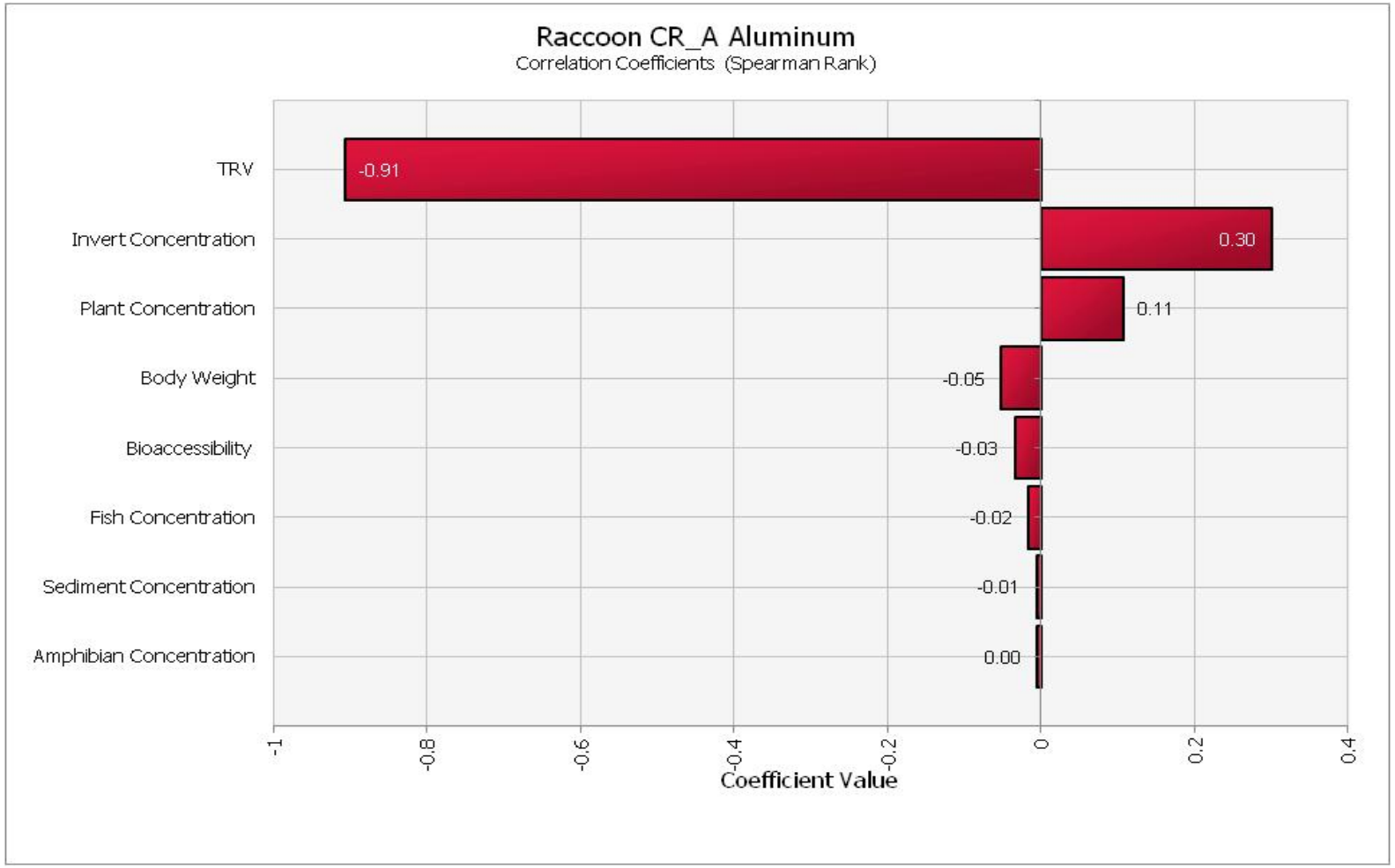
FIGURE
13



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
CLINCH RIVER REACH A

Sensitivity Analysis of Relative Influence of Parameters for Raccoon Aluminum Dietary Dose - Emory River Reach A (ER_A)

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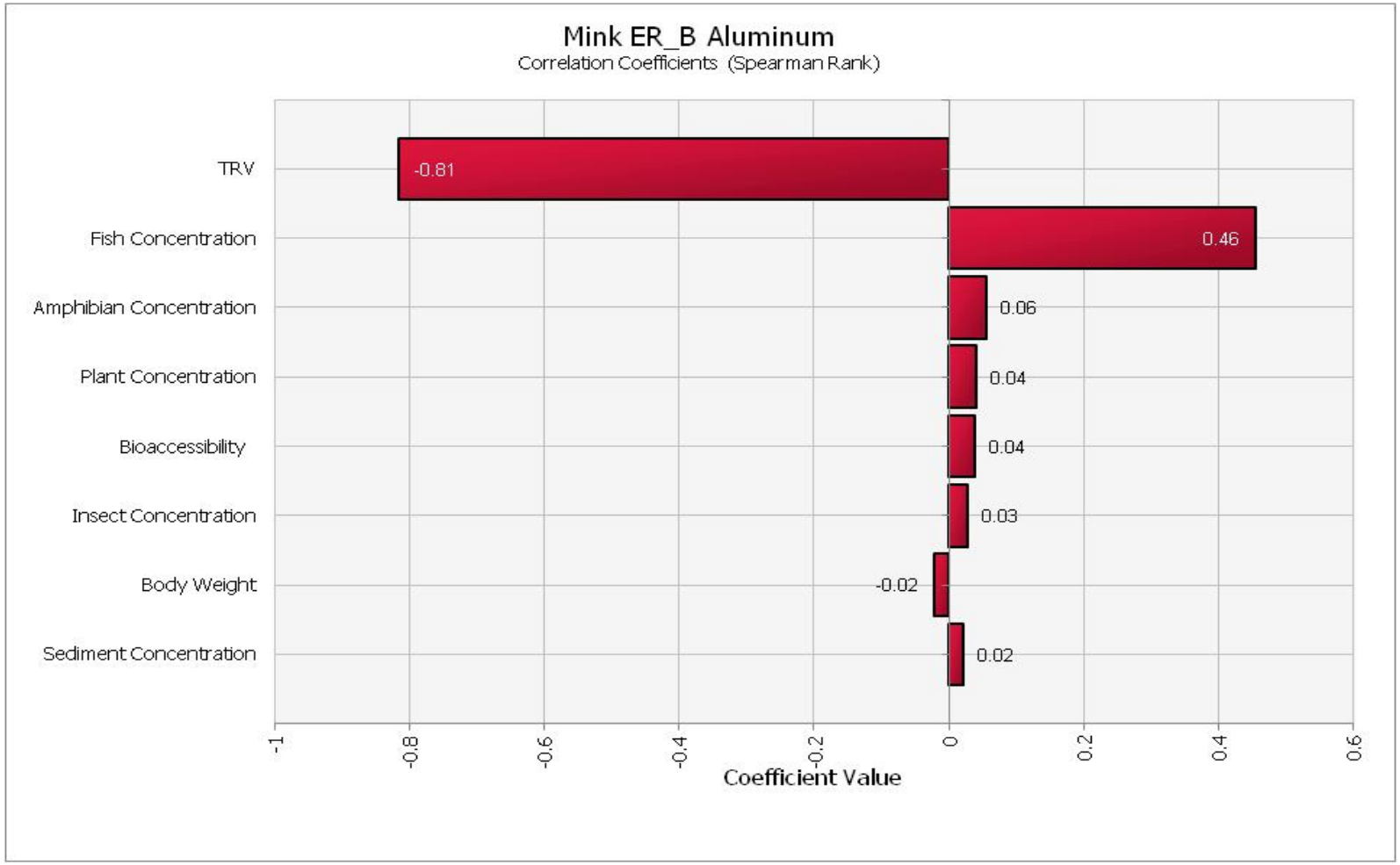
FIGURE
14



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH B

Sensitivity Analysis of Relative Influence of Parameters for Mink Aluminum Dietary Dose - Emory River Reach A (ER_B)

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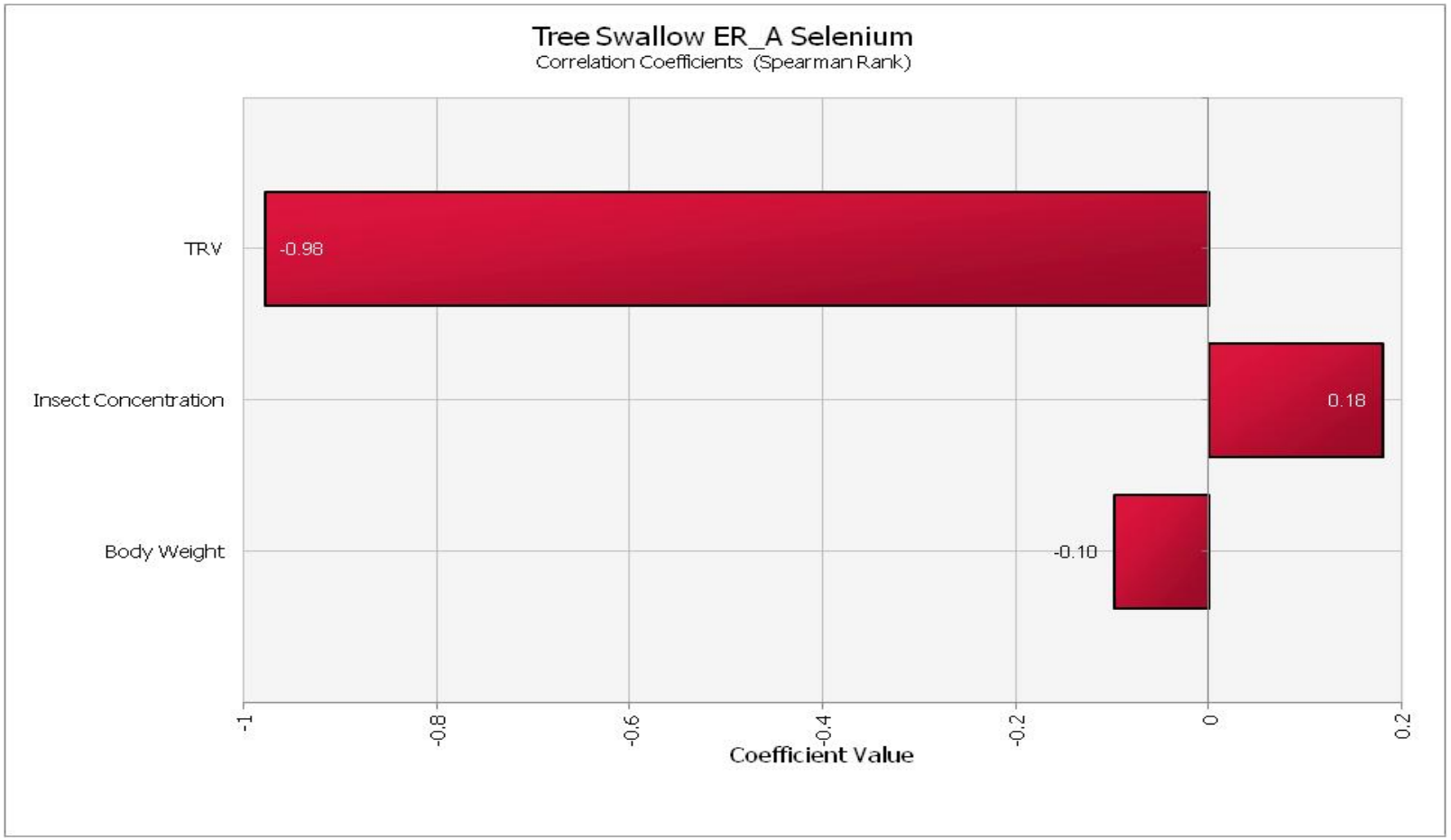
FIGURE
15



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A

Sensitivity Analysis of Relative Influence of Parameters for Tree Swallow Selenium Dietary Dose - Emory River Reach A (ER_A)

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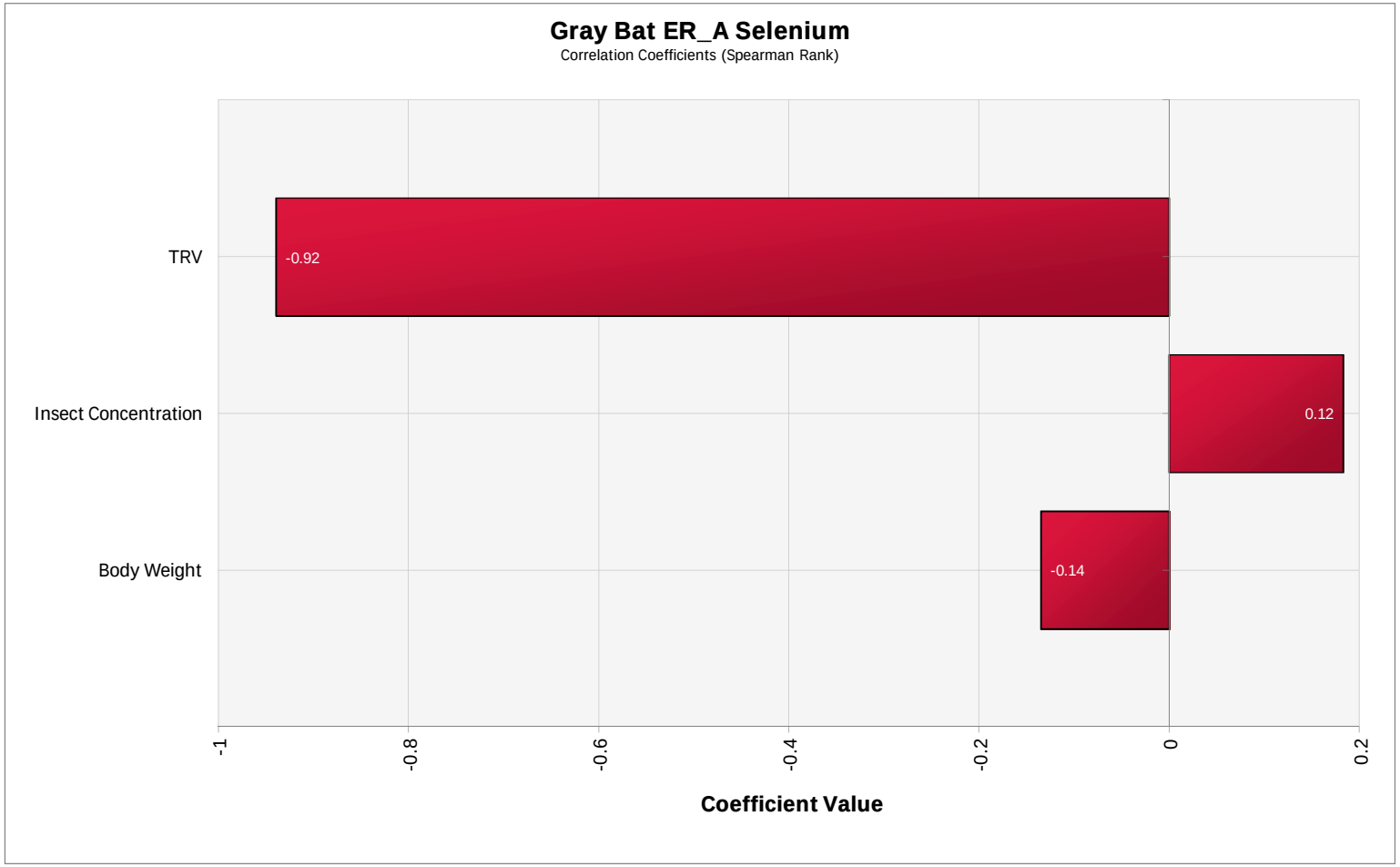
FIGURE
16



TENNESSEE VALLEY AUTHORITY
KINGSTON ASH RECOVERY PROJECT, TENNESSEE
EMORY RIVER REACH A

Sensitivity Analysis of Relative Influence of Parameters for Gray Bat Selenium Dietary Dose - Emory River Reach A (ER_A)

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FIGURE
17

Attachment 1

Aluminum Prey Tissue Data Evaluation

Table 1-1
Larval Mayfly Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plant
Tennessee Valley Authority

Analyte Name	Location Unit	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5
	Species	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010	5/4/2010
	Equis Field Sample ID/ Units	KIF-CRM1.5_MF N.W.C.01-MS-050410	KIF-CRM1.5_MF N.W.C.02-MS-050410	KIF-CRM1.5_MF N.W.C.03-MS-050410	KIF-CRM1.5_MF N.W.C.04-MS-050410	KIF-CRM1.5_MF N.W.C.05-MS-050410	KIF-CRM1.5_MF N.W.C.06-MS-050410	KIF-CRM3.5_MF N.W.C.01-MS-050410	KIF-CRM3.5_MF N.W.C.02-MS-050410	KIF-CRM3.5_MF N.W.C.03-MS-050410	KIF-CRM3.5_MF N.W.C.04-MS-050410	KIF-CRM3.5_MF N.W.C.05-MS-050410	KIF-CRM3.5_MF N.W.C.06-MS-050410
Aluminum	mg/kg	10900	9080	6930	623	453	914	8440	9120	9050	1210	1450	737
Antimony	mg/kg	0.24	0.27	0.19	0.042	<0.029	0.052	0.23	0.25	0.24	0.072	0.075	0.046
Arsenic	mg/kg	13.3	14.6	12.6	4.5	2	4.7	13.6	16.4	13.7	5.3	4.5	3.7
Barium	mg/kg	104	99.8	75.9	17	12.2	20.7	92.5	96.9	94.8	24.5	23.6	18.8
Beryllium	mg/kg	0.84	0.79	0.55	0.051	<0.058	0.082	0.72	0.77	0.73	0.12	0.13	0.058
Boron	mg/kg	8.9	9	6.6	5.4	2.7	3.9	7	7.2	6.2	4.1	3.7	2.2
Cadmium	mg/kg	1.4	2.1	1.1	0.59	1.8	0.89	1.2	0.76	1.1	1.4	1.2	1.1
Calcium	mg/kg	3030	2980	2880	1980	95.37	2410	2780	2760	2950	2530	2510	2400
Chromium	mg/kg	13.4	11.8	8.7	0.98	0.87	1.4	10.8	11.7	11.5	1.9	2.2	1.2
Cobalt	mg/kg	8.3	7.7	5.7	1.1	1.2	1.4	7.4	7.3	7.7	1.6	1.8	1.4
Copper	mg/kg	23.2	23.4	18.6	34.1	32.4	32.6	20.4	20.6	21	30.3	35.1	30
Iron	mg/kg	11900	9540	7180	795	536	1100	9160	9230	9560	1280	1520	908
Lead	mg/kg	10.5	9.2	6.7	2.6	2.3	3.1	8.6	8.7	8.9	3.1	3.3	2.5
Magnesium	mg/kg	1800	1660	1570	1220	1170	1210	1600	1640	1670	1260	1300	1130
Manganese	mg/kg	891	959	733	174	136	213	807	759	782	201	186	215
Mercury	mg/kg	0.31	0.29	0.27	0.087	0.069	0.086	0.3	0.26	0.3	0.084	0.099	0.088
Molybdenum	mg/kg	1.5	1.6	1.6	1.9	1.3	1.9	1.5	1.6	1.6	1.6	1.6	1.4
Nickel	mg/kg	14.1	12.7	9.6	1.5	1.2	1.8	11.9	12.4	12.4	2.3	2.5	1.6
Potassium	mg/kg	5520	5750	6750	9410	9400	9200	6110	<7980	<8310	9010	8980	9050
Selenium	mg/kg	6.5	6.6	6.6	7.1	6.9	7.4	7.1	7.4	6.6	8.3	7.8	7.6
Silver	mg/kg	0.08	0.067	0.054	0.036	0.028	0.033	0.065	0.064	0.061	0.029	0.05	0.022
Sodium	mg/kg	3970	3620	4680	5510	5160	4970	4220	4390	3900	5290	4470	4250
Strontium	mg/kg	29	31	22.9	9	7.3	9.7	26.1	31.1	28.7	12.3	12	9
Thallium	mg/kg	<0.24	<0.33	<0.2	<0.03	<0.039	<0.038	<0.28	<0.31	<0.3	<0.061	<0.061	<0.034
Vanadium	mg/kg	20.7	19.3	13.6	1.7	1.3	2.3	17.1	18.9	18.5	3.1	3.6	2
Zinc	mg/kg	194	188	175	184	224	196	179	172	182	202	205	197

Table 1-1
Larval Mayfly Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plant
Tennessee Valley Authority

Analyte Name	Location Unit	CR_R	CR_R	CR_R	CR_R	CR_R	CR_R	ER_A	ER_A	ER_A	ER_A	ER_A	ER_A
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	CRM6.0	CRM6.0	CRM6.0	CRM6.0	CRM6.0	CRM6.0	ERM1.0	ERM1.0	ERM1.0	ERM1.0	ERM1.0	ERM1.0
	Species	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	5/6/2010	5/6/2010	5/6/2010	6/1/2010	6/1/2010	6/14/2010	5/5/2010	5/5/2010	5/12/2010	5/17/2010	5/17/2010	5/17/2010
	Equis Field Sample ID/ Units	KIF-CRM6.0_MF N.W.C.01-MS-050610	KIF-CRM6.0_MF N.W.C.02-MS-050610	KIF-CRM6.0_MF N.W.C.03-MS-050610	KIF-CRM6.0_MF N.W.C.04-MS-060110	KIF-CRM6.0_MF N.W.C.05-MS-060110	KIF-CRM6.0_MF N.W.C.06-MS-061410	KIF-ERM1.0_MF N.W.C.01-MS-050510	KIF-ERM1.0_MF N.W.C.02-MS-050510	KIF-ERM1.0_MF N.W.C.03-MS-051210	KIF-ERM1.0_MF N.W.C.04-MS-051710	KIF-ERM1.0_MF N.W.C.05-MS-051710	KIF-ERM1.0_MF N.W.C.06-MS-051710
Aluminum	mg/kg	7620	7220	6610	258	316	374	7540	8190	8540	1220	2140	1620
Antimony	mg/kg	0.098	0.093	0.091	<0.021	<0.021	<0.02	0.45	0.53	0.26	0.13	0.23	0.21
Arsenic	mg/kg	5	4.7	5.2	1.5	2.1	2.2	54.5	97	33.5	18.2	34.6	41.6
Barium	mg/kg	59.8	56.9	56.4	6.1	6.8	6.4	138	140	91.3	34	42.7	40.6
Beryllium	mg/kg	0.36	0.33	0.34	<0.079	<0.078	<0.042	0.9	0.96	0.77	0.14	0.25	0.19
Boron	mg/kg	7.9	5.7	6.5	2.6	5.2	6.7	7.2	8.7	5.4	4	3.7	2.4
Cadmium	mg/kg	0.95	0.92	0.74	0.97	1.1	2.1	0.56	1.1	0.24	0.5	0.73	0.24
Calcium	mg/kg	3030	3070	3240	2300	2380	2320	2410	2650	2350	2180	2290	1990
Chromium	mg/kg	9.9	9	9.2	0.52	0.66	0.7	11	12	10.8	1.8	3.3	2.5
Cobalt	mg/kg	6.2	6	5.7	0.93	0.93	1.7	7.4	7.5	8.1	1.5	2.4	1.8
Copper	mg/kg	19.3	19.2	18.3	35.8	37.1	40.4	19.5	21.2	20.4	31.8	41.3	36.8
Iron	mg/kg	9230	8640	8920	412	561	593	8760	9920	11600	1940	3310	3430
Lead	mg/kg	9.8	9.2	9.5	2.8	3	3.2	9.9	10.3	8.6	4	7.2	6.3
Magnesium	mg/kg	1970	1950	1860	1310	1290	1260	1190	1320	1370	1180	1180	1110
Manganese	mg/kg	1040	963	905	91.8	110	138	504	535	482	177	186	216
Mercury	mg/kg	1.1	0.81	1.2	0.16	0.16	0.13	0.095	0.1	0.14	0.046	0.049	0.041
Molybdenum	mg/kg	0.78	0.79	0.67	0.91	0.89	0.92	2.9	2.4	1.6	2.4	3	3.2
Nickel	mg/kg	10.4	9.7	9.6	1.1	1.1	1.2	12.4	12.9	13.3	2.3	3.6	2.9
Potassium	mg/kg	7530	7940	6900	9920	9250	8700	6220	6710	<8370	9210	8590	8650
Selenium	mg/kg	4.6	4.6	4.2	4.5	4	4.1	11.9	11.8	6.3	8.4	8.7	6.9
Silver	mg/kg	<0.095	<0.061	<0.057	0.028	0.027	0.037	<0.047	<0.04	<0.112	<0.022	0.039	0.032
Sodium	mg/kg	5310	5910	5180	5380	5120	3380	4220	4910	4670	6270	5770	5800
Strontium	mg/kg	9.4	8.9	9.2	5	5.3	4	52.3	57.2	27.5	16.5	18.7	17.9
Thallium	mg/kg	<0.11	<0.11	<0.094	<0.04	<0.04	<0.02	0.56	0.52	0.23	<0.058	<0.15	<0.094
Vanadium	mg/kg	11.9	11.2	10.9	0.58	0.7	0.82	22.8	25.5	19.1	3.9	7.4	6.5
Zinc	mg/kg	187	197	168	245	260	324	137	155	146	183	189	179

Table 1-1
Larval Mayfly Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plant
Tennessee Valley Authority

Analyte Name	Location Unit	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_C	ER_C	ER_C	ER_C	ER_C	ER_C
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	ERM2.5	ERM2.5	ERM2.5	ERM2.5	ERM2.5	ERM2.5	ERM4.0	ERM4.0	ERM4.0	ERM4.0	ERM4.0	ERM4.0
	Species	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	5/12/2010	5/12/2010	5/12/2010	5/27/2010	5/27/2010	5/27/2010	5/17/2010	6/16/2010	6/16/2010	6/8/2010	6/8/2010	6/8/2010
	Equis Field Sample ID/ Units	KIF-ERM2.5_MF N.W.C.01-MS-051210	KIF-ERM2.5_MF N.W.C.02-MS-051210	KIF-ERM2.5_MF N.W.C.03-MS-051210	KIF-ERM2.5_MF N.W.C.04-MS-052710	KIF-ERM2.5_MF N.W.C.05-MS-052710	KIF-ERM2.5_MF N.W.C.06-MS-052710	KIF-ERM4.0_MF N.W.C.01-MS-051710	KIF-ERM4.0_MF N.W.C.02-MS-061610	KIF-ERM4.0_MF N.W.C.03-MS-061610	KIF-ERM4.0_MF N.W.C.04-MS-060810	KIF-ERM4.0_MF N.W.C.05-MS-060810	KIF-ERM4.0_MF N.W.C.06-MS-060810
Aluminum	mg/kg	9050	9730	10300	491	525	424	6340	5330	5330	1400	675	1110
Antimony	mg/kg	0.2	0.22	0.22	0.035	0.04	0.036	0.12	0.12	0.11	0.04	0.029	0.04
Arsenic	mg/kg	13.1	17.6	13.9	2.1	3.4	3.3	8.1	6.8	7.2	3.1	2.6	3.6
Barium	mg/kg	84.9	90.8	93	20.1	21.7	20.6	63	54.2	54.3	23.4	17.8	19.6
Beryllium	mg/kg	0.74	0.77	0.88	0.048	<0.11	<0.073	0.5	0.4	0.4	<0.61	0.049	<0.53
Boron	mg/kg	5	<5.8	5.4	1.6	2.7	0.95	3.3	2.8	2.9	<4.2	2.4	<3.7
Cadmium	mg/kg	0.68	0.45	0.6	0.96	0.54	0.58	0.25	0.19	<0.17	0.14	0.07	0.09
Calcium	mg/kg	2200	2210	2240	2030	2170	2180	1930	1860	1880	2040	1800	1930
Chromium	mg/kg	10.9	11.6	12.4	0.86	0.82	0.68	7.2	6.2	6.2	1.7	0.82	1.4
Cobalt	mg/kg	9	8.9	9.8	1.7	1.1	1	6.1	5.2	5.1	1.6	1.4	1.6
Copper	mg/kg	17.8	19.3	19.4	23.3	29	25.6	13.1	11.6	11.5	37.2	32.5	37.6
Iron	mg/kg	10200	11300	11400	728	968	909	9220	6850	6940	2420	1990	2480
Lead	mg/kg	8.8	8.9	9.7	1.6	1.8	1.9	6.3	6.1	5.9	3.2	2.6	3.4
Magnesium	mg/kg	1490	1600	1570	1200	1220	1170	1340	1310	1270	1340	1130	1290
Manganese	mg/kg	520	454	498	129	107	126	407	252	246	129	244	99.6
Mercury	mg/kg	0.078	0.076	0.078	0.049	0.053	0.047	0.071	0.067	0.066	0.063	0.055	0.057
Molybdenum	mg/kg	1.2	1.4	1.2	1.1	1.2	1.1	0.71	0.76	0.76	0.8	0.71	1.1
Nickel	mg/kg	14.1	14.7	15.6	1.1	1.2	0.95	9.6	8.4	8.3	2.4	1.3	2.1
Potassium	mg/kg	<7500	<10200	<9310	9260	9630	9110	7190	6250	6480	9520	9120	9840
Selenium	mg/kg	6.6	7.2	7.2	4.8	5.8	5.9	3.8	5	4.9	3.8	3.3	4.1
Silver	mg/kg	0.037	0.048	<0.124	0.034	0.037	0.034	<0.047	<0.039	<0.033	0.041	0.035	0.038
Sodium	mg/kg	5770	6950	5910	6170	6850	6320	5960	4490	4910	6110	6660	5910
Strontium	mg/kg	22.1	23.8	25	9.8	10.4	9.8	12.7	11.8	12	8.6	5.7	7.7
Thallium	mg/kg	0.21	0.24	0.26	<0.043	<0.032	<0.02	<0.11	<0.12	<0.11	<0.054	<0.028	<0.048
Vanadium	mg/kg	17.3	18.7	19.7	1.3	1.5	1.4	10.7	9.7	9.5	2.7	1.7	2.5
Zinc	mg/kg	174	179	187	229	228	218	153	217	193	232	259	238

Table 1-1
Larval Mayfly Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plant
Tennessee Valley Authority

Analyte Name	Location Unit	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	TR_A	TR_A	TR_A
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	LERM1.0	LERM1.0	LERM1.0	ERM6.0	ERM6.0	ERM6.0	ERM6.0	ERM6.0	ERM6.0	TRM560.8	TRM560.8	TRM560.8
	Species	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body
	Sample Date	6/16/2010	6/16/2010	6/16/2010	6/14/2010	6/15/2010	6/15/2010	6/14/2010	6/14/2010	6/14/2010	6/22/2010	6/22/2010	6/22/2010
	Equis Field Sample ID/ Units	KIF-LERM1.0_MFN.W.C.01-MS-061610	KIF-LERM1.0_MFN.W.C.02-MS-061610	KIF-LERM1.0_MFN.W.C.03-MS-061610	KIF-ERM6.0_MFN.W.C.04-MS-061410	KIF-ERM6.0_MFN.W.C.05-MS-061510	KIF-ERM6.0_MFN.W.C.06-MS-061510	KIF-ERM6.0_MFN.W.C.01-MS-061410	KIF-ERM6.0_MFN.W.C.02-MS-061410	KIF-ERM6.0_MFN.W.C.03-MS-061410	KIF-TRM560.8_MFN.W.C.01-MS-062210	KIF-TRM560.8_MFN.W.C.02-MS-062210	KIF-TRM560.8_MFN.W.C.03-MS-062210
Aluminum	mg/kg	4370	4550	4090	4350	5910	6380	502	1380	689	10400	8060	10900
Antimony	mg/kg	0.085	0.082	0.074	0.057	0.071	0.073	<0.022	0.024	<0.022	0.16	0.15	0.16
Arsenic	mg/kg	3.6	4.5	3.6	3	2.8	3.2	0.85	1.1	0.9	11	9.3	10.6
Barium	mg/kg	49.7	58.6	47.8	43.2	50.2	55.1	9.6	16.4	9.3	84.7	66.1	86.2
Beryllium	mg/kg	0.2	0.23	0.19	0.22	0.28	0.29	<0.045	0.072	<0.044	0.56	0.44	0.66
Boron	mg/kg	3.1	3.5	3.2	2.5	2.7	4	2.2	1.9	2	5.3	<3.8	5.6
Cadmium	mg/kg	2	0.92	2.4	0.61	0.45	0.35	0.91	0.46	0.87	0.76	1.6	0.94
Calcium	mg/kg	1700	1640	1590	1630	1710	1550	1750	1610	1440	2600	2370	2710
Chromium	mg/kg	5	5.2	4.5	4.6	6.2	6.8	0.69	1.5	0.81	11.7	9.3	12.2
Cobalt	mg/kg	7.2	6.2	6.1	4.1	5.1	4.9	1.4	2.2	1.8	7.8	6.7	7.8
Copper	mg/kg	11.2	12.8	10.8	9.5	10.3	10.6	31.8	30.1	33.1	21.3	19.7	21.7
Iron	mg/kg	6450	7200	5930	6090	7710	8430	810	2010	1070	11600	9040	11700
Lead	mg/kg	4.8	5	4.5	5.2	6.1	6.8	2	2.8	2.3	10.1	8	10.4
Magnesium	mg/kg	1310	1170	1200	1030	1280	1170	1080	1140	1080	1920	1840	1930
Manganese	mg/kg	1370	1170	1380	378	441	430	102	214	122	1430	1190	1500
Mercury	mg/kg	0.059	0.052	0.066	0.055	0.061	0.06	0.043	0.048	0.039	0.17	0.14	0.17
Molybdenum	mg/kg	0.72	0.71	0.72	0.53	0.5	0.5	0.55	0.52	0.54	0.93	0.93	0.97
Nickel	mg/kg	7.1	7.4	6.7	5.3	7	6.7	1.1	2.1	1.2	10.5	8.4	10.8
Potassium	mg/kg	6200	5680	5920	5650	5960	5580	8910	8540	8300	<7120	7040	<7430
Selenium	mg/kg	3.9	4.2	3.7	3.2	2.7	2.6	2.3	2.7	2.2	5.9	4.9	5.6
Silver	mg/kg	0.14	0.14	0.16	0.038	0.032	0.03	0.05	0.042	0.051	0.077	0.043	0.064
Sodium	mg/kg	4240	4320	4090	4620	4770	4040	4350	4220	3810	5720	4920	5430
Strontium	mg/kg	4.9	5.5	4.5	5.8	6.7	6.4	3.8	3.7	2.7	20.4	17.3	20.9
Thallium	mg/kg	<0.053	<0.052	<0.053	<0.057	<0.073	<0.073	<0.021	<0.017	<0.021	0.15	0.13	0.16
Vanadium	mg/kg	7.2	7.4	6.7	6.7	8.6	9.4	0.85	2.1	1.1	17.5	14	18.3
Zinc	mg/kg	303	218	316	173	191	167	254	255	243	218	292	243

Table 1-1
Larval Mayfly Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plant
Tennessee Valley Authority

Analyte Name	Location Unit	TR_B	TR_B	TR_B	TR_B	TR_B	TR_B	TR_R	TR_R	TR_R	TR_R	TR_R	TR_R
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	TRM566.3	TRM566.3	TRM566.3	TRM566.3	TRM566.3	TRM566.3	TRM571.9	TRM571.9	TRM571.9	TRM571.9	TRM571.9	TRM571.9
	Species	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph	Mayfly Nymph
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	5/11/2010	5/11/2010	5/11/2010	5/27/2010	5/27/2010	5/27/2010	5/10/2010	5/10/2010	5/10/2010	5/24/2010	5/24/2010	5/24/2010
	Equis Field Sample ID/ Units	KIF-TRM566.3_MFN.W.C.01-MS-051110	KIF-TRM566.3_MFN.W.C.02-MS-051110	KIF-TRM566.3_MFN.W.C.03-MS-051110	KIF-TRM566.3_MFN.W.C.04-MS-052710	KIF-TRM566.3_MFN.W.C.05-MS-052710	KIF-TRM566.3_MFN.W.C.06-MS-052710	KIF-TRM571.9_MFN.W.C.01-MS-051010	KIF-TRM571.9_MFN.W.C.02-MS-051010	KIF-TRM571.9_MFN.W.C.03-MS-051010	KIF-TRM571.9_MFN.W.C.04-MS-052410	KIF-TRM571.9_MFN.W.C.05-MS-052410	KIF-TRM571.9_MFN.W.C.06-MS-052410
Aluminum	mg/kg	9250	9480	10700	780	589	313	6710	8350	9420	1730	1010	767
Antimony	mg/kg	0.16	0.17	0.18	0.029	0.022	0.022	0.078	0.091	0.1	0.036	0.029	0.025
Arsenic	mg/kg	9.1	9.4	10.4	2.2	1.7	1.6	4.4	5.8	6	1.8	1.1	1.4
Barium	mg/kg	73.1	82.8	87.6	10.4	8.3	7	58.1	73.7	87	15.6	10.4	10
Beryllium	mg/kg	0.42	0.49	0.62	<0.096	<0.083	<0.087	0.29	0.35	0.4	0.069	<0.053	<0.043
Boron	mg/kg	7.4	6.6	6.9	4.7	2.6	2.7	2.2	3.3	3.4	2.4	1.6	1.8
Cadmium	mg/kg	1.7	0.96	1.5	1.5	3	2.5	1.1	1.3	1.2	1.5	2.1	1.7
Calcium	mg/kg	2570	2470	2710	2030	1850	2140	1930	2180	2280	2230	2090	2360
Chromium	mg/kg	10.8	10.6	12.1	1.2	1.1	0.64	7.5	9.2	10.6	2.1	1.4	1.1
Cobalt	mg/kg	6.3	6.4	7.2	1.4	1.5	1.6	4.4	5.4	6	1.7	1.7	1.3
Copper	mg/kg	20.7	20.2	21.4	32.7	29.3	27.7	12	13.8	15	24.9	28.2	27.3
Iron	mg/kg	10300	10400	11400	913	733	399	8290	10400	12000	2270	1360	965
Lead	mg/kg	9	8.9	10.1	2.3	2.9	2.9	8.3	10.5	12.1	4.7	4.6	3.6
Magnesium	mg/kg	1810	1720	1900	1180	1170	1190	1440	1600	1750	1150	1130	1110
Manganese	mg/kg	979	1460	1390	153	89.5	75.9	861	1540	1390	321	181	153
Mercury	mg/kg	0.13	0.11	0.13	0.045	0.036	0.041	0.051	0.057	0.066	0.039	0.04	0.032
Molybdenum	mg/kg	0.88	1.3	1.1	0.79	0.61	0.82	0.51	0.56	0.69	0.5	0.51	0.56
Nickel	mg/kg	9.3	9.4	10.6	1.3	1.1	0.82	5.7	7.1	8	1.8	1.3	1.1
Potassium	mg/kg	<9620	<10200	<8950	8990	8730	9060	6170	5950	5840	7970	9190	7990
Selenium	mg/kg	5.6	6	5.8	3.7	3.3	3.9	4	4.7	4.8	2.3	2.3	2
Silver	mg/kg	<0.128	<0.136	0.039	<0.027	0.03	<0.024	<0.055	<0.069	<0.063	0.046	0.051	0.045
Sodium	mg/kg	6170	5400	5290	3700	3590	4850	3620	3360	3230	4170	3800	3720
Strontium	mg/kg	19.5	20.2	22.4	5.2	4.5	5	7.2	8.7	8.9	4.5	3.9	4.7
Thallium	mg/kg	<0.15	<0.16	0.19	<0.022	<0.019	<0.032	<0.083	<0.11	<0.1	<0.027	<0.025	<0.02
Vanadium	mg/kg	16.2	16.3	18.4	1.5	1.2	0.72	10.7	13.3	15.1	2.7	1.7	1.3
Zinc	mg/kg	240	193	229	275	353	317	211	212	214	308	354	306

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A	CR_A
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5	CRM1.5
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	4/12/2010	4/12/2010	4/12/2010	12/21/2010	12/21/2010	12/21/2010	4/12/2010	4/12/2010	4/12/2010	12/21/2010	12/21/2010	12/21/2010	12/21/2010
	Equis Field Sample ID/ Units	KIF-CRM1.5_GZ.W.C.01-FH-041210	KIF-CRM1.5_GZ.W.C.02-FH-041210	KIF-CRM1.5_GZ.W.C.03-FH-041210	KIF-CRM1.5_GZ.W.C.07-FH-122110-A	KIF-CRM1.5_GZ.W.C.08-FH-122110-A	KIF-CRM1.5_GZ.W.C.09-FH-122110-A	KIF-CRM1.5_GZ.G.C.04-FH-041210	KIF-CRM1.5_GZ.G.C.05-FH-041210	KIF-CRM1.5_GZ.G.C.06-FH-041210	KIF-CRM1.5_GZ.G.C.01-FH-122110-A	KIF-CRM1.5_GZ.G.C.02-FH-122110-A	KIF-CRM1.5_GZ.G.C.03-FH-122110-A	KIF-CRM1.5_GZ.G.C.04-FH-122110-A
Aluminum	mg/kg	441	1010	807	2429	3074	1662	51.1	153	601	132	55.09	130	24.79
Antimony	mg/kg	<0.065	0.064	<0.067	0.09217	0.107	0.06481	<0.064	<0.066	<0.061	<0.06667	<0.06481	<0.07246	<0.06303
Arsenic	mg/kg	1.6	2	2.5	4.608	5.116	3.657	0.84	1.1	1.6	1.689	1.296	1.546	1.723
Barium	mg/kg	18.1	25.4	21.4	41.94	43.26	31.48	17.5	18.7	24.9	16.44	13.43	14.98	13.03
Beryllium	mg/kg	<0.541	<0.493	<0.278	0.2304	0.2698	0.162	<0.531	<0.546	<0.501	<0.2756	<0.2718	<0.2942	<0.2584
Boron	mg/kg	<3.7	<3.4	<1.9	1.982	95.37	<1.806	<3.7	<3.8	<3.5	<1.911	<1.898	<2.029	<1.807
Cadmium	mg/kg	0.068	0.09	0.087	0.07373	0.06512	0.0463	0.037	0.039	0.077	0.04889	<0.06991	<0.07585	<0.06639
Calcium	mg/kg	53900	47300	46800	47465	32512	40556	52300	60800	50100	40444	40231	42995	40252
Chromium	mg/kg	<1.1	1.6	1.7	4.009	4.651	2.778	<1.1	<1.2	1.5	<0.5778	<0.5556	<0.628	<0.5462
Cobalt	mg/kg	0.47	0.74	0.69	1.889	2.047	1.296	0.16	0.24	0.53	0.2622	0.2315	0.2415	0.1975
Copper	mg/kg	5.4	6.4	5.6	14.75	13.49	10.65	3	4	6.4	6.667	4.63	6.28	4.118
Iron	mg/kg	448	929	863	1355	1395	1162	<107	185	627	121.3	95.37	124.2	70.17
Lead	mg/kg	0.75	1.3	1.2	2.949	3.209	1.806	0.32	0.48	0.91	0.3911	0.2222	0.285	0.2437
Magnesium	mg/kg	1630	1660	1690	1585	1498	1542	1550	1740	1690	1253	1338	1348	1340
Manganese	mg/kg	141	140	152	326.7	287	241.2	142	159	124	182.7	150.9	165.2	124.8
Mercury	mg/kg	0.06	0.11	0.095	0.1475	0.1395	0.08796	<0.051	0.067	0.019	<0.05333	<0.05093	<0.05797	<0.05042
Molybdenum	mg/kg	<0.16	<0.15	<0.16	0.1613	0.1814	<0.1528	<0.16	<0.16	<0.15	<0.16	<0.162	<0.1739	<0.1513
Nickel	mg/kg	1.2	1.4	1.3	12.44	4.14	2.315	<0.87	<0.89	1.2	0.6667	<0.4444	0.8213	<0.4202
Potassium	mg/kg	12800	13400	13900	10553	11209	11157	12100	13000	12000	8889	9444	9614	10042
Selenium	mg/kg	2	2.5	2.5	3.18	3.442	3.426	1.7	1.8	3.1	2.8	2.315	2.85	2.479
Silver	mg/kg	0.015	0.014	<0.013	0.01889	0.0386	0.01528	<0.013	<0.013	<0.012	<0.01333	<0.01296	<0.01401	<0.01261
Sodium	mg/kg	5210	4690	5070	4318	4502	4449	4840	5270	4890	3787	4083	4000	3601
Strontium	mg/kg	37.3	40.2	37.4	46.54	40.93	45.83	42.8	46.5	42.3	36.89	31.48	36.71	36.55
Thallium	mg/kg	<0.1	<0.14	<0.11	<0.1567	<0.1442	<0.1296	<0.077	<0.1	<0.11	<0.06222	<0.09259	<0.06763	<0.05882
Vanadium	mg/kg	1.1	2.7	2.2	5.991	6.977	3.935	<0.41	<0.42	1.8	0.4889	0.2824	0.4831	0.2899
Zinc	mg/kg	85.4	79.2	73.7	130.9	117.7	122.7	76.8	81.6	79	134.2	103.2	113	105.5

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	CR_A	CR_A	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B	CR_B
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	CRM1.5	CRM1.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM3.5
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	12/21/2010	12/21/2010	6/15/2010	6/15/2010	6/15/2010	12/21/2010	12/21/2010	12/21/2010	6/15/2010	6/15/2010	6/15/2010	12/15/2010	12/15/2010
	Equis Field Sample ID/ Units	KIF-CRM1.5_GZ.G.C.05-FH-122110-A	KIF-CRM1.5_GZ.G.C.06-FH-122110-A	KIF-CRM3.5_GZ.W.C.01-FH-061510	KIF-CRM3.5_GZ.W.C.02-FH-061510	KIF-CRM3.5_GZ.W.C.03-FH-061510	KIF-CRM3.5_GZ.W.C.07-FH-122110-A	KIF-CRM3.5_GZ.W.C.08-FH-122110-A	KIF-CRM3.5_GZ.W.C.09-FH-122110-A	KIF-CRM3.5_GZ.G.C.04-FH-061510	KIF-CRM3.5_GZ.G.C.05-FH-061510	KIF-CRM3.5_GZ.G.C.06-FH-061510	KIF-CRM3.5_GZ.G.C.01-FH-121510-A	KIF-CRM3.5_GZ.G.C.02-FH-121510-A
Aluminum	mg/kg	27.73	30.25	1560	1340	934	602.7	636.4	683.7	193	215	177	56.43	30.93
Antimony	mg/kg	<0.06364	<0.05882	0.084	0.065	<0.058	<0.05936	<0.06364	<0.06047	<0.058	<0.055	<0.052	<0.05809	<0.05508
Arsenic	mg/kg	1.545	1.008	3.1	2.5	1.9	2.74	2.864	2.744	1.4	1.3	1.3	0.9129	0.7203
Barium	mg/kg	14.09	11.76	25.7	19.6	22	16.89	18.18	19.53	16.2	13	15.8	12.03	13.14
Beryllium	mg/kg	<0.2595	<0.2483	0.13	0.1	<0.12	<0.1233	<0.1318	<0.1256	<0.23	<0.22	<0.21	<0.1203	<0.1144
Boron	mg/kg	<1.818	<1.723	<1.6	<1.4	<1.7	<1.735	<1.864	<1.721	<3.3	<3.2	<3	<1.701	<1.653
Cadmium	mg/kg	<0.06682	<0.06387	0.094	0.059	0.051	0.05023	0.05455	0.06047	<0.061	<0.059	<0.055	<0.03112	<0.03008
Calcium	mg/kg	45318	48739	37400	38800	41700	38813	39500	44186	62800	54500	69900	61411	52119
Chromium	mg/kg	<0.5455	<0.5462	4.2	4.1	2.3	1.142	1.273	1.256	<1	<0.97	<0.91	<0.5394	<0.5085
Cobalt	mg/kg	0.2	0.1681	1.6	1.3	0.79	0.6849	0.6818	0.7907	0.3	0.29	0.24	0.2033	0.1525
Copper	mg/kg	8.636	2.563	7.9	8	5.1	7.306	9.545	7.907	3	4.1	3.6	2.863	8.898
Iron	mg/kg	80.45	92.44	1870	1430	1010	616.4	663.6	702.3	254	357	255	123.7	103.8
Lead	mg/kg	0.1955	0.2101	3.2	2.9	1.2	0.6849	0.8636	0.7907	0.56	0.5	0.48	0.2324	0.6356
Magnesium	mg/kg	1400	1391	1590	1460	1500	1333	1286	1381	1810	1570	1660	1494	1483
Manganese	mg/kg	134.5	94.12	233	180	135	133.8	137.7	157.2	150	124	152	109.1	72.88
Mercury	mg/kg	0.05455	0.05042	0.11	0.079	0.088	0.05479	<0.05	<0.04651	<0.046	0.049	0.054	0.05394	0.05932
Molybdenum	mg/kg	<0.1545	<0.1471	0.19	0.15	<0.14	<0.1461	<0.1591	<0.1488	<0.14	<0.13	<0.13	<0.1452	<0.1398
Nickel	mg/kg	0.5455	<0.4076	2.3	5.7	1.4	1.05	1.455	1.163	<0.78	<0.74	<0.7	<0.4025	<0.3856
Potassium	mg/kg	11000	10882	11000	9860	11100	11507	11227	11674	11200	11000	9610	9793	9703
Selenium	mg/kg	2.364	1.891	1.9	2.1	1.6	3.196	3.227	3.349	1.5	1.6	1.6	1.66	2.373
Silver	mg/kg	<0.01273	<0.01218	0.014	<0.0095	<0.012	0.01507	0.01591	0.01442	<0.012	<0.011	<0.01	<0.01203	<0.01144
Sodium	mg/kg	3968	4126	3150	3020	3090	4489	4332	4744	3630	3580	3630	3581	3585
Strontium	mg/kg	45.91	33.19	31.1	29.3	33.2	36.07	39.55	42.79	41.2	33.8	43.3	38.17	32.63
Thallium	mg/kg	<0.05909	<0.05882	<0.16	<0.082	<0.089	<0.1123	<0.1214	<0.113	<0.055	<0.053	<0.05	<0.05809	<0.05508
Vanadium	mg/kg	0.2818	0.2731	3.8	2.9	2.2	1.826	1.955	2.047	0.52	0.61	0.73	0.3651	0.3559
Zinc	mg/kg	96.36	71.43	70.3	66.4	50.2	108.7	107.3	111.2	66.3	70.4	63.2	76.35	68.64

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	CR_B	CR_B	CR_B	CR_B	CR_R	CR_R	CR_R	CR_R	CR_R	CR_R	CR_R	CR_R	CR_R
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	CRM3.5	CRM3.5	CRM3.5	CRM3.5	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	12/15/2010	12/21/2010	12/21/2010	12/21/2010	4/13/2010	4/13/2010	4/13/2010	12/20/2010	12/20/2010	12/20/2010	4/13/2010	4/13/2010	4/13/2010
	Equis Field Sample ID/ Units	KIF-CRM3.5_GZ.G.C.03-FH-121510-A	KIF-CRM3.5_GZ.G.C.04-FH-122110-A	KIF-CRM3.5_GZ.G.C.05-FH-122110-A	KIF-CRM3.5_GZ.G.C.06-FH-122110-A	KIF-CRM8.0_GZ.W.C.01-FH-041310	KIF-CRM8.0_GZ.W.C.02-FH-041310	KIF-CRM8.0_GZ.W.C.03-FH-041310	KIF-CRM8.0_GZ.W.C.07-FH-122010-A	KIF-CRM8.0_GZ.W.C.08-FH-122010-A	KIF-CRM8.0_GZ.W.C.09-FH-122010-A	KIF-CRM8.0_GZ.G.C.04-FH-041310	KIF-CRM8.0_GZ.G.C.05-FH-041310	KIF-CRM8.0_GZ.G.C.06-FH-041310
Aluminum	mg/kg	219.5	35.54	49.79	47.11	440	645	370	101.7	181.5	201.4	<16.7	<87.7	<32.1
Antimony	mg/kg	<0.06364	<0.05785	<0.06173	<0.06667	<0.069	<0.066	<0.065	<0.0641	<0.06306	<0.06364	<0.06	<0.064	<0.058
Arsenic	mg/kg	0.8182	1.116	1.029	1.867	1.9	1.8	2.1	1.88	1.982	1.955	1.1	1.2	1.4
Barium	mg/kg	15	8.678	11.52	15.11	21.5	17.6	17.5	10.68	15.32	12.73	<0.19	18.8	18.3
Beryllium	mg/kg	<0.1318	<0.2434	<0.1235	<0.1333	<0.14	<0.13	<0.13	<0.1282	<0.1261	<0.1318	<0.12	<0.13	<0.12
Boron	mg/kg	<1.864	<1.694	<1.728	<1.867	<2	<1.9	<1.9	<1.838	<1.802	<1.864	<1.7	<1.8	<1.7
Cadmium	mg/kg	<0.03409	<0.06281	<0.0321	<0.03422	0.061	0.063	0.059	0.04701	0.04054	0.05	<0.032	<0.034	<0.03
Calcium	mg/kg	54545	40620	51029	55556	65500	57600	53800	36325	63514	43045	638	64300	71200
Chromium	mg/kg	<0.5455	<0.5372	<0.535	<0.5778	1	2	0.87	<0.5556	<0.5405	<0.5909	<0.53	<0.56	<0.51
Cobalt	mg/kg	0.2636	0.1653	0.1852	0.2444	0.51	0.6	0.45	0.312	0.3514	0.3773	<0.059	0.21	0.2
Copper	mg/kg	3.318	3.595	4.527	3.689	9.9	4.7	4	5.556	7.207	10	1.5	3.2	3.2
Iron	mg/kg	259.1	95.45	192.6	91.56	478	712	434	166.7	236.9	260.5	71	150	95.6
Lead	mg/kg	0.3545	0.2107	0.284	0.2667	0.85	1.1	0.57	0.2564	0.4009	0.4545	<0.12	0.3	0.31
Magnesium	mg/kg	1577	1281	1444	1516	1900	1840	1730	1265	1401	1364	1300	1820	1880
Manganese	mg/kg	99.09	78.93	93	144.9	203	181	178	117.5	155.4	128.6	1.1	174	182
Mercury	mg/kg	<0.05	0.04959	0.05761	<0.05333	0.11	0.1	0.066	<0.05128	<0.04955	<0.05	0.18	0.071	0.061
Molybdenum	mg/kg	<0.1545	<0.1446	<0.1481	<0.16	<0.17	<0.16	<0.16	<0.1538	<0.1532	<0.1591	<0.15	<0.16	<0.14
Nickel	mg/kg	<0.4364	<0.3967	0.6996	<0.44	4.4	1.3	0.61	<0.4274	<0.4189	<0.4409	<0.41	<0.43	<0.39
Potassium	mg/kg	10545	11240	11687	11200	13500	13000	13400	11368	11802	12227	17400	11800	12600
Selenium	mg/kg	2.409	1.653	2.428	2.267	3.2	2.9	3.5	2.607	2.432	2.864	2	2.3	2
Silver	mg/kg	<0.01273	<0.01198	<0.01235	<0.01289	<0.014	<0.013	<0.013	<0.01282	0.01441	<0.01318	<0.012	<0.013	<0.012
Sodium	mg/kg	4145	3488	4156	4164	5830	5520	5760	4444	4955	4864	1420	5020	5370
Strontium	mg/kg	32.73	25.21	31.28	49.78	54.9	41.3	40.1	32.91	58.56	35.91	0.36	47.1	48.7
Thallium	mg/kg	<0.05909	<0.05785	<0.1136	<0.1218	<0.066	<0.071	<0.062	<0.05983	<0.05856	<0.06364	<0.057	<0.061	<0.055
Vanadium	mg/kg	0.7273	0.2231	0.3292	0.4444	1.2	1.5	1	0.3718	0.5856	0.5455	<0.19	0.38	0.36
Zinc	mg/kg	71.82	59.92	68.31	106.7	95.4	85.9	82.5	109	107.2	108.2	46.7	80.1	83.2

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	CR_R	CR_R	CR_R	CR_R	CR_R	CR_R	ER_A	ER_A	ER_A	ER_A	ER_A	ER_A	ER_B
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0	CRM8.0	ERM0.9	ERM0.9	ERM0.9	ERM0.9	ERM0.9	ERM0.9	ERM2.5
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body
	Sample Date	12/20/2010	12/20/2010	12/20/2010	12/20/2010	12/20/2010	12/20/2010	4/7/2010	4/7/2010	4/7/2010	4/7/2010	4/7/2010	4/7/2010	12/20/2010
	Equis Field Sample ID/ Units	KIF-CRM8.0_GZ.G.C.01-FH-122010-A	KIF-CRM8.0_GZ.G.C.02-FH-122010-A	KIF-CRM8.0_GZ.G.C.03-FH-122010-A	KIF-CRM8.0_GZ.G.C.04-FH-122010-A	KIF-CRM8.0_GZ.G.C.05-FH-122010-A	KIF-CRM8.0_GZ.G.C.06-FH-122010-A	KIF-ERM0.9_GZ.W.C.01-FH-040710	KIF-ERM0.9_GZ.W.C.02-FH-040710	KIF-ERM0.9_GZ.W.C.03-FH-040710	KIF-ERM0.9_GZ.G.C.04-FH-040710	KIF-ERM0.9_GZ.G.C.05-FH-040710	KIF-ERM0.9_GZ.G.C.06-FH-040710	KIF-ERM2.5_GZ.W.C.04-FH-122010-A
Aluminum	mg/kg	38.91	31.44	23.32	58.02	24.29	40.09	1970	1700	1670	272	218	295	44.91
Antimony	mg/kg	<0.06787	<0.06114	<0.06278	<0.05761	<0.06073	<0.06034	<0.066	<0.064	<0.065	<0.059	<0.064	<0.069	<0.06944
Arsenic	mg/kg	1.538	1.659	1.57	1.235	1.093	1.034	2.1	2	2	1.4	1.3	1.3	2.222
Barium	mg/kg	12.67	13.97	12.56	15.64	13.36	15.09	31.3	30	32	24.2	23.7	20.4	13.43
Beryllium	mg/kg	<0.1403	<0.1223	<0.1256	<0.1152	<0.1215	<0.1207	<0.14	<0.13	<0.13	<0.12	<0.13	<0.14	<0.287
Boron	mg/kg	<1.946	<1.703	<1.794	<1.646	<1.7	<1.724	1.9	<8.6	<8.6	<7.8	<7.8	<9.2	<1.991
Cadmium	mg/kg	0.04977	<0.03144	<0.03274	<0.03004	<0.03117	<0.0319	<0.074	<0.071	<0.078	<0.043	<0.041	<0.042	0.05556
Calcium	mg/kg	46606	48908	44574	66255	73684	70690	66700	71500	76200	78600	78000	69300	40972
Chromium	mg/kg	<0.5882	<0.524	<0.5381	<0.4938	<0.5263	<0.5172	5.9	3.5	4.1	0.87	0.91	1.1	<0.6019
Cobalt	mg/kg	0.2262	0.2358	0.2018	0.2469	0.1862	0.2198	1.7	1.6	1.5	<0.4	<0.38	<0.45	0.2685
Copper	mg/kg	3.982	4.061	4.395	3.498	2.551	2.845	6	5.6	5.5	3.2	3.7	3.6	7.407
Iron	mg/kg	84.16	80.35	72.65	121	80.16	119	2020	1660	1610	308	252	332	101.4
Lead	mg/kg	0.2217	0.262	0.2242	0.3663	0.2591	0.3017	2	1.7	1.7	<0.5	<0.49	<0.48	0.1481
Magnesium	mg/kg	1403	1384	1390	1576	1518	1625	1900	1820	1960	1840	1810	1690	1366
Manganese	mg/kg	147.1	157.6	149.3	144.4	113.4	145.3	146	144	149	96.3	108	192	129.2
Mercury	mg/kg	<0.0543	<0.04803	<0.04933	0.07407	0.05263	0.04741	0.07	0.095	0.061	0.052	<0.052	0.064	<0.05556
Molybdenum	mg/kg	<0.1629	<0.1441	<0.1525	<0.1399	<0.1457	<0.1466	<0.16	<0.16	<0.16	<0.14	<0.16	<0.17	<0.1667
Nickel	mg/kg	<0.4525	<0.4017	<0.417	<0.3827	<0.4008	<0.4052	2.4	2.1	2.1	0.63	5.7	0.81	<0.463
Potassium	mg/kg	10950	10437	11166	11440	11700	12198	13100	12800	13600	12700	12300	11800	11157
Selenium	mg/kg	2.941	2.271	2.332	2.016	2.065	2.026	2	1.9	2.7	1.8	2	1.7	3.38
Silver	mg/kg	<0.01357	<0.01179	<0.01256	<0.01152	<0.01174	<0.01207	<0.015	<0.013	<0.013	<0.012	<0.013	<0.014	<0.01389
Sodium	mg/kg	4199	3900	4314	4856	4453	5172	6060	6470	6250	6150	6080	5890	4245
Strontium	mg/kg	37.56	43.23	35.43	42.39	50.61	45.26	49.2	47.6	52.6	62	60.9	54.8	43.06
Thallium	mg/kg	<0.06335	<0.05677	<0.0583	<0.0535	<0.05668	<0.05603	<0.21	<0.16	<0.19	<0.11	<0.12	<0.089	<0.1065
Vanadium	mg/kg	0.3484	0.3144	0.2825	0.3704	0.332	0.319	3.1	2.8	2.7	<0.23	<0.2	<0.22	0.3194
Zinc	mg/kg	100	99.56	103.1	81.48	65.59	73.28	91.5	87.6	86.8	88.9	87.3	87	111.6

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_B	ER_C	ER_C
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	ERM2.5	ERM2.5	ERM3.0	ERM3.0	ERM3.0	ERM2.5	ERM2.5	ERM2.5	ERM3.0	ERM3.0	ERM3.0	ERM4.5	ERM4.5
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body
	Sample Date	12/20/2010	12/20/2010	4/21/2010	4/21/2010	4/21/2010	12/20/2010	12/20/2010	12/20/2010	4/21/2010	4/21/2010	4/21/2010	5/19/2010	5/19/2010
	Equis Field Sample ID/ Units	KIF-ERM2.5_GZ.W.C.05-FH-122010-A	KIF-ERM2.5_GZ.W.C.06-FH-122010-A	KIF-ERM3.0_GZ.W.C.01-FH-042110	KIF-ERM3.0_GZ.W.C.02-FH-042110	KIF-ERM3.0_GZ.W.C.03-FH-042110	KIF-ERM2.5_GZ.G.C.01-FH-122010-A	KIF-ERM2.5_GZ.G.C.02-FH-122010-A	KIF-ERM2.5_GZ.G.C.03-FH-122010-A	KIF-ERM3.0_GZ.G.C.01-FH-042110	KIF-ERM3.0_GZ.G.C.02-FH-042110	KIF-ERM3.0_GZ.G.C.03-FH-042110	KIF-ERM4.5_GZ.W.C.01-FH-051910	KIF-ERM4.5_GZ.W.C.02-FH-051910
Aluminum	mg/kg	368.8	44.6	1700	897	2590	<19.16	<18.06	<17.84	597	265	522	515	573
Antimony	mg/kg	<0.06829	<0.06573	0.097	<0.064	0.12	<0.07009	<0.06481	<0.06573	<0.059	<0.067	<0.064	<0.058	<0.056
Arsenic	mg/kg	2.098	2.113	3.5	2	4.3	1.589	1.713	1.643	1.9	0.85	1	1.5	1.3
Barium	mg/kg	16.1	15.96	38	28	43.4	14.02	13.89	15.49	22.9	18.7	25.1	15.7	14.9
Beryllium	mg/kg	<0.2927	<0.2723	0.16	<0.13	0.25	<0.1402	<0.1343	<0.1315	<0.12	<0.14	<0.13	<0.12	<0.11
Boron	mg/kg	<2	<1.878	2.2	<1.8	2.2	<1.963	<1.852	<1.878	<1.7	<1.9	1.9	<1.7	<1.6
Cadmium	mg/kg	<0.07317	<0.07042	0.11	0.084	0.11	<0.03645	<0.03426	<0.03427	0.053	0.044	0.065	0.059	0.046
Calcium	mg/kg	41415	48357	54100	49100	41000	48131	52778	49765	58900	63400	60400	47200	43500
Chromium	mg/kg	<0.6341	<0.5634	3.7	3	4	<0.6075	<0.5556	<0.5634	1.3	1.1	1.6	1.8	2
Cobalt	mg/kg	0.3561	0.216	1.5	0.94	2.2	0.2103	0.2037	0.1925	0.56	0.4	0.71	0.57	0.65
Copper	mg/kg	6.829	7.981	9.1	5.7	7.3	4.439	6.019	3.709	4.3	3.1	5.4	4.2	4.2
Iron	mg/kg	425.4	105.6	1710	1190	2480	63.55	63.43	58.69	566	322	758	673	714
Lead	mg/kg	0.4488	0.1549	2	1.3	2.8	0.1636	0.2824	0.1549	0.81	0.46	0.84	0.71	0.71
Magnesium	mg/kg	1371	1427	1970	1480	1550	1477	1495	1446	1730	1710	1870	1600	1560
Manganese	mg/kg	122	152.1	218	164	202	145.3	154.2	157.7	169	143	157	147	150
Mercury	mg/kg	<0.05854	<0.05164	0.08	0.092	0.09	<0.05607	<0.05093	<0.05164	0.068	0.087	0.074	0.059	0.059
Molybdenum	mg/kg	<0.1707	<0.1596	0.25	0.16	0.26	<0.1682	<0.1574	<0.1596	<0.14	<0.16	0.16	<0.14	<0.14
Nickel	mg/kg	<0.478	<0.4413	6.5	<2.1	4.2	<0.4673	<0.4352	<0.4366	<0.97	<0.6	<1.3	0.84	1
Potassium	mg/kg	11951	11315	15600	10600	12100	11822	11620	11268	14000	14100	15200	12700	12700
Selenium	mg/kg	3.951	3.192	2.8	2.2	2.5	2.523	2.593	2.629	2.1	1.9	2.6	2	1.8
Silver	mg/kg	<0.01415	<0.01315	0.023	0.019	0.022	<0.01355	<0.01296	<0.01315	<0.012	<0.013	<0.013	<0.012	<0.011
Sodium	mg/kg	4512	4150	5190	4900	4360	4542	4176	4286	4790	5010	5410	4040	4050
Strontium	mg/kg	40.98	46.01	47.6	37.4	41.2	45.33	45.37	38.97	41.6	44	43.3	30.9	30.5
Thallium	mg/kg	<0.1268	<0.06103	<0.19	<0.11	<0.2	<0.06542	<0.06019	<0.06103	<0.059	<0.064	<0.061	<0.087	<0.053
Vanadium	mg/kg	0.7805	0.3521	4.5	2.4	6.3	0.3598	0.3796	0.3333	1.7	0.6	1.2	1	1
Zinc	mg/kg	110.7	115	139	82	74.7	113.1	109.3	106.1	73.7	75.7	73.9	74.8	73.9

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	ER_C	ER_C	ER_C	ER_C	ER_C	ER_C	ER_C	ER_C	ER_C	ER_C	ER_R	ER_R	ER_R
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM4.5	ERM8.0	ERM8.0	ERM8.0
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body	Whole Body	Whole Body
	Sample Date	5/19/2010	12/20/2010	12/20/2010	12/20/2010	5/19/2010	5/19/2010	5/19/2010	12/20/2010	12/20/2010	12/20/2010	5/11/2010	5/11/2010	5/11/2010
	Equis Field Sample ID/ Units	KIF-ERM4.5_GZ.W.C.03-FH-051910	KIF-ERM4.5_GZ.W.C.06-FH-122010-A	KIF-ERM4.5_GZ.W.C.07-FH-122010-A	KIF-ERM4.5_GZ.W.C.08-FH-122010-A	KIF-ERM4.5_GZ.G.C.04-FH-051910	KIF-ERM4.5_GZ.G.C.05-FH-051910	KIF-ERM4.5_GZ.G.C.06-FH-051910	KIF-ERM4.5_GZ.G.C.01-FH-122010-A	KIF-ERM4.5_GZ.G.C.02-FH-122010-A	KIF-ERM4.5_GZ.G.C.03-FH-122010-A	KIF-ERM8.0_GZ.W.C.01-FH-051110	KIF-ERM8.0_GZ.W.C.02-FH-051110	KIF-ERM8.0_GZ.W.C.03-FH-051110
Aluminum	mg/kg	387	25.66	33.94	<18.81	66.6	165	91	<17.75	<15.06	<15.74	1710	1430	1400
Antimony	mg/kg	<0.054	<0.06195	<0.05882	<0.06881	<0.054	<0.064	<0.058	<0.06494	<0.05439	<0.05532	<0.058	<0.058	<0.062
Arsenic	mg/kg	1.1	1.637	1.81	1.697	0.94	0.67	0.96	1.472	1.59	1.617	1.4	1.3	1.3
Barium	mg/kg	16.7	11.95	12.22	10.55	12	15.1	16.3	12.99	11.72	12.77	42.4	39	30.4
Beryllium	mg/kg	<0.22	<0.2522	<0.2443	<0.2798	<0.22	<0.13	<0.24	<0.2641	<0.2218	<0.2383	<0.24	<0.24	<0.26
Boron	mg/kg	<3.1	<1.77	<1.674	<1.927	<3.1	<1.8	<3.3	<1.818	<1.548	<1.66	<1.7	<1.7	<1.8
Cadmium	mg/kg	0.05	<0.06637	<0.06335	<0.07339	<0.058	0.037	0.034	<0.06926	<0.05858	<0.05957	0.29	0.066	0.071
Calcium	mg/kg	49200	37345	36923	33303	49300	53400	64900	39091	40000	38851	35600	53300	45800
Chromium	mg/kg	1.5	<0.531	<0.4977	<0.5963	<0.95	1.1	1.1	<0.5628	<0.4603	<0.5106	6.5	4.6	6.2
Cobalt	mg/kg	0.49	0.2212	0.2172	0.2064	0.19	0.31	0.22	0.1558	0.159	0.1617	1.5	1.3	1.3
Copper	mg/kg	4.3	7.522	5.43	4.587	3.9	3.6	3.1	3.29	8.787	4.255	11.8	37.5	5.1
Iron	mg/kg	483	88.5	93.21	79.36	142	244	165	53.68	53.97	53.19	2690	2270	2330
Lead	mg/kg	0.66	0.1991	0.2262	<0.1284	0.25	0.39	0.29	0.1645	0.2218	0.2	3	3.7	2.5
Magnesium	mg/kg	1710	1270	1281	1280	1650	1710	1810	1277	1272	1255	1420	1640	1580
Manganese	mg/kg	153	117.7	117.6	99.08	117	134	148	125.5	122.6	116.6	180	190	188
Mercury	mg/kg	0.056	<0.04867	<0.04525	<0.05505	0.046	0.06	0.057	<0.05195	<0.04184	<0.04681	0.079	0.056	0.057
Molybdenum	mg/kg	<0.13	<0.1504	<0.1448	<0.1651	<0.13	<0.15	<0.14	<0.1558	<0.1297	<0.1404	<0.27	<0.22	<0.23
Nickel	mg/kg	<0.74	0.8407	<0.3982	<0.4587	<0.73	0.94	<0.78	<0.4286	<0.364	<0.3872	12.3	32	2.3
Potassium	mg/kg	13600	11150	11493	11330	13400	13300	12700	10303	10377	10170	9840	10600	11200
Selenium	mg/kg	2	2.876	3.213	2.706	1.7	1.7	1.7	2.684	2.301	2.723	1.9	1.9	2.2
Silver	mg/kg	0.012	<0.01239	<0.01176	<0.0133	<0.011	<0.013	<0.012	<0.01255	<0.01088	<0.01149	0.015	0.015	0.012
Sodium	mg/kg	4610	4088	4303	4307	4510	4150	4370	3688	3603	3672	3990	3920	4380
Strontium	mg/kg	33.4	31.42	33.94	28.9	31	36.9	49.4	34.2	37.66	32.34	23.4	46.1	31.9
Thallium	mg/kg	<0.052	<0.05752	<0.0543	<0.06422	<0.052	<0.061	<0.055	<0.06061	<0.05021	<0.05532	<0.055	<0.056	<0.059
Vanadium	mg/kg	0.69	0.2566	0.2896	<0.2156	<0.68	0.47	<0.72	0.2771	0.251	0.2723	3.8	3.1	3.4
Zinc	mg/kg	74.2	93.81	97.29	95.87	70.1	62.5	70	90.04	88.7	94.47	71.9	91.5	69.5

Table 1-2
Gizzard Shad Whole Body Versus Whole Body Minus Gut Data
Kingston Fossil Plan
Tennessee Valley Authority

Analyte Name	Location Unit	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R	ER_R
	Year	2010	2010	2010	2010	2010	2010	2010	2010	2010
	Location	LERM2.0	LERM2.0	LERM2.0	ERM8.0	ERM8.0	ERM8.0	LERM2.0	LERM2.0	LERM2.0
	Species	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad	Gizzard Shad
	Aliquot Type	Whole Body	Whole Body	Whole Body	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)	Whole Body (minus gut content)
	Sample Date	4/26/2010	4/26/2010	4/26/2010	5/11/2010	5/11/2010	5/11/2010	4/26/2010	4/26/2010	4/26/2010
	Equis Field Sample ID/ Units	KIF-LERM2.0_GZ.W.C.01-FH-042610	KIF-LERM2.0_GZ.W.C.02-FH-042610	KIF-LERM2.0_GZ.W.C.03-FH-042610	KIF-ERM8.0_GZ.G.C.04-FH-051110	KIF-ERM8.0_GZ.G.C.05-FH-051110	KIF-ERM8.0_GZ.G.C.06-FH-051110	KIF-LERM2.0_GZ.G.C.04-FH-042610	KIF-LERM2.0_GZ.G.C.05-FH-042610	KIF-LERM2.0_GZ.G.C.06-FH-042610
Aluminum	mg/kg	1970	1250	706	555	142	380	47.9	44.3	49.3
Antimony	mg/kg	<0.066	<0.066	<0.062	<0.061	<0.062	<0.058	<0.056	<0.065	<0.063
Arsenic	mg/kg	1.4	1.2	1.3	0.84	0.65	0.76	1.2	0.95	1.1
Barium	mg/kg	34.3	26.1	19.1	22.5	12.6	17.7	14.7	13.1	14.5
Beryllium	mg/kg	<0.13	<0.13	<0.13	<0.25	<0.26	<0.24	<0.11	<0.13	<0.13
Boron	mg/kg	<8.8	<8.8	<8.3	<1.7	<1.8	<1.7	<7.5	<8.7	<8.4
Cadmium	mg/kg	<0.11	<0.097	<0.066	0.043	<0.066	0.035	<0.03	<0.034	<0.033
Calcium	mg/kg	46000	51400	41800	58100	39900	46700	52900	58600	61600
Chromium	mg/kg	6.6	3.1	2.6	2.1	0.76	1.1	<0.49	<0.57	<0.55
Cobalt	mg/kg	2.1	<1.2	<0.81	0.55	0.27	0.45	<0.2	<0.19	<0.19
Copper	mg/kg	6.9	5.9	5	3.4	2.6	3.9	4.1	3.1	3.1
Iron	mg/kg	2960	1790	1190	929	342	694	116	108	114
Lead	mg/kg	2.4	1.6	<0.89	0.98	0.36	0.86	<0.2	<0.21	<0.2
Magnesium	mg/kg	1810	1770	1600	1640	1420	1510	1660	1770	1780
Manganese	mg/kg	443	253	205	162	103	120	144	133	145
Mercury	mg/kg	0.077	0.064	0.06	0.074	0.05	0.068	<0.045	0.057	<0.05
Molybdenum	mg/kg	<0.21	<0.22	<0.15	<0.17	<0.15	<0.14	<0.14	<0.16	<0.15
Nickel	mg/kg	4.1	2.7	2	1.1	0.55	0.84	0.53	0.74	0.54
Potassium	mg/kg	13100	13500	13700	11700	11900	11700	13100	13800	13700
Selenium	mg/kg	2.3	2.6	2.2	1.9	1.8	1.8	1.8	1.8	1.7
Silver	mg/kg	<0.092	<0.05	<0.034	<0.012	<0.012	<0.012	<0.011	<0.013	<0.013
Sodium	mg/kg	6050	6010	5160	4710	3590	4030	4760	5160	5080
Strontium	mg/kg	24.5	27.9	27.3	41.5	28.2	30.8	36.1	33.1	40.6
Thallium	mg/kg	<0.063	<0.066	<0.059	<0.058	<0.059	<0.055	<0.073	<0.062	<0.06
Vanadium	mg/kg	3	1.8	<0.86	1.3	0.42	0.81	<0.18	<0.21	<0.2
Zinc	mg/kg	70.9	75.1	72.6	78.6	55.9	57.7	71.3	71.7	66.3

Table 1-3
Percentage of Aluminum in Nymph Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Aluminum (mg/kg)	Fraction Aluminum in Gut (Fgut)
CR_A	CRM1.5	Whole Body	KIF-CRM1.5_MFN.W.C.01-MS-050410	10900	
CR_A	CRM1.5	Whole Body	KIF-CRM1.5_MFN.W.C.02-MS-050410	9080	
CR_A	CRM1.5	Whole Body	KIF-CRM1.5_MFN.W.C.03-MS-050410	6930	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1.5_MFN.W.C.04-MS-050410	623	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1.5_MFN.W.C.05-MS-050410	453	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1.5_MFN.W.C.06-MS-050410	914	
					93%
CR_B	CRM3.5	Whole Body	KIF-CRM3.5_MFN.W.C.01-MS-050410	8440	
CR_B	CRM3.5	Whole Body	KIF-CRM3.5_MFN.W.C.02-MS-050410	9120	
CR_B	CRM3.5	Whole Body	KIF-CRM3.5_MFN.W.C.03-MS-050410	9050	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3.5_MFN.W.C.04-MS-050410	1210	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3.5_MFN.W.C.05-MS-050410	1450	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3.5_MFN.W.C.06-MS-050410	737	
					87%
CR_R	CRM6.0	Whole Body	KIF-CRM6.0_MFN.W.C.01-MS-050610	7620	
CR_R	CRM6.0	Whole Body	KIF-CRM6.0_MFN.W.C.02-MS-050610	7220	
CR_R	CRM6.0	Whole Body	KIF-CRM6.0_MFN.W.C.03-MS-050610	6610	
CR_R	CRM6.0	Whole Body (minus gut content)	KIF-CRM6.0_MFN.W.C.04-MS-060110	258	
CR_R	CRM6.0	Whole Body (minus gut content)	KIF-CRM6.0_MFN.W.C.05-MS-060110	316	
CR_R	CRM6.0	Whole Body (minus gut content)	KIF-CRM6.0_MFN.W.C.06-MS-061410	374	
					96%
ER_A	ERM1.0	Whole Body	KIF-ERM1.0_MFN.W.C.01-MS-050510	7540	
ER_A	ERM1.0	Whole Body	KIF-ERM1.0_MFN.W.C.02-MS-050510	8190	
ER_A	ERM1.0	Whole Body	KIF-ERM1.0_MFN.W.C.03-MS-051210	8540	
ER_A	ERM1.0	Whole Body (minus gut content)	KIF-ERM1.0_MFN.W.C.04-MS-051710	1220	
ER_A	ERM1.0	Whole Body (minus gut content)	KIF-ERM1.0_MFN.W.C.05-MS-051710	2140	
ER_A	ERM1.0	Whole Body (minus gut content)	KIF-ERM1.0_MFN.W.C.06-MS-051710	1620	
					79%
ER_B	ERM2.5	Whole Body	KIF-ERM2.5_MFN.W.C.01-MS-051210	9050	
ER_B	ERM2.5	Whole Body	KIF-ERM2.5_MFN.W.C.02-MS-051210	9730	
ER_B	ERM2.5	Whole Body	KIF-ERM2.5_MFN.W.C.03-MS-051210	10300	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2.5_MFN.W.C.04-MS-052710	491	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2.5_MFN.W.C.05-MS-052710	525	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2.5_MFN.W.C.06-MS-052710	424	
					95%

Table 1-3
Percentage of Aluminum in Nymph Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Aluminum (mg/kg)		Fraction Aluminum in Gut
ER_C	ERM4.0	Whole Body	KIF-ERM4.0_MFN.W.C.01-MS-051710	6340		
ER_C	ERM4.0	Whole Body	KIF-ERM4.0_MFN.W.C.02-MS-061610	5330		
ER_C	ERM4.0	Whole Body	KIF-ERM4.0_MFN.W.C.03-MS-061610	5330		
ER_C	ERM4.0	Whole Body (minus gut content)	KIF-ERM4.0_MFN.W.C.04-MS-060810	1400		
ER_C	ERM4.0	Whole Body (minus gut content)	KIF-ERM4.0_MFN.W.C.05-MS-060810	675		
ER_C	ERM4.0	Whole Body (minus gut content)	KIF-ERM4.0_MFN.W.C.06-MS-060810	1110		
						81%
ER_R	ERM6.0	Whole Body	KIF-ERM6.0_MFN.W.C.04-MS-061410	4350		
ER_R	ERM6.0	Whole Body	KIF-ERM6.0_MFN.W.C.05-MS-061510	5910		
ER_R	ERM6.0	Whole Body	KIF-ERM6.0_MFN.W.C.06-MS-061510	6380		
ER_R	ERM6.0	Whole Body (minus gut content)	KIF-ERM6.0_MFN.W.C.01-MS-061410	502		
ER_R	ERM6.0	Whole Body (minus gut content)	KIF-ERM6.0_MFN.W.C.02-MS-061410	1380		
ER_R	ERM6.0	Whole Body (minus gut content)	KIF-ERM6.0_MFN.W.C.03-MS-061410	689		
						85%
TR_A	TRM560.8	Whole Body	KIF-TRM560.8_MFN.W.C.01-MS-062210	10400		
TR_A	TRM560.8	Whole Body	KIF-TRM560.8_MFN.W.C.02-MS-062210	8060		
TR_A	TRM560.8	Whole Body	KIF-TRM560.8_MFN.W.C.03-MS-062210	10900		
						NA
TR_B	TRM566.3	Whole Body	KIF-TRM566.3_MFN.W.C.01-MS-051110	9250		
TR_B	TRM566.3	Whole Body	KIF-TRM566.3_MFN.W.C.02-MS-051110	9480		
TR_B	TRM566.3	Whole Body	KIF-TRM566.3_MFN.W.C.03-MS-051110	10700		
TR_B	TRM566.3	Whole Body (minus gut content)	KIF-TRM566.3_MFN.W.C.04-MS-052710	780		
TR_B	TRM566.3	Whole Body (minus gut content)	KIF-TRM566.3_MFN.W.C.05-MS-052710	589		
TR_B	TRM566.3	Whole Body (minus gut content)	KIF-TRM566.3_MFN.W.C.06-MS-052710	313		
						94%
TR_R	TRM571.9	Whole Body	KIF-TRM571.9_MFN.W.C.01-MS-051010	6710		
TR_R	TRM571.9	Whole Body	KIF-TRM571.9_MFN.W.C.02-MS-051010	8350		
TR_R	TRM571.9	Whole Body	KIF-TRM571.9_MFN.W.C.03-MS-051010	9420		
TR_R	TRM571.9	Whole Body (minus gut content)	KIF-TRM571.9_MFN.W.C.04-MS-052410	1730		
TR_R	TRM571.9	Whole Body (minus gut content)	KIF-TRM571.9_MFN.W.C.05-MS-052410	1010		
TR_R	TRM571.9	Whole Body (minus gut content)	KIF-TRM571.9_MFN.W.C.06-MS-052410	767		
						86%
			Range	79%	to	96%
			Average			88%

Table 1-4
Percentage of Aluminum in Fish Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Aluminum (mg/kg)	Fraction Aluminum in Gut (Fgut)
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_01-FH-041210	441	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_02-FH-041210	1010	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_03-FH-041210	807	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_07-FH-122110-A	2429	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_08-FH-122110-A	3074	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_09-FH-122110-A	1662	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_04-FH-041210	51.1	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_05-FH-041210	153	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_06-FH-041210	601	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_01-FH-122110-A	132	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_02-FH-122110-A	95.37	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_03-FH-122110-A	130	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_04-FH-122110-A	24.79	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_05-FH-122110-A	27.73	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_06-FH-122110-A	30.25	
					91.48%
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_01-FH-061510	1560	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_02-FH-061510	1340	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_03-FH-061510	934	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_07-FH-122110-A	602.7	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_08-FH-122110-A	636.4	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_09-FH-122110-A	683.7	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_04-FH-061510	193	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_05-FH-061510	215	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_06-FH-061510	177	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_01-FH-121510-A	56.43	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_02-FH-121510-A	30.93	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_03-FH-121510-A	219.5	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_04-FH-122110-A	35.54	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_05-FH-122110-A	49.79	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_06-FH-122110-A	47.11	
					88.14%

Table 1-4
Percentage of Aluminum in Fish Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Aluminum (mg/kg)	Fraction Aluminum in Gut (Fgut)
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_01-FH-041310	440	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_02-FH-041310	645	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_03-FH-041310	370	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_07-FH-122010-A	101.7	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_08-FH-122010-A	181.5	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_09-FH-122010-A	201.4	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_04-FH-041310	<16.7	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_05-FH-041310	<87.7	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_06-FH-041310	<32.1	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_01-FH-122010-A	38.91	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_02-FH-122010-A	31.44	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_03-FH-122010-A	23.32	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_04-FH-122010-A	58.02	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_05-FH-122010-A	24.29	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_06-FH-122010-A	40.09	
					88.86%
ER_A	ERM0.9	Whole Body	KIF-ERM0_9_GZ_W_C_01-FH-040710	1970	
ER_A	ERM0.9	Whole Body	KIF-ERM0_9_GZ_W_C_02-FH-040710	1700	
ER_A	ERM0.9	Whole Body	KIF-ERM0_9_GZ_W_C_03-FH-040710	1670	
ER_A	ERM0.9	Whole Body (minus gut content)	KIF-ERM0_9_GZ_G_C_04-FH-040710	272	
ER_A	ERM0.9	Whole Body (minus gut content)	KIF-ERM0_9_GZ_G_C_05-FH-040710	218	
ER_A	ERM0.9	Whole Body (minus gut content)	KIF-ERM0_9_GZ_G_C_06-FH-040710	295	
					85.30%
ER_B	ERM2.5	Whole Body	KIF-ERM2_5_GZ_W_C_04-FH-122010-A	44.91	
ER_B	ERM2.5	Whole Body	KIF-ERM2_5_GZ_W_C_05-FH-122010-A	368.8	
ER_B	ERM2.5	Whole Body	KIF-ERM2_5_GZ_W_C_06-FH-122010-A	44.6	
ER_B	ERM3.0	Whole Body	KIF-ERM3_0_GZ_W_C_01-FH-042110	1700	
ER_B	ERM3.0	Whole Body	KIF-ERM3_0_GZ_W_C_02-FH-042110	897	
ER_B	ERM3.0	Whole Body	KIF-ERM3_0_GZ_W_C_03-FH-042110	2590	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2_5_GZ_G_C_01-FH-122010-A	<19.16	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2_5_GZ_G_C_02-FH-122010-A	<18.06	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2_5_GZ_G_C_03-FH-122010-A	<17.84	
ER_B	ERM3.0	Whole Body (minus gut content)	KIF-ERM3_0_GZ_G_C_01-FH-042110	597	
ER_B	ERM3.0	Whole Body (minus gut content)	KIF-ERM3_0_GZ_G_C_02-FH-042110	265	
ER_B	ERM3.0	Whole Body (minus gut content)	KIF-ERM3_0_GZ_G_C_03-FH-042110	522	
					74.51%

Table 1-4
Percentage of Aluminum in Fish Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Aluminum (mg/kg)	Fraction Aluminum in Gut (Fgut)
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_01-FH-051910	515	
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_02-FH-051910	573	
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_03-FH-051910	387	
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_06-FH-122010-A	25.66	
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_07-FH-122010-A	33.94	
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_08-FH-122010-A	<18.81	
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_04-FH-051910	66.6	
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_05-FH-051910	165	
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_06-FH-051910	91	
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_01-FH-122010-A	<17.75	
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_02-FH-122010-A	<15.06	
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_03-FH-122010-A	<15.74	
					76.11%
ER_R	ERM8.0	Whole Body	KIF-ERM8_0_GZ_W_C_01-FH-051110	1710	
ER_R	ERM8.0	Whole Body	KIF-ERM8_0_GZ_W_C_02-FH-051110	1430	
ER_R	ERM8.0	Whole Body	KIF-ERM8_0_GZ_W_C_03-FH-051110	1400	
ER_R	LERM2.0	Whole Body	KIF-LERM2_0_GZ_W_C_01-FH-042610	1970	
ER_R	LERM2.0	Whole Body	KIF-LERM2_0_GZ_W_C_02-FH-042610	1250	
ER_R	LERM2.0	Whole Body	KIF-LERM2_0_GZ_W_C_03-FH-042610	706	
ER_R	ERM8.0	Whole Body (minus gut content)	KIF-ERM8_0_GZ_G_C_04-FH-051110	555	
ER_R	ERM8.0	Whole Body (minus gut content)	KIF-ERM8_0_GZ_G_C_05-FH-051110	142	
ER_R	ERM8.0	Whole Body (minus gut content)	KIF-ERM8_0_GZ_G_C_06-FH-051110	380	
ER_R	LERM2.0	Whole Body (minus gut content)	KIF-LERM2_0_GZ_G_C_04-FH-042610	47.9	
ER_R	LERM2.0	Whole Body (minus gut content)	KIF-LERM2_0_GZ_G_C_05-FH-042610	44.3	
ER_R	LERM2.0	Whole Body (minus gut content)	KIF-LERM2_0_GZ_G_C_06-FH-042610	49.3	
					85.61%
			Range	75% to	91%
			Average		84%

Table 1-5
Percentage of Iron in Nymph Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Iron (mg/kg)	Fraction Iron in Gut (Fgut)
CR_A	CRM1.5	Whole Body	KIF-CRM1.5_MFN.W.C.01-MS-050410	11900	
CR_A	CRM1.5	Whole Body	KIF-CRM1.5_MFN.W.C.02-MS-050410	9540	
CR_A	CRM1.5	Whole Body	KIF-CRM1.5_MFN.W.C.03-MS-050410	7180	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1.5_MFN.W.C.04-MS-050410	795	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1.5_MFN.W.C.05-MS-050410	536	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1.5_MFN.W.C.06-MS-050410	1100	
%	Gut				92%
CR_B	CRM3.5	Whole Body	KIF-CRM3.5_MFN.W.C.01-MS-050410	9160	
CR_B	CRM3.5	Whole Body	KIF-CRM3.5_MFN.W.C.02-MS-050410	9230	
CR_B	CRM3.5	Whole Body	KIF-CRM3.5_MFN.W.C.03-MS-050410	9560	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3.5_MFN.W.C.04-MS-050410	1280	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3.5_MFN.W.C.05-MS-050410	1520	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3.5_MFN.W.C.06-MS-050410	908	
%	Gut				87%
CR_R	CRM6.0	Whole Body	KIF-CRM6.0_MFN.W.C.01-MS-050610	9230	
CR_R	CRM6.0	Whole Body	KIF-CRM6.0_MFN.W.C.02-MS-050610	8640	
CR_R	CRM6.0	Whole Body	KIF-CRM6.0_MFN.W.C.03-MS-050610	8920	
CR_R	CRM6.0	Whole Body (minus gut content)	KIF-CRM6.0_MFN.W.C.04-MS-060110	412	
CR_R	CRM6.0	Whole Body (minus gut content)	KIF-CRM6.0_MFN.W.C.05-MS-060110	561	
CR_R	CRM6.0	Whole Body (minus gut content)	KIF-CRM6.0_MFN.W.C.06-MS-061410	593	
CR_R	in				94%
ER_A	ERM1.0	Whole Body	KIF-ERM1.0_MFN.W.C.01-MS-050510	8760	
ER_A	ERM1.0	Whole Body	KIF-ERM1.0_MFN.W.C.02-MS-050510	9920	
ER_A	ERM1.0	Whole Body	KIF-ERM1.0_MFN.W.C.03-MS-051210	11600	
ER_A	ERM1.0	Whole Body (minus gut content)	KIF-ERM1.0_MFN.W.C.04-MS-051710	1940	
ER_A	ERM1.0	Whole Body (minus gut content)	KIF-ERM1.0_MFN.W.C.05-MS-051710	3310	
ER_A	ERM1.0	Whole Body (minus gut content)	KIF-ERM1.0_MFN.W.C.06-MS-051710	3430	
ER_A_per sed					71%
ER_B	ERM2.5	Whole Body	KIF-ERM2.5_MFN.W.C.01-MS-051210	10200	
ER_B	ERM2.5	Whole Body	KIF-ERM2.5_MFN.W.C.02-MS-051210	11300	
ER_B	ERM2.5	Whole Body	KIF-ERM2.5_MFN.W.C.03-MS-051210	11400	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2.5_MFN.W.C.04-MS-052710	728	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2.5_MFN.W.C.05-MS-052710	968	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2.5_MFN.W.C.06-MS-052710	909	
ER_B_per sed					92%

Table 1-5
Percentage of Iron in Nymph Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Iron (mg/kg)		Fraction Iron in Gut (Fgut)
ER_C	ERM4.0	Whole Body	KIF-ERM4.0_MFN.W.C.01-MS-051710	9220		
ER_C	ERM4.0	Whole Body	KIF-ERM4.0_MFN.W.C.02-MS-061610	6850		
ER_C	ERM4.0	Whole Body	KIF-ERM4.0_MFN.W.C.03-MS-061610	6940		
ER_C	ERM4.0	Whole Body (minus gut content)	KIF-ERM4.0_MFN.W.C.04-MS-060810	2420		
ER_C	ERM4.0	Whole Body (minus gut content)	KIF-ERM4.0_MFN.W.C.05-MS-060810	1990		
ER_C	ERM4.0	Whole Body (minus gut content)	KIF-ERM4.0_MFN.W.C.06-MS-060810	2480		
ER_C_per sed						70%
ER_R	LERM1.0	Whole Body	KIF-LERM1.0_MFN.W.C.01-MS-061610	6450		
ER_R	LERM1.0	Whole Body	KIF-LERM1.0_MFN.W.C.02-MS-061610	7200		
ER_R	LERM1.0	Whole Body	KIF-LERM1.0_MFN.W.C.03-MS-061610	5930		
ER_R	ERM6.0	Whole Body	KIF-ERM6.0_MFN.W.C.04-MS-061410	6090		
ER_R	ERM6.0	Whole Body	KIF-ERM6.0_MFN.W.C.05-MS-061510	7710		
ER_R	ERM6.0	Whole Body	KIF-ERM6.0_MFN.W.C.06-MS-061510	8430		
ER_R	ERM6.0	Whole Body (minus gut content)	KIF-ERM6.0_MFN.W.C.01-MS-061410	810		
ER_R	ERM6.0	Whole Body (minus gut content)	KIF-ERM6.0_MFN.W.C.02-MS-061410	2010		
ER_R	ERM6.0	Whole Body (minus gut content)	KIF-ERM6.0_MFN.W.C.03-MS-061410	1070		
ER_R_per sed						81%
TR_A	TRM560.8	Whole Body	KIF-TRM560.8_MFN.W.C.01-MS-062210	11600		
TR_A	TRM560.8	Whole Body	KIF-TRM560.8_MFN.W.C.02-MS-062210	9040		
TR_A	TRM560.8	Whole Body	KIF-TRM560.8_MFN.W.C.03-MS-062210	11700		
TR_A_per sed						
TR_B	TRM566.3	Whole Body	KIF-TRM566.3_MFN.W.C.01-MS-051110	10300		
TR_B	TRM566.3	Whole Body	KIF-TRM566.3_MFN.W.C.02-MS-051110	10400		
TR_B	TRM566.3	Whole Body	KIF-TRM566.3_MFN.W.C.03-MS-051110	11400		
TR_B	TRM566.3	Whole Body (minus gut content)	KIF-TRM566.3_MFN.W.C.04-MS-052710	913		
TR_B	TRM566.3	Whole Body (minus gut content)	KIF-TRM566.3_MFN.W.C.05-MS-052710	733		
TR_B	TRM566.3	Whole Body (minus gut content)	KIF-TRM566.3_MFN.W.C.06-MS-052710	399		
TR_B_per sed						94%
TR_R	TRM571.9	Whole Body	KIF-TRM571.9_MFN.W.C.01-MS-051010	8290		
TR_R	TRM571.9	Whole Body	KIF-TRM571.9_MFN.W.C.02-MS-051010	10400		
TR_R	TRM571.9	Whole Body	KIF-TRM571.9_MFN.W.C.03-MS-051010	12000		
TR_R	TRM571.9	Whole Body (minus gut content)	KIF-TRM571.9_MFN.W.C.04-MS-052410	2270		
TR_R	TRM571.9	Whole Body (minus gut content)	KIF-TRM571.9_MFN.W.C.05-MS-052410	1360		
TR_R	TRM571.9	Whole Body (minus gut content)	KIF-TRM571.9_MFN.W.C.06-MS-052410	965		
						86%
				70%	to	94%
						85%

Table 1-6
Percentage of Aluminum in Fish Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Iron (mg/kg)	Fraction Iron in Gut (Fgut)
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_01-FH-041210	448	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_02-FH-041210	929	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_03-FH-041210	863	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_07-FH-122110-A	1355	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_08-FH-122110-A	1395	
CR_A	CRM1.5	Whole Body	KIF-CRM1_5_GZ_W_C_09-FH-122110-A	1162	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_04-FH-041210	<107	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_05-FH-041210	185	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_06-FH-041210	627	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_01-FH-122110-A	121.3	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_02-FH-122110-A	95.37	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_03-FH-122110-A	124.2	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_04-FH-122110-A	70.17	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_05-FH-122110-A	80.45	
CR_A	CRM1.5	Whole Body (minus gut content)	KIF-CRM1_5_GZ_G_C_06-FH-122110-A	92.44	
					83%
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_01-FH-061510	1870	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_02-FH-061510	1430	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_03-FH-061510	1010	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_07-FH-122110-A	616.4	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_08-FH-122110-A	663.6	
CR_B	CRM3.5	Whole Body	KIF-CRM3_5_GZ_W_C_09-FH-122110-A	702.3	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_04-FH-061510	254	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_05-FH-061510	357	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_06-FH-061510	255	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_01-FH-121510-A	123.7	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_02-FH-121510-A	103.8	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_03-FH-121510-A	259.1	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_04-FH-122110-A	95.45	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_05-FH-122110-A	192.6	
CR_B	CRM3.5	Whole Body (minus gut content)	KIF-CRM3_5_GZ_G_C_06-FH-122110-A	91.56	
					82%

Table 1-6
Percentage of Aluminum in Fish Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Iron (mg/kg)	Fraction Iron in Gut (Fgut)
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_01-FH-041310	478	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_02-FH-041310	712	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_03-FH-041310	434	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_07-FH-122010-A	166.7	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_08-FH-122010-A	236.9	
CR_R	CRM8.0	Whole Body	KIF-CRM8_0_GZ_W_C_09-FH-122010-A	260.5	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_04-FH-041310	71	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_05-FH-041310	150	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_06-FH-041310	95.6	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_01-FH-122010-A	84.16	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_02-FH-122010-A	80.35	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_03-FH-122010-A	72.65	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_04-FH-122010-A	121	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_05-FH-122010-A	80.16	
CR_R	CRM8.0	Whole Body (minus gut content)	KIF-CRM8_0_GZ_G_C_06-FH-122010-A	119	
					75%
ER_A	ERM0.9	Whole Body	KIF-ERM0_9_GZ_W_C_01-FH-040710	2020	
ER_A	ERM0.9	Whole Body	KIF-ERM0_9_GZ_W_C_02-FH-040710	1660	
ER_A	ERM0.9	Whole Body	KIF-ERM0_9_GZ_W_C_03-FH-040710	1610	
ER_A	ERM0.9	Whole Body (minus gut content)	KIF-ERM0_9_GZ_G_C_04-FH-040710	308	
ER_A	ERM0.9	Whole Body (minus gut content)	KIF-ERM0_9_GZ_G_C_05-FH-040710	252	
ER_A	ERM0.9	Whole Body (minus gut content)	KIF-ERM0_9_GZ_G_C_06-FH-040710	332	
					83%
ER_B	ERM2.5	Whole Body	KIF-ERM2_5_GZ_W_C_04-FH-122010-A	101.4	
ER_B	ERM2.5	Whole Body	KIF-ERM2_5_GZ_W_C_05-FH-122010-A	425.4	
ER_B	ERM2.5	Whole Body	KIF-ERM2_5_GZ_W_C_06-FH-122010-A	105.6	
ER_B	ERM3.0	Whole Body	KIF-ERM3_0_GZ_W_C_01-FH-042110	1710	
ER_B	ERM3.0	Whole Body	KIF-ERM3_0_GZ_W_C_02-FH-042110	1190	
ER_B	ERM3.0	Whole Body	KIF-ERM3_0_GZ_W_C_03-FH-042110	2480	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2_5_GZ_G_C_01-FH-122010-A	63.55	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2_5_GZ_G_C_02-FH-122010-A	63.43	
ER_B	ERM2.5	Whole Body (minus gut content)	KIF-ERM2_5_GZ_G_C_03-FH-122010-A	58.69	
ER_B	ERM3.0	Whole Body (minus gut content)	KIF-ERM3_0_GZ_G_C_01-FH-042110	566	
ER_B	ERM3.0	Whole Body (minus gut content)	KIF-ERM3_0_GZ_G_C_02-FH-042110	322	
ER_B	ERM3.0	Whole Body (minus gut content)	KIF-ERM3_0_GZ_G_C_03-FH-042110	758	
					70%

Table 1-6
Percentage of Aluminum in Fish Gut Content
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	SampleType	Equis Field Sample ID	Iron (mg/kg)		Fraction Iron in Gut (Fgut)
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_01-FH-051910	673		
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_02-FH-051910	714		
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_03-FH-051910	483		
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_06-FH-122010-A	88.5		
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_07-FH-122010-A	93.21		
ER_C	ERM4.5	Whole Body	KIF-ERM4_5_GZ_W_C_08-FH-122010-A	79.36		
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_04-FH-051910	142		
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_05-FH-051910	244		
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_06-FH-051910	165		
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_01-FH-122010-A	53.68		
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_02-FH-122010-A	53.97		
ER_C	ERM4.5	Whole Body (minus gut content)	KIF-ERM4_5_GZ_G_C_03-FH-122010-A	53.19		
						67%
ER_R	ERM8.0	Whole Body	KIF-ERM8_0_GZ_W_C_01-FH-051110	2690		
ER_R	ERM8.0	Whole Body	KIF-ERM8_0_GZ_W_C_02-FH-051110	2270		
ER_R	ERM8.0	Whole Body	KIF-ERM8_0_GZ_W_C_03-FH-051110	2330		
ER_R	LERM2.0	Whole Body	KIF-LERM2_0_GZ_W_C_01-FH-042610	2960		
ER_R	LERM2.0	Whole Body	KIF-LERM2_0_GZ_W_C_02-FH-042610	1790		
ER_R	LERM2.0	Whole Body	KIF-LERM2_0_GZ_W_C_03-FH-042610	1190		
ER_R	ERM8.0	Whole Body (minus gut content)	KIF-ERM8_0_GZ_G_C_04-FH-051110	929		
ER_R	ERM8.0	Whole Body (minus gut content)	KIF-ERM8_0_GZ_G_C_05-FH-051110	342		
ER_R	ERM8.0	Whole Body (minus gut content)	KIF-ERM8_0_GZ_G_C_06-FH-051110	694		
ER_R	LERM2.0	Whole Body (minus gut content)	KIF-LERM2_0_GZ_G_C_04-FH-042610	116		
ER_R	LERM2.0	Whole Body (minus gut content)	KIF-LERM2_0_GZ_G_C_05-FH-042610	108		
ER_R	LERM2.0	Whole Body (minus gut content)	KIF-LERM2_0_GZ_G_C_06-FH-042610	114		
						83%
			Range	67%	to	83%
			Average			77%

ARCADIS

Attachment 2

Sediment Bioaccessibility Estimates

Imagine the result

Tennessee Valley Authority

Wildlife Dietary Uptake

Attachment 2

Sediment Bioaccessibility

Sediment Bioaccessibility

This attachment presents methods used to estimate sediment bioaccessibility for the wildlife receptors of interest (ROI) indentified for evaluation in the Baseline Ecological Risk Assessment (BERA) at the Tennessee Valley Authority (TVA) Kingston site. The data provided in this attachment are used in the wildlife dietary uptake models.

Bioaccessibility is defined by the U.S. Environmental Protection Agency (USEPA) Framework for Metals Risk Assessment (USEPA 2007b) as "the amount of environmentally available metal that actually interacts with the organism's contact surface (e.g., membrane) and is potentially available for absorption." It follows that the bioaccessible fraction of a chemical is that fraction that dissolves or desorbs from its matrix (e.g., sediment) in the gastrointestinal tract and is available for absorption (ITRC 2011). This is not to be confused with the bioavailable fraction, which is defined as the percentage of the amount of an element that an organism is exposed to that is absorbed by that organism during a given time under defined conditions (USEPA 2007b). The bioaccessibility factor is the percentage of a metal that is potentially available for absorption, and is therefore a conservative estimate of the bioavailable fraction.

The bioavailability of a constituent is highly dependent on the bioaccessible fraction of that constituent. As such, using total metal concentration in sediment to predict the amount of metal uptake is tantamount to assuming that 100 percent of the metal in sediment is accessible and bioavailable, which usually is not the case (Furman et al. 2005; Poggio et al. 2009). For the purpose of accounting for the bioaccessibility of incidentally ingested sediment in the dietary uptake models, it was imperative to estimate the bioaccessible fraction of some constituents in sediment.

Many of the inorganic constituents of potential ecological concern (COPECs) at the site are naturally occurring in sediment and some are major components of sediment (e.g., aluminum in aluminum-silicate clays). Therefore, the bioaccessibility of these COPECs in sediment should be considered in the dietary uptake models. Bioaccessibility of all COPECs was assumed to equal the bioavailable fraction in the dietary uptake model and was set at 100 percent in the screening dietary uptake models. However, bioaccessibility of metal from incidentally ingested sediment relative to bioaccessibility of the form used in the toxicity reference value (TRV) study was considered in the refined dietary models.

The following COPECs were carried into the refined assessment: aluminum, arsenic, copper, iron, lead, manganese, selenium, and vanadium. Bioaccessibility of arsenic and selenium depends on sediment composition and speciation. Thus, for those two COPECs, the speciation data from the site were used to select the TRV with similar speciation of the COPEC in the sediment, and thus the bioavailable fraction of sediment was not adjusted (remained at 100 percent) as described in more detail in the main text of the Dietary Exposure Modeling document. However, after a review of the bioaccessibility of aluminum, iron, lead, manganese, and vanadium in sediment, bioaccessibility in sediment was estimated at less than 100 percent. Copper was only a COPEC in the refined analysis for aerial feeders that do not ingest

sediment and thus sediment bioavailability did not have to be adjusted. Its bioavailablity from tissue was retained at 100 percent.

Aluminum is the most abundant metal in the earth's crust (USEPA 2003) and is a major component of most common inorganic soil particles (USEPA 2003). Oral toxicity of aluminum in soil and sediment is dependent on its chemical form, and aluminum must be soluble for toxicity to occur. The mobility of aluminum is influenced by pH, with increased mobility occurring as pH decreases.

Iron is one of the most abundant metals on earth and is an important component of sediment. Iron is essential to most life forms. In animals, iron is an essential part of hemoglobin, the protein in red blood cells that carries oxygen to tissues. Animals can regulate iron absorption (USNIH 2012). Iron absorption is also influenced by the type of dietary iron consumed. For example, absorption of heme iron from meat proteins is efficient, while absorption of nonheme iron in plant foods ranges between 2 percent to 20 percent (USNIH 2012).

Lead is a naturally occurring element that is relatively immobile and persistent (USEPA 2005a). It also forms complexes with organic matter and clay minerals, which limits its mobility. Concentrations of bioavailable lead in a soil/sediment solution reach a minimum between pH 5 and 6 because metal-organic complexes form in this pH range (USEPA 2005a).

Manganese is an abundant trace element, existing in several oxidation states. Manganese (II) is the most stable oxidation state dissolved in water, while manganese (III) and (IV) compounds are immobile solids (USEPA 2007a). Organic matter may reduce manganese (III) and (IV) compounds, resulting in the formation of soluble and relatively mobile manganese (II) compounds. Insoluble manganese compounds are formed under aerobic conditions, and soluble compounds are formed under anaerobic conditions. Decreasing soil and sediment pH and aeration increases the solubility of manganese (USEPA 2007a).

Vanadium occurs in rock, soil, and sediment generally in either the relatively insoluble trivalent form (+III oxidation state) or in the more soluble pentavalent form (+V oxidation state) (USEPA 2005b). The bulk of vanadium in the environment is retained in the soil and sediment, mainly in association with organic matter. The mobility of vanadium in soils and sediment is affected by pH with mobility decreasing with decreasing pH (USEPA 2005b).

In conclusion, aluminum, iron, lead, manganese, and vanadium are naturally occurring and are often found in insoluble chemical species, which are of limited mobility and likely have bioaccessibility of less than 100 percent in the animal's stomach. The mobility, and thus the bioaccessibility and the bioavailability, of these elements is heavily governed by the pH of the stomach.

Total metal concentration in sediment does not reflect the portion of the metal that is accessible for uptake in the animal stomach because it is measured after a digestion of the sediment with concentrated acids at a pH close to zero, which is capable of dissolving the mineral matrix, not just the bioaccessible fraction. The

pH in the gastrointestinal tract of wildlife, on the other hand, is typically higher, and is limited in function to solubilizing metals that have been adsorbed to different geochemical phases. Stomach acidity in wildlife ranges from pH 1 to pH 5 (CalEPA 2000). For example, guinea pigs typically have a stomach pH of 1 to 2, while rat stomachs have a pH of 3 to 5. The pH in birds' stomachs and gizzards is typically in the 2 to 3.2 range (Kimball and Munir 1971) and the duck gizzard pH has been reported at around 2.5 (Duke et al. 1975).

Bioavailability from oral ingestion for terrestrial organisms can be measured using in vivo animal (swine) feeding tests such as those used for estimating bioavailablity of lead and arsenic used in human health risk assessment. Further, bioaccessibility is sometimes used to approximate oral bioavailability, and that can be measured by *in vitro* physiologically-based extraction tests using reagents that mimic the gastric and intestinal fluid and/or chemical extractions that extract the chemical phases that are expected to be liberated in the gastrointestinal tract.

Oral bioavailability of soil-borne contaminants is the combined result of soil ingestion, bioaccessibility, absorption, and the first-pass effect. Metals in the sediment can be partitioned into the following forms likely bioaccessible to wildlife: water-soluble fraction, readily exchangeable fraction (ion fraction), carbonate bound (weakly absorbed /acid-soluble fraction), hydrous (iron and manganese) oxide bound (easily-reducible) fraction, organically and sulfide bound (easily oxidizable) fraction, and finally metals in the residual sediment lattice material. Many sequential extraction procedures (SEPs) have been used in the literature to estimate those various metal phases (Filguieras et al. 2002). For TVA, sediment bioaccessibility was estimated using data from an SEP procedure based on that established by Querol et al. (1996; Exhibit 1) up to Querol step 4a, thus accounting for water-soluble, exchangeable, carbonate bound, and oxide bound fractions.

In the SEP procedure used for TVA, the sediment was placed in water to leach out the water-soluble fraction as the first step. Ammonium acetate was used to remove the exchangeable ions from the inert and immobile mineral matrix in the second step. Weak carbonic acid at a pH of 5 was used to identify the acid-soluble fraction in the third step, and hydroxylamine hydrochloride/acetic acid was used to release the manganese/iron oxide bound ions to identify the easily-reducible fraction in the fourth step. The fourth step was conducted at a pH of 1.5 at 95ºC for 15 hours. Step 4 will also dissolve some sulfide-bound and organic-bound metal because the low pH will dissolve most sulfides and oxidize some of the organics (especially at that high temperature and low pH for an extended period). However, it probably will not oxidize all of the organic matter. The last step of Querol et al. (1996) (step 4b), which includes hydrogen peroxide at low pH, is designed to extract the organic- and sulfide-bound fractions. As a consequence, step 4 of the SEP used for TVA was a combination of Querol step 4a and part of Querol step 4b, but not including the hydrogen peroxide that would help to more completely oxidize the organic matter. For TVA, the cumulative percentage of the total metal concentration, extracted by steps 1 through 4, was used as the bioaccessible fraction for aluminum, iron, lead, manganese, and vanadium. It is recognized that the low pH (1.5) in step 4 might have tended to overestimate the bioaccessible metal; whereas the absence of peroxide

in step 4 might have tended to underestimate the bioaccessible metal; and the combined result of those two counteracting potential biases is unknown.

Using extractions ending at the so-called manganese- and iron-oxide extractable step (a pH of 1.5 for 15 hours at 95ºC) to assess bioaccessibility is uncertain. The last step may overestimate the reducible fraction because wildlife stomach pH values are generally higher than 1.5 (e.g., pH of birds is 2 to 3) and the temperature in the vertebrate stomach is only approximately 38ºC. Some metals bound to organics would probably be released in the stomach or intestine by enzymes and these metals would not be included in the bioaccessibility estimate. Such under- and over-estimations make the bioaccessibility fraction a crude approximation of bioaccessibility. The sediment bioaccessibility fraction calculations are presented in Table 2-1 through Table 2-5 for aluminum, iron, lead, manganese, and vanadium and were used to represent the bioavailable fraction. Sediment bioavailable fractions for those constituents are also summarized in Table 2-6.

There has been some debate in the literature about using SEPs to estimate bioaccessibility. The criticism is mainly regarding the limited selectivity of extractants, and the potential for trace element redistribution among phases during the extraction procedure (Zimmerman and Weindorf 2010; Filguieras et al. 2002). In our application of the SEP metal data to estimate bioaccessibility, we decreased these limitations by using the cumulative metal extracted from all four steps, ending in pH 1.5, which limits redistribution of the metals. The pH 1.5 solution used in step 4 would have liberated any metals that may have been liberated and then redistributed into sediment during earlier extractions.

A recent publication compared bioaccessibility measured using two methods: a physiologically based extraction test and a chemical SEP protocol, the modified Community Bureau of Reference method (BCR; Karadaş and Kara 2012). The former simulates gastric and intestinal fluids, and presumably most closely approximates bioaccessibility from a real digestive system. The BCR SEP method's cumulative result from phase 1 and 2 is very similar to the TVA four-step method and ends in pH 1.5 (but uses a much cooler temperature of 22°C). The modified BCR did an acceptable job at producing similar (within 15 percent on average) bioavailability to that estimated using the in vitro methods based on the cumulative metals of all steps up to iron-manganese oxidation step for lead, manganese, nickel, and zinc in one set of soils tested (used data in Karadas and Kara 2012 averaged over nine soils). The SEP BCR did not perform as well for chromium and to some extent copper, which are often associated with the organic fraction. Copper bioaccessibility was up to 35 percent underestimated. The underestimate, if assumed applicable to our sediment samples, is less of an issue for birds than mammals because stomach pH generally ranges between 2 and 3 for birds and using pH 1.5 is conservative, and does not make a significant difference in the calculated risks (within rounding error) for aluminum, iron, manganese, lead, and vanadium. Oomen (2002) demonstrated that pH of the solutions used for in vitro tests strongly affects bioavailability estimates, with lower pH being more conservative. Also, in the SEP procedure used for TVA, time in pH 1.5 was 15 hours at 95ºC, which is conservative (releases more metals) compared to most SEP tests that use shorter times and lower temperatures.

The degree of bias associated with the TVA SEP method for aluminum, iron, and vanadium has not been evaluated in the literature. Iron and aluminum are most abundant in the residual fraction because they are common elements in minerals that can only be dissolved in strong acids at high temperatures. While there is some uncertainty with using data from the SEP method to estimate bioaccessibility (oral bioavailablity), any underestimation may be offset by the conservative assumptions used in the refined dietary exposure models (e.g., using 95% UCLs for exposure point concentrations and the assumption that all food and sediment comes from the river).

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Table 2-1
Extractable Sediment Aluminum at pH 1.5
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	UnqSampleID	Sample Date	Units	Water Extractable Fraction	Ion Exchange Fraction	Carbonate Bound Fraction	Hydroxide Fraction	Total Metals	Fraction of Total Metal Extracted at a pH of 1.5
CR_A	CRM0.0	KIF-CRM0.0-SED-020711	2/7/2011	mg/kg	18.8	4.5	22.6	134	17600	1.02%
CR_A	CRM1.5	KIF-CRM1.5-SED-020711	2/7/2011	mg/kg	17	5.5	11.8	84.8	18800	0.63%
CR_A	CRM2.0	KIF-CRM2.0-SED-020711	2/7/2011	mg/kg	23.3	2.8	14.8	83.6	13800	0.90%
CR_A	CRM2.5	KIF-CRM2.5-SED-020711	2/7/2011	mg/kg	18.4	3.3	13.1	74.8	13500	0.81%
CR_B	CRM3.0	KIF-CRM3.0-SED-020811	2/8/2011	mg/kg	21.7	3.9	26.8	122	16200	1.08%
CR_B	CRM3.5	KIF-CRM3.5-SED-020811	2/8/2011	mg/kg	43.8	12.5	25.7	179	18500	1.41%
CR_B	CRM4.0	KIF-CRM4.0-SED-020811	2/8/2011	mg/kg	22.2	12.6	14.3	112	14500	1.11%
CR_B	CRM4.5	KIF-CRM4.5-SED-020811	2/8/2011	mg/kg	23.8	4.7	15.5	86.5	19100	0.68%
CR_R	CRM_REF	KIF-CRM_REF-SED-020911	2/9/2011	mg/kg	3	0.45	2	8.6	4290	0.33%
ER_A	ERM0.5	KIF-ERM0.5-SED-052311	5/23/2011	mg/kg	5.4	0.2	21.7	111	9590	1.44%
ER_A	ERM0.8	KIF-ERM0.8-SED-052311	5/23/2011	mg/kg	2.5	0.11	22.5	108	11900	1.12%
ER_A	ERM1.0	KIF-ERM1.0-SED-052311	5/23/2011	mg/kg	5.1	0.13	23.9	96	13100	0.96%
ER_B	ERM2.5	KIF-ERM2.5-SED-052311	5/23/2011	mg/kg	2.9	0.049	36.2	306	13100	2.63%
ER_B	ERM3.0	KIF-ERM3.0-SED-052411	5/24/2011	mg/kg	6.5	0.077	26.5	138	12600	1.36%
ER_B	ERM3.5	KIF-ERM3.5-SED-052411	5/24/2011	mg/kg	1.8	<0.03	27.4	306	13000	2.58%
ER_C	ERM4.0	KIF-ERM4.0-SED-052311	5/23/2011	mg/kg	0.33	0.13	9.7	60.7	12500	0.57%
ER_C	ERM5.5	KIF-ERM5.5-SED-052411	5/24/2011	mg/kg	0.34	0.11	11.7	56.5	10100	0.68%
ER_R	ERM_REF	KIF-ERM_REF-SED-052511	5/25/2011	mg/kg	6.6	0.2	11.1	88.4	6030	1.76%
								Minimum		**0.33%**
								Maximum		**2.63%**
								Average		**1.17%**
								Standard Deviation		**0.63%**

Table 2-2
Extractable Sediment Iron at pH 1.5
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	UnqSampleID	Sample Date	Units	Water Extractable Fraction	Ion Exchange Fraction	Carbonate Bound Fraction	Hydroxide Fraction	Total Metals	Fraction of Total Metal Extracted at a pH of 1.5
ER_A	ERM1.0	KIF-ERM1.0-SED-052311	5/23/2011	mg/kg	5.7		14.6	799	19600	4.18%
ER_B	ERM2.5	KIF-ERM2.5-SED-052311	5/23/2011	mg/kg	1.8		7.6	846	10900	7.85%
ER_B	ERM3.0	KIF-ERM3.0-SED-052411	5/24/2011	mg/kg	7.3		16.9	893	18300	5.01%
ER_B	ERM3.5	KIF-ERM3.5-SED-052411	5/24/2011	mg/kg	1		10.4	1380	14000	9.94%
ER_C	ERM4.0	KIF-ERM4.0-SED-052311	5/23/2011	mg/kg	<0.22		7	1150	21000	5.51%
ER_C	ERM5.5	KIF-ERM5.5-SED-052411	5/24/2011	mg/kg	<0.23		19.3	659	18400	3.69%
ER_R	ERM_REF	KIF-ERM_REF-SED-052511	5/25/2011	mg/kg	11.2		6.6	959	12600	7.75%
								Minimum		**3.69%**
								Maximum		**9.94%**
								Average		**6.28%**
								Standard Deviation		**2.29%**

Table 2-3
Extractable Sediment Manganese at pH 1.5
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	UnqSampleID	Sample Date	Units	Water Extractable Fraction	Ion Exchange Fraction	Carbonate Bound Fraction	Hydroxide Fraction	Total Metals	Fraction of Total Metal Extracted at a pH of 1.5
CR_A	CRM0.0	KIF-CRM0.0-SED-020711	2/7/2011	mg/kg	0.94	1.3	131	873	1190	84.56%
CR_A	CRM1.5	KIF-CRM1.5-SED-020711	2/7/2011	mg/kg	0.97	2	123	1420	2030	76.16%
CR_A	CRM2.0	KIF-CRM2.0-SED-020711	2/7/2011	mg/kg	0.8	0.58	66.8	553	889	69.87%
CR_A	CRM2.5	KIF-CRM2.5-SED-020711	2/7/2011	mg/kg	0.61	0.8	62.9	548	1090	56.18%
CR_B	CRM3.0	KIF-CRM3.0-SED-020811	2/8/2011	mg/kg	0.7	0.97	97.1	685	972	80.63%
CR_B	CRM3.5	KIF-CRM3.5-SED-020811	2/8/2011	mg/kg	1.6	1.8	112	739	1200	71.20%
CR_B	CRM4.0	KIF-CRM4.0-SED-020811	2/8/2011	mg/kg	0.46	0.54	64.8	400	657	70.90%
CR_B	CRM4.5	KIF-CRM4.5-SED-020811	2/8/2011	mg/kg	0.55	1.9	98.9	690	1070	73.96%
CR_R	CRM_REF	KIF-CRM_REF-SED-020911	2/9/2011	mg/kg	1	0.79	49.5	537	970	60.65%
ER_A	ERM0.5	KIF-ERM0.5-SED-052311	5/23/2011	mg/kg	0.25	45.1	52.2	172	279	96.61%
ER_A	ERM0.8	KIF-ERM0.8-SED-052311	5/23/2011	mg/kg	3.4	3.5	64.5	253	419	77.42%
ER_A	ERM1.0	KIF-ERM1.0-SED-052311	5/23/2011	mg/kg	2.9	3.8	65.3	238	404	76.73%
ER_B	ERM2.5	KIF-ERM2.5-SED-052311	5/23/2011	mg/kg	0.46	9.9	34.3	60.6	125	84.21%
ER_B	ERM3.0	KIF-ERM3.0-SED-052411	5/24/2011	mg/kg	10.1	70.3	119	229	472	90.76%
ER_B	ERM3.5	KIF-ERM3.5-SED-052411	5/24/2011	mg/kg	0.24	5.3	29.5	86.9	166	73.46%
ER_C	ERM4.0	KIF-ERM4.0-SED-052311	5/23/2011	mg/kg	6.9	1.6	74.8	252	467	71.80%
ER_C	ERM5.5	KIF-ERM5.5-SED-052411	5/24/2011	mg/kg	20.2	0.89	139	297	717	63.75%
ER_R	ERM_REF	KIF-ERM_REF-SED-052511	5/25/2011	mg/kg	3.1	11.1	55.8	175	357	68.63%
								Minimum		**56.18%**
								Maximum		**96.61%**
								Average		**74.86%**
								Standard Deviation		**10.09%**

Table 2-4
Extractable Sediment Lead at pH 1.5
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	UnqSampleID	Sample Date	Units	Water Extractable Fraction	Ion Exchange Fraction	Carbonate Bound Fraction	Hydroxide Fraction	Total Metals	Fraction of Total Metal Extracted at a pH of 1.5
CR_A	CRM0.0	KIF-CRM0.0-SED-020711	2/7/2011	mg/kg	0.044	0.034	0.17	0.65	25	3.59%
CR_A	CRM1.5	KIF-CRM1.5-SED-020711	2/7/2011	mg/kg	0.027	0.048	0.24	0.8	34.2	3.26%
CR_A	CRM2.0	KIF-CRM2.0-SED-020711	2/7/2011	mg/kg	0.035	0.022	0.14	0.38	20	2.89%
CR_A	CRM2.5	KIF-CRM2.5-SED-020711	2/7/2011	mg/kg	0.03	0.027	0.16	0.33	21	2.60%
CR_B	CRM3.0	KIF-CRM3.0-SED-020811	2/8/2011	mg/kg	0.04	0.031	0.23	0.48	23.2	3.37%
CR_B	CRM3.5	KIF-CRM3.5-SED-020811	2/8/2011	mg/kg	0.081	0.052	0.31	1.2	27.6	5.95%
CR_B	CRM4.0	KIF-CRM4.0-SED-020811	2/8/2011	mg/kg	0.035	0.032	0.22	0.41	21.5	3.24%
CR_B	CRM4.5	KIF-CRM4.5-SED-020811	2/8/2011	mg/kg	0.03	0.029	0.16	0.54	29.4	2.58%
CR_R	CRM_REF	KIF-CRM_REF-SED-020911	2/9/2011	mg/kg	0.011	0.011	0.041	0.18	12	2.03%
ER_A	ERM0.5	KIF-ERM0.5-SED-052311	5/23/2011	mg/kg	0.011	0.0093	0.21	0.51	12.9	5.74%
ER_A	ERM0.8	KIF-ERM0.8-SED-052311	5/23/2011	mg/kg	0.0035	0.014	0.23	0.91	17	6.81%
ER_A	ERM1.0	KIF-ERM1.0-SED-052311	5/23/2011	mg/kg	0.0093	0.015	0.25	0.85	17.8	6.32%
ER_B	ERM2.5	KIF-ERM2.5-SED-052311	5/23/2011	mg/kg	0.003	0.0022	0.051	0.49	19.4	2.82%
ER_B	ERM3.0	KIF-ERM3.0-SED-052411	5/24/2011	mg/kg	0.012	0.0097	0.17	0.84	18.9	5.46%
ER_B	ERM3.5	KIF-ERM3.5-SED-052411	5/24/2011	mg/kg	0.0018	0.0055	0.13	1.2	19.8	6.75%
ER_C	ERM4.0	KIF-ERM4.0-SED-052311	5/23/2011	mg/kg	<0.00056	0.021	0.3	0.8	18.8	5.96%
ER_C	ERM5.5	KIF-ERM5.5-SED-052411	5/24/2011	mg/kg	<0.00061	0.012	0.18	0.37	15.4	3.65%
ER_R	ERM_REF	KIF-ERM_REF-SED-052511	5/25/2011	mg/kg	0.018	0.022	0.26	0.91	11.1	10.90%
								Minimum		**2.03%**
								Maximum		**10.90%**
								Average		**4.66%**
								Standard Deviation		**2.25%**

Table 2-5
Extractable Sediment Vanadium at pH 1.5
Kingston Fossil Plant
Tennesse Valley Authority

Location Unit	Location	UnqSampleID	Sample Date	Units	Water Extractable Fraction	Ion Exchange Fraction	Carbonate Bound Fraction	Hydroxide Fraction	Total Metals	Fraction of Total Metal Extracted at a pH of 1.5
CR_A	CRM0.0	KIF-CRM0.0-SED-020711	2/7/2011	mg/kg	0.073	0.067	0.061	0.39	49.9	0.78%
CR_A	CRM1.5	KIF-CRM1.5-SED-020711	2/7/2011	mg/kg	0.037	0.051	0.065	0.27	41.4	0.65%
CR_A	CRM2.0	KIF-CRM2.0-SED-020711	2/7/2011	mg/kg	0.082	0.041	0.051	0.22	42.9	0.51%
CR_A	CRM2.5	KIF-CRM2.5-SED-020711	2/7/2011	mg/kg	0.066	0.045	0.047	0.23	39.4	0.58%
CR_B	CRM3.0	KIF-CRM3.0-SED-020811	2/8/2011	mg/kg	0.075	0.061	0.07	0.29	46.1	0.63%
CR_B	CRM3.5	KIF-CRM3.5-SED-020811	2/8/2011	mg/kg	0.13	0.085	0.084	0.37	50.6	0.73%
CR_B	CRM4.0	KIF-CRM4.0-SED-020811	2/8/2011	mg/kg	0.072	0.088	0.064	0.42	44.8	0.94%
CR_B	CRM4.5	KIF-CRM4.5-SED-020811	2/8/2011	mg/kg	0.08	0.061	0.058	0.22	55.1	0.40%
CR_R	CRM_REF	KIF-CRM_REF-SED-020911	2/9/2011	mg/kg			<0.0069	0.034	10.2	0.33%
ER_A	ERM0.5	KIF-ERM0.5-SED-052311	5/23/2011	mg/kg	0.035		<0.014	0.16	38.7	0.41%
ER_A	ERM0.8	KIF-ERM0.8-SED-052311	5/23/2011	mg/kg	<0.015		<0.015	0.47	44.2	1.06%
ER_A	ERM1.0	KIF-ERM1.0-SED-052311	5/23/2011	mg/kg	<0.014		<0.014	0.43	46.6	0.92%
ER_B	ERM2.5	KIF-ERM2.5-SED-052311	5/23/2011	mg/kg	0.3	0.23	0.18	11.8	60.8	19.41%
ER_B	ERM3.0	KIF-ERM3.0-SED-052411	5/24/2011	mg/kg	0.054		<0.014	0.5	51.2	0.98%
ER_B	ERM3.5	KIF-ERM3.5-SED-052411	5/24/2011	mg/kg	0.15	0.056	0.074	8.1	57	14.21%
ER_C	ERM4.0	KIF-ERM4.0-SED-052311	5/23/2011	mg/kg	<0.014		<0.014	0.15	26.5	0.57%
ER_C	ERM5.5	KIF-ERM5.5-SED-052411	5/24/2011	mg/kg	<0.015		<0.015	0.033	26.4	0.13%
ER_R	ERM_REF	KIF-ERM_REF-SED-052511	5/25/2011	mg/kg	<0.015		<0.015	0.16	12.5	1.28%
								Minimum		**0.13%**
								Maximum		**19.41%**
								Average		**2.47%**
								Standard Deviation		**5.30%**

Table 2-6
Summary of Bioavailable Fractions used in Dietary Exposure Model
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Bioavailable Fractions			
	Minimum	Maximum	Average	Standard Deviation
Aluminum	0.33%	2.63%	1.17%	0.63%
Iron	3.69%	9.94%	6.28%	2.29%
Manganese	56.18%	96.61%	74.86%	10.09%
Vanadium	0.13%	19.41%	2.47%	5.30%
Lead	2.03%	10.90%	4.66%	2.25%

TestAmerica Pittsburgh procedure for Emory and reanalyzed Emory sequentially extracted metals.
The procedure for Clinch sequentially extracted metals is identical except there was no filtration step.

1. Percent Moisture was performed on the samples upon receipt.
2. **Water Extractable Fraction**- Sample mass was based on 4 grams of ash on a dry weight basis combined with 20 mL of water and agitated by rotation (approx 30rpm) for 15 +/-1 hours at room temperature. Following extraction the sample was centrifuged for 30 minutes. The supernatant was decanted and the recovered volume was measured prior to filtration. It was then brought to a final volume of 50 mls and acidified with nitric acid to pH less than 2. The sample was not digested. It was analyzed using ICP/MS by USEPA method 6020. Method Detection Limit data for routine waters including digestion was used for reporting data. Data was reported in ug/L units. A water method blank and lab fortified water sample were analyzed along with this fraction.
3. **Readily Exchangeable Ion Fraction-** The residue was combined with 20 mL of 1 M NH4Ac, pH 7 and again agitated by rotation as above for 15 hours at room temperature. Following extraction the sample was centrifuged as before, the supernatant was decanted and the recovered volume measured. The supernatant was filtered and brought to a final volume of 50 mls prior to being acidified with nitric acid to pH less than 2. The sample was not digested. It was analyzed using ICP/MS by USEPA method 6020. Method Detection Limit data for routine waters including digestion was used for reporting data. Data was reported in ug/L units. A reagent blank and a reagent-fortified sample was analyzed along with this fraction.
4. **Carbonate bound, Surface Oxide Bound Ion Fraction**- The residue was combined with 20 mL of 1 M NH4Ac, pH 5 and again agitated by rotation as above for 15 hours at room temperature. Following extraction the sample was centrifuged as before, the supernatant was decanted and the recovered volume measured. The supernatant was filtered, brought to a final volume of 50 mls and then acidified with nitric acid to pH less than 2. The sample was not digested. It was analyzed using ICP/MS by USEPA method 6020. Method Detection Limit data for routine waters including digestion were used for reporting data. Data was reported in ug/L units. A reagent blank and a reagent-fortified sample were analyzed along with this fraction.
5. **Ions Bound to Fe- Mn Oxides**- The residue will be combined with 20 mL of 0.1M hydroxylamine hydrochloride in 25% v/v Acetic Acid. This fraction was then digested using hot blocks at 95 deg C for 15 hours. If the digestate approached dryness during the digestion process water was added to keep the sample from going to dryness during the digestion. Following digestion the digestate was removed, centrifuged for 30 minutes and adjusted to a final volume of 50 mls and acidified to a pH less than 2 using nitric acid. The digestate was filtered. It was analyzed using ICP/MS by USEPA method 6020. A method detection limit study was performed using these reagents and digestion protocol consistent with 40CFR 136 Part B. Data was reported in ug/L units. A reagent blank and a reagent-fortified sample were analyzed along with this fraction.

The volumes were normalized to 50 mls. If the intent is that the data represent the concentration of metals in the extraction fluid, the volume of extraction fluid used or recovered should be considered to create a dilution factor (50 mls/20 mls). This could be used in conjunction with the liquid to solid ratio (20 mls/4 g) in the extraction to correlate the results to the total concentration of the sample in mg/kg. Alternatively, the calculation can be taken back to mg/kg based on the initial weight of the sample (final volume equals 50 mls, initial dry weight equals 4 grams). This would represent the extractable portion in mg/kg. The liquid to solid ratio in the extraction would still need to be factored in for comparison to the total results of the sample.

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Attachment 3

Toxicity Reference Values

Imagine the result

Tennessee Valley Authority

Wildlife Dietary Exposure Models

Attachment 3

Toxicity Reference Values

1. Introduction

Toxicity reference values (TRVs) were used in the assessment of wildlife through dietary exposure to the constituents of potential ecological concern (COPECs) at the Tennessee Valley Authority (TVA) Kingston Recovery Project baseline ecological risk assessment (BERA).

TRVs are typically based on studies using laboratory species because toxicological studies have not been conducted on most wildlife species. TRVs are typically reported as no observed adverse effects levels (NOAELs) and lowest observed adverse effects levels (LOAELs). TRVs are typically reported as dietary doses in units of milligram constituent per kilogram body weight per day (mg/kg-day).

Screening-level TRVs were selected to provide an initial, conservative screen to identify contaminants that had hazard quotients (HQs) less than or equal to 1 for the NOAEL and thus, would not require further evaluation. However, inorganic constituents with HQs >1 were retained for a more accurate assessment of risk, which entailed refining the TRVs to a more realistic, more site-specific value that applies to the most sensitive species tested. That value was used in a deterministic dietary exposure model. For the probabilistic Monte Carlo dietary exposure modeling, a mean, standard deviation and distribution of TRVs was estimated, incorporating the range of species represented by a functional receptor group. Probabilistic modeling was only conducted on constituents with HQs that exceeded 1 and that also exceeded the HQs at the reference reaches in the refined deterministic models. Of note, the variability observed in TRVs mostly represents uncertainty in the TRV for a receptor group, unlike the variability in the calculated dose of the dietary exposure model, which mostly represents measured variability in the input parameters.

2. Screening Toxicity Reference Values

Screening TRVs used in the exposure models (Tables 6 and 7 in Wildlife Dietary Exposure Models document), which were all NOAELs, were obtained from the following sources that developed conservative criteria:

- TRVs identified in the U.S. Environmental Protection Agency (USEPA) Ecological Screening Levels for Soil (EcoSSL) documents (USEPA 2012),
- TRVs compiled by the Oak Ridge National Laboratory (Sample et al. 1996),
- TRVs identified by the United States Army Center for Health Promotion and Prevention Wildlife Toxicity Assessment program (USACHPPM 2012), and
- TRVs recommended by the USEPA Region IX Biological Technical Assistance Group (USEPA 2009).

The list is in order of preference [i.e., EcoSSL NOAEL TRVs selected first followed by Sample et al. (1996) for constituents without EcoSSL TRVs, etc.]. If none of the four sources contained a TRV for a given element, TRVs were based on toxicological studies referenced in the open literature, except beryllium. No avian toxicity studies were found for beryllium; the screening level NOAEL used for mammals was applied to birds.

The following sections discuss screening TRVs that were unavailable from the above sources and thus were derived from studies available in the open literature. These studies are not of the quality desired, but were used because no other studies were available.

2.1 Antimony Avian TRV*

Only one chronic dietary toxicity study was found identifying effects of antimony in lead shot on avian receptors. Damron and Wilson (1975) exposed 10-week old bobwhite quail to antimony weekly in their diet for 6 weeks and studied the effects on growth and mortality. The NOAEL dose calculated from results reported by Damron and Wilson is 18 mg/kg-day. Thus, the screening avian TRV for antimony was set at the NOAEL of 18 mg/kg-day (see Table 3-1 for data used in the calculation of doses). Chronic antimony avian toxicity studies, other than the one used to derive the TRV, were not available in the literature. The TRV was used in the absence of another alternative with the understanding that it is associated with uncertainty.

2.2 Iron Avian TRV

Three literature studies were identified that have explored iron toxicity to avian receptors (Table 3-2). All three studies reported effects on growth. TRVs were calculated using available information and ingestion rates were calculated using the Nagy (2001) equations for all birds based on reported body weights. The lowest LOAEL was selected as the LOAEL TRV, while the highest NOAEL that is lower than the lowest LOAEL was selected as the NOAEL TRV. The TRVs were 109 mg/kg-day (NOAEL) and 790 mg/kg-day (LOAEL).

2.3 Iron Mammalian TRV

Two literature studies were identified that have explored iron toxicity to cattle (Table 3-2.) Both studies reported effects on growth. TRVs were calculated using available information and ingestion rates were calculated using the Nagy (2001) equations for all mammals based on reported body weights. The lowest LOAEL was selected as the LOAEL TRV, while the highest NOAEL that is lower than the lowest LOAEL was selected as the NOAEL TRV. The TRVs were 22.8 mg/kg-day (NOAEL) and 31.6 mg/kg-day (LOAEL).

2.4 Strontium Avian TRV

Three literature studies were identified that have explored strontium toxicity to avian receptors (Wheeler 1919, Mraz 1961, Mraz et al. 1967) (Table 3-3). All studies reported effects on growth, but the Mraz et al. (1967) study also reported effects on reproduction. Wheeler (1919) reported that 11,210 mg/kg of strontium

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* See response to agency comments provided in Attachment 8.

in the diet fed to 0.45 kg Pekin ducklings on a low-calcium diet for 3 weeks resulted in reduced weight. Such a diet is equivalent to a dose of 1,041 mg/kg-day using the reported body weight and Nagy (2001) allometric estimates of ingestion rate (see Table 3-3 for data used in calculation of doses). Wheeler's (1919) study also showed that 15,930 mg/kg strontium in food fed for 2 days to 3.6 kg Pekin ducks with low calcium diets (equivalent to a dose of 769 mg/kg-day) reduced egg production and the eggs had high levels of strontium in their eggshells (120,000 mg/kg strontium). Mraz (1961) data showed a reduction in weight gain for 0.22 gram chicks fed a diet with 10,900 mg/kg strontium (equivalent to a dose of 1,272 mg/kg-day). In another study focusing on adult chickens, Mraz et al. (1967) reported that 10,000 mg/kg of strontium in an otherwise regular diet fed to yearling chickens for 4 weeks resulted in lost weight (equivalent to a dose of 624 mg/kg-day). A diet with 20,000 mg/kg of strontium (equivalent to dose of 1,249 mg/kg-day) resulted I reproductive effects including increased cracking and reduced egg production (55 percent reduction in uncracked egg production). A dose-response relationship was evident after 1 week with more cracked eggs produced as dose increased. No effects on chicken reproduction were observed at strontium concentrations of < 5,000 mg/kg (equivalent to dose of 312 mg/kg-day). Although Wheeler (1919) and Mraz et al. (1967) did not apply statistical analyses to confirm their conclusions, the screening dose NOAEL TRV of 312 mg/kg-day calculated from Mraz et al. (1967) was used for strontium for the BERA because it was lower than any of the LOAELs reported (Table 3-3).

3. Refined Toxicity Reference Values

For COPECs that had a NOAEL HQ >1 for at least one receptor in at least one reach from the screening dietary exposure modeling, the screening TRVs were evaluated to determine if they needed refinement to better represent the site and its receptors, and to identify LOAEL TRVs. Aluminum, arsenic, vanadium, copper, and selenium avian NOAELs and aluminum, manganese, and selenium mammalian NOAELs were refined and LOAELs identified in an effort to be more specific to speciation of chemicals and receptors at the site. Below is a discussion of the refinement of the TRVs for the deterministic and probabilistic dietary exposure models.

3.1 Aluminum Avian TRV

The avian aluminum NOAEL TRV used in the screening risk calculations was evaluated for site applicability and found to be appropriate. The screening NOAEL TRV for aluminum is from Sample et al. (1996) and is based on a chronic feeding experiment on adult ring doves by Carriere at al. (1986) that showed no adverse effects of aluminum on reproduction and growth at the concentrations tested. The NOAEL dose in that study was 109.7 mg/kg-day. A second experiment reported in the same paper (Table 3-4) evaluated response of 21-day old ring dove chicks to aluminum in their diet and provided a second NOAEL of 164.5 mg/kg-day. The deterministic models in the refined analysis used the lower value of 109.7 mg/kg-day as the screening NOAEL. Deobald and Elvehjem (1935) showed adverse effects of aluminum fed to young chicks, which reduced growth and resulted in rickets at a dose of 387 mg/kg-day (Table 3-4). Thus, the LOAEL selected was 387 mg/kg-day.

To estimate probability of exceeding a HQ of 1, probabilistic models used the mean and standard deviation of the two aluminum NOAELs (137 mg/kg-day and 39 mg/kg-day, respectively). The LOAEL of 387 mg/kg was selected as the mean and109 mg/kg-day was selected as the standard deviation that gives the same coefficient of variation as the NOAEL (Table 3-4).

3.2 Aluminum Mammalian TRV

The mammalian aluminum TRV used in the screening risk calculations was evaluated for site applicability. The screening mammalian aluminum NOAEL TRV is from Sample et al. (1996) and is based on chronic drinking experiments on mice by Ondreicka et al. (1966) that showed reduced growth in offspring. Other studies reported in that same paper (Table 3-4) were two feeding experiments, which are more appropriate for the TVA site because most aluminum uptake is from sediment and prey items, not from drinking water. One study on mice documented reduced food intake but not reduced weight gain, and the other, on rats, documented reduced food intake and reduced body weight. The refined TRVs selected are based on the Ondreicka et al. (1966) rat study because it showed an effect on growth. These refined mammalian TRVs for aluminum are 17 mg/kg-day (NOAEL) and 212.6 mg/kg-day (LOAEL).

For the probabilistic analysis, the three sets of NOAELs and LOAELs for the mammalian endpoints in Table 3-4 were averaged and a standard deviation calculated for each. However, the NOAEL of 1.93 mg/kg-day for the drinking experiment (Ondreicka et al. 1966) was Sample's estimate after dividing the LOAEL of that experiment by 10. Much uncertainty exists as to whether the NOAEL in that experiment might have been ten times lower or only as little as two times lower than the LOAEL. In the other studies in this paper, the differences between NOAELs and LOAELs suggest it could be only two times lower. Therefore, the midpoint of the NOAELs obtained when the LOAEL was divided by 2 and then by 10 was used as the mean NOAEL dose (5.8 mg/kg-day) for that study. The mean and standard deviation of the two NOAEL doses were 16 mg/kg-day and 10 mg/kg-day, respectively, and the mean and standard deviation of the three LOAEL doses were 96 mg/kg-day and 103 mg/kg-day, respectively. These TRV values were used in the Monte Carlo analysis assuming normal distributions.

3.3 Arsenic Avian TRV*

To refine the avian arsenic TRV, the first step was to evaluate the list of studies from the arsenic EcoSSL document used to derive the screening TRV. None of the studies used food as the exposure medium, nor did they use arsenite (0 to 55 percent of TVA impacted sediment is arsenite) as the form of arsenic. At TVA, speciation of arsenic in the sediment indicates arsenite, arsenate, and some organic arsenic are dominant. Inorganic arsenic such as arsenite is one of the more toxic forms of arsenic to birds; but when fed to invertebrates and incorporated into the invertebrate body, it apparently forms organo-arsenic compounds

* See response to agency comments provided in Attachment 8.

that have much lower toxicity (Whitehead 1932). Wildlife is exposed to the dominant forms of arsenic at the site mostly in food (incorporated in invertebrates) or from incidental sediment ingestion.

None of the laboratory toxicity studies in the arsenic EcoSSL document (Table 3-5) (excluding Whitehead 1932) describing the effects of arsenic on birds provide a bounded LOAEL or NOAEL. For arsenic oxide, arsenate, and arsenic chloride, the unbounded NOAEL doses ranged from 2 to 4 mg/kg-day with one outlier that was 17 mg/kg-day and the unbounded LOAEL doses ranged from about 2 to 17 mg/kg-day, with reduction in growth and survival of young, or reduction in egg weight as the measured effect (Table 3-5). Whitehead (1932) was the only study found in the open literature that evaluated arsenic effects when arsenite was ingested by a prey item that was then consumed by a bird. Whitehead evaluated the effect on reproduction of songbirds in a variety of species by feeding nestlings in the field poisoned grasshoppers that had been fed arsenic oxide. Natural mortality of nestlings is high and variable and must be taken into accounted before assessing if there is an effect of the arsenic. The mortality of the unpoisoned nestlings was similar to that of the poisoned nestlings in a red-winged blackbird study, which may indicate the received dose of 131 mg/kg-day (calculated using data in Table 3-5) had no effect. Such a potential field-based NOAEL is significantly higher than most laboratory-based NOAEL doses of inorganic forms of arsenic on growth of adults or chicks, which range from 2 to 4 mg/kg-day (Table 3-5). Other songbird species studied in the same way as the blackbirds in Whitehead (1932) often showed slightly higher mortality if fed arsenic-oxide poisoned grasshoppers than the control birds, but typically not more than 10 percent higher (with the exception of the brown thrasher which had high mortality overall from the force-feeding experiment, making those results less reliable). Thus, the dose of 131 mg/kg-day could be considered a LOAEL dose that is close to a NOAEL dose. Such a dose should be divided in half (65 mg/kg-day) if applied to the TVA site because arsenite-poisoned grasshoppers are about twice as toxic as arsenic oxide-poisoned grasshoppers (Whitehead 1932).

If the birds survive to fledge, further exposure to arsenic through feeding on poisoned invertebrates or arsenic-impacted vegetation may reduce growth. Whitehead (1932) documented in the laboratory that ducks will reduce their food consumption and lose weight (Table 3-5) when fed grasshoppers poisoned with arsenite, and he found similar results with chickens and turkeys. For ducks, the LOAEL dose was 18 mg/kg-day, much higher than the laboratory studies that did not assess organic arsenic effects. Likely population-level effects would not be observed at that level because birds would avoid eating prey with high arsenic concentrations and find food with lower concentrations of arsenic as demonstrated in Whitehead (1932) and other laboratory studies. Although Whitehead (1932) did not conduct statistical analyses, his data support the conclusion that population-level effects are likely at much higher dietary arsenic concentrations than the NOAEL of 2.24 mg/kg-day arsenic used for screening.

The TRV was weighted by percentage of organic and inorganic arsenic ingested since organic is less toxic than inorganic forms. The arsenic dose for the killdeer, the receptor with an HQ > 1 during the screening evaluation, is from several sources: sediment, water (miniscule), invertebrate gut, and invertebrate tissue. According to the dietary exposure model, a large percentage of the birds' intake of arsenic is from the invertebrate but a large portion of arsenic in such invertebrates is in the invertebrate gut. A small proportion

is from sediment. To calculate a TRV that is weighted by proportion As in organic and inorganic form consumed, arsenic in tissue was assumed to be organic arsenic and all arsenic in sediment (including that in prey gut) was assumed to be inorganic. Based on the dietary model, 2% of the dose for the killdeer in Emory River Reach A (ER_A, reach with HQ > 1) was from sediment and the rest (98%) from arsenic in the invertebrate prey. Since 49% of the arsenic in the invertebrates at ER_A is in the gut (Table 1-7 in Attachment 1 of Appendix W in BERA) and 68% of the sediment is inorganic (Appendix A), the portion of the dose that was inorganic arsenic was calculated as (0.49 x 98%) +(0.68 x 2%) = 49%. The (49%) was conservatively assumed to be the more toxic arsenite. The rest (51% in tissue) is assumed to be organic arsenic in the prey items at the TVA site. These percentages were used to estimate a refined weighted NOAEL of 5.8 mg/kg-day, based on the conservative assumption that a dose of 10 mg/kg-day organic arsenic and 1.4 mg/kg-day arsenite would have no detrimental population-level effects on birds (weighted average is 0.49*1.4 + 0.51*10 = 5.8). A LOAEL of 13 mg/kg-day was selected for the refined analysis, assuming 30 mg/kg-day organic arsenic in prey items and 1.49 mg/kg-day (lowest LOAEL or NOAEL, Table 3-5) arsenite in sediment/gut causes population-level effects.

Clearly, a great degree of uncertainty exists with the refined arsenic TRVs. For the Monte Carlo analysis, the range of NOAEL doses is estimated to extend from 2 to 24 mg/kg-day (to calculate the high end of 24 mg/kg, 1.49 mg/kg-day was selected as the highest NOAEL dose for sediment/gut and 52 mg/kg-day, slightly lower than the high LOAEL of 65 mg/kg, was selected as the highest tissue NOAEL dose). The LOAEL dose is estimated to range from 2 to 37 mg/kg-day (for the high end of 37 mg/kg, 17 mg/kg-day was selected as the sediment/gut LOAEL dose and 65 mg/kg-day as the tissue dose). The higher end of the LOAEL range is influenced by actual songbird nests and more likely represents population-level effects, but much uncertainty exists regarding the effect level for field studies with such high natural variability. The low end is likely too conservative because growth effects from avoidance of eating arsenic-laced food is not always translated into population effects. Given such uncertainty, a triangular distribution was applied to these ranges to estimate probabilities of exceeding HQ of 1.

3.4 Manganese Mammalian TRV

To refine the mammalian manganese TRV, the first step was to evaluate the form of manganese likely at the site. The speciation results of arsenic and selenium in sediment suggest anoxic sediments might be common and thus soluble manganese, common in anoxic sediments, is the form on which the refined TRV was based. The studies used to derive the screening TRV in the manganese EcoSSL document were evaluated to identify those that used a highly soluble form, species relevant to the site, and methods appropriate to derive TRVs. The studies with rats and mice were selected because they are rodents and because the representative receptor of concern for manganese at the TVA site is the muskrat, also a rodent. Studies showing a decrease in gonad weight or histology were omitted because such changes may not be pertinent at the population level.

Methods appeared inappropriate for some of the remaining rat and mouse studies (Table 3-6). The LOAELs for manganese often relied on non-significant results. When only significant results were recorded as

LOAELs, the LOAELs for growth of young ranged between 214 and 284 mg/kg-day (Table 3-6). Moreover, a number of studies did not have bounded NOAELs or LOAELs. The studies that used food to deliver manganese to the test organism as would occur on the TVA site did not provide any LOAELs (Table 3-6). A number of studies that used gavage to deliver the soluble manganese were deleted from consideration because gavage can cause effects unrelated to the manganese (Eichenbaum et al. 2011). One study with bounded TRVs that did not use gavage, Kontur and Fechter (1985), evaluated the soluble, most toxic form of manganese (manganese chloride) on rats via drinking water. The effect was reduced growth, probably not as pertinent at the population level as the higher effects levels of reproductive endpoints (Table 3-6). Nonetheless, Kontur and Fechter (1985) was the best study that matched the TVA conditions. Therefore, the NOAEL and LOAEL from that study were selected as the refined TRVs, which are 162 mg/kg-day for the NOAEL and 271 mg/kg-day for the LOAEL (Table 3-6).

3.5 Selenium Avian TRV*

Birds will be exposed to mostly organic selenium in the food chain and in the sediment. Further the sediment contribution to selenium dose is around 2 percent and speciation of the sediment indicates organic selenium is the dominant form (>80 percent) at the site followed by some selenite, only studies that evaluated toxicity of organic selenium to wild birds similar to birds found on the site were evaluated in an effort to refine the selenium TRV to be more site-specific. Organic selenium is more toxic than inorganic selenium (Heinz et al. 1987). Basing the refined TRV on the more toxic form of selenium biases the risk only slightly high given that most of the dose (> 96 percent) is from prey tissue and very little from sediment. For the avian TRV refinement, chicken studies used to derive the screening selenium TRV in the selenium EcoSSL document were eliminated because many wild bird studies were available, particularly for the mallard, a sensitive receptor for the study area. Mallard studies where birds were fed selenium in food were closely examined because mallards are the most sensitive of wild species tested (Table 3-7). Fortunately, a number of toxicity tests on organic selenium (forms of selenomethionine and selenium in yeast) for the mallard were conducted in a consistent manner with consistent results by Heinz and colleagues over the years, as well as by a few other authors (Table 3-7). Mallard studies with high LOAELs based on selenium concentrations >100 mg/kg in food, as well as studies that were not primary studies of selenium toxicity (i.e., focused on interactions with other elements, not on refining the dietary LOAEL) or that evaluated effects on testes were eliminated from consideration. Studies with survival or growth as the endpoint were also eliminated because reproduction is the more sensitive endpoint, affected at lower concentrations. Of the remaining mallard studies that evaluated the most toxic form of selenium, selenomethionine, two studies of reproductive effects had the highest diet NOAEL and lowest LOAEL, which were Heinz et al. (1989) and Stanley et al. (1996) (Table 3-6). Hatching success and ducklings produced per female were adversely affected on the LOAEL diet, endpoints relevant to population growth. Dose per body weight of adult mallards appeared to be less relevant and consistent than dietary NOAELs and LOAELs, which were very consistent

* See response to agency comments provided in Attachment 8.

from study to study. Thus, the highest NOAEL and lowest LOAEL of selenium concentrations in food (Table 3-7) of the remaining mallard studies were selected, which were 4 mg/kg and 7 mg/kg, respectively. This dietary NOAEL and LOAEL was converted to 0.4 mg/kg-day and 0.7 mg/kg-day, respectively, using adult mallard ingestion rates and body weights in the only paper by Heinz and his colleagues providing reported captive mallard ingestion rates (Heinz et al. 1987; 100 grams daily ingestion for 1,000 gram bird). These are the refined selenium TRVs selected for the deterministic models. Of note is that studies have shown elevated arsenic or mercury in the diet can alleviate or reduce effects of selenium on birds (Hoffman et al. 1992). Therefore, the selenium TRVs selected may be conservative because they do not account for these constituents which are present on site.

For the probabilistic models, the suite of birds represented on the site was considered, rather than the most sensitive species, the mallard (Janz et al. 2010). Concentrations of selenium in eggs that affected hatchability are available from Janz et al. (2010) for seven species. These effect concentrations (EC) [e.g., ECs that affect 10 percent of the population (EC10) and NOAELs] for egg concentrations were translated into dietary LOAELs for species without reported dietary LOAELs (Table 3-8 shows calculations). Dietary NOAELs were estimated as almost half of the dietary LOAELs based on the relationship between mallard NOAEL and LOAELs. The dose TRVs were then calculated (Table 3-8). The mean and standard deviation of the TRVs were calculated as 1.69 and 1.11 mg/kg-day for the NOAEL and 3.03 and 1.71 mg/kg-day for the LOAEL, respectively, and were used for the probabilistic analysis (Table 3-8) for all but the mallard receptor. The normal distribution was selected for estimation of these statistics, given the observed distribution of these data.

For the mallard receptor species, since there were many specific studies on that receptor and its sensitivity is believed to represent ducks (Janz et al. 2010), the TRV range of uncertainty was much less. For this receptor, the selenium TRV was set to a range of diet NOAELs (4 to10 mg/kg food) and LOAELs (7 to 12 mg/kg food) reported in the literature for mallards (Janz et al. 2010, Ohlendorf and Heinz 2011, EcoSSL studies), but the high end was adjusted upward slightly to account for extrapolating from individual to population-level effects. These diet TRVs were converted to doses of 0.4 to 1.0 mg/kg-day for NOAEL and 0.7 to 1.2 mg/kg-day for LOAEL and were applied as the range in a triangular distribution for the probabilistic model of the mallard receptor representing omnivorous aquatic- and riparian-feeding birds.

3.6 Selenium Mammalian TRV*

The mammalian selenium NOAELs and LOAELs reported in the selenium EcoSSL document were reviewed and the studies evaluated for applicability to the site. Because organic selenium is the dominant form available at the TVA site, only studies that evaluated organic selenium were considered initially. The test species in the studies included rats, mice, hamsters, pigs, sheep, and pronghorn. None of these are similar

* See response to agency comments provided in Attachment 8.

to the carnivorous species of concern (i.e., the mink and gray bat), that have high protein diets which may reduce absorption and toxicity of selenium (Harr et al. 1967). In particular, mink consume bone and meat which have less bioavailable selenium than plants (Mahan 2001). A dog study not in the selenium EcoSSL document was reviewed and indicated a dietary LOAEL of 7.2 mg/kg organic selenium in food reduced weight gain in 60-day old dogs (Rhian and Moxon 1943). Using a body weight of 12 kg and an ingestion rate from Nagy (2001, “all mammals” allometric equation) of 0.464 kg/day, a LOAEL of 0.28 mg/kg-day was calculated from this dog study. This LOAEL is similar to the selenite LOAEL of 0.215 mg/kg-day in the pig study used to define the EcoSSL screening level NOAEL of 0.143 mg/kg-day (Mahan and Moxon 1984). Therefore, the selenium mammalian NOAEL TRV was not further refined, and the LOAEL dose TRV was set at 0.215 mg/kg-day, the value of the LOAEL in the same selenite study (Mahan and Moxon 1984, see EcoSSL document).

The refined selenium mammalian TRVs are likely too conservative. The refined TRV for mammals is half that of the TRV selected for birds, yet population-level effects from decreased reproduction and deformed embryos are more often observed in birds than mammals (Clark 1987). For example, none of the documented incidences of elevated selenium in mammalian tissue at Kesterson National Wildlife Refuge (Kesterson) indicated any clear, adverse impacts on the small mammal or raccoon populations (Clark 1987; Clark et al. 1989; Janz et al. 2010). CH2M HILL (2000), cited in Santolo (2009), reported on long-term biological monitoring of small mammal populations at Kesterson National Wildlife Refuge. They reported small mammal populations have high reproductive rates, likely not affected by the selenium. Long-term monitoring of several species of mice, voles, and shrews at Kesterson has not identified effects that can be clearly attributed to selenium, partly because of confounding habitat differences among reference and impacted sites (Santolo 2009). However, small mammal populations adapted to the grassland habitat at Kesterson (ponds were removed in late 1980s) are being sustained through time despite elevated selenium in the diet (plants: 2.6 to 6.2 mg/kg, invertebrates: 6.5 to 15 mg/kg). The adverse effect on growth observed in the laboratory is a subtle effect that may not translate to population-level effects. Thus, there is much uncertainty in the selenium mammalian TRV selected for the refined deterministic analysis. The probabilistic analysis may be more informative.

The NOAELs and LOAELs from the EcoSSL list of laboratory studies were evaluated for site applicability first. Then field studies were evaluated to estimate population-level TRVs and compare them to the laboratory TRVs. NOAELs and LOAELs from laboratory studies were not consistent within or among mammalian species, unlike the more consistent results for birds. Different studies could have very different results for the same species, selenium form, and endpoint. Thus, regardless of species used, for the probabilistic analysis, all NOAELs and LOAELs from EcoSSL studies that evaluated an organic form of selenium (except one study on cysteine, which had an unusually high NOAEL) and did not evaluate testes weight as the endpoint, were pooled. The resultant studies were all growth studies (Table 3-9). Unfortunately, no laboratory studies evaluated the reproductive effects of organic forms of selenium on mammals, information that would aid assessment of field study results.

The logical step following laboratory toxicity studies is to evaluate whether the laboratory-predicted effects are observed in the field; the available field investigations suggest there is little evidence for selenium effects on populations of small mammals in places where effects on bird populations have been documented. Field study NOAEL doses of selenium were calculated from data in Clark (1987) and Clark et al. (1989) for omnivorous or carnivorous species, the raccoon, ornate shrew, and western harvest mouse (Table 3-9), which ranged from 1.35 to 13 mg/kg-day. Both studies concluded no clear adverse effect of selenium on small mammal or raccoon populations and hence no LOAEL was identified. The ornate shrew had the highest selenium intake of these three species from its high invertebrate diet (stomach contents of 59 mg/kg selenium equivalent to a dose of 13 mg/kg-day). Yet, this species had high pregnancy rates (57 percent, typical range of *Sorex* species is from 16 to 50 percent, Sheftel 1989), litter size (4 to 7 compared to typical range of 4 to 6) (Hoffman 1999), and population density (higher number per trap compared to reference site, Clark 1987). No mammalian studies documented a diet concentration that would be a LOAEL, but Clark (1987) mentions sensitive species, such as mink, may have disappeared from the Kesterson study area due to selenium. Assuming that is true and using concentrations of food items reported for Kesterson and diet proportions from the BERA exposure profiles for mink, a LOAEL dose of 8.61 mg/kg-day for the mink could be calculated (Table 3-9).

These results suggest much uncertainty in the estimate of selenium TRVs for mammals, especially for potential effects on the mink since the effect level could be low for that species. It is re-assuring that studies in selenium-contaminated areas have not shown evidence of significant adverse effects to wild small mammal populations, in contrast to the predictions of laboratory studies showing decreased growth. That finding suggests the laboratory observation of decreased growth of mammals at very low doses of selenium (mostly from reduced food consumption, even in carnivores) does not translate to poor survival or reproduction in wild small mammal populations.

The NOAELs for selenium in mammals range from 0.11 to 13 mg/kg-day, while the LOAELs range from 0.16 to >14 mg/kg-day (Table 3-9). The higher end represents population-level endpoints with many confounding factors that may obscure real effects. The low end may be over-conservative because reduced growth from avoidance of food with high selenium content may not affect population size or viability. With such uncertainty a triangular distribution was applied to the ranges of 0.11 to 13 mg/kg-day for the NOAEL and 0.16 to 14 mg/kg-day for the LOAEL.

3.7 Copper Avian TRV

The avian studies used to select the copper EcoSSL document were reviewed to evaluate whether it could be confined to wildlife studies more relevant to site receptors. Given that data on reproduction effects for wild birds or birds related to species present at the site were unavailable, and because the NOAEL and LOAEL ranges reported for turkeys and ducks were within the range of reported studies, the conservative NOAEL based on the chicken used for the EcoSSL was retained and not further refined. The LOAEL for copper selected is from the same study as the selected NOAEL (al Ankari et al. 1998). Thus, the TRVs for copper in the refined analysis were 4.05 mg/kg-day (NOAEL) and 12.1 mg/kg-day (LOAEL).

3.8 Lead Avian TRV

The conservative lead EcoSSL NOAEL TRV was retained without further review because the addition of the bioavailable fraction to the refined model removed concerns with lead (HQs were <1). The LOAEL TRV used in the refined analysis was the LOAEL of the study from which the EcoSSL NOAEL TRV came. These TRVs for the refined analysis were 1.63 mg/kg-day and 3.3 mg/kg-day, respectively.

3.9 Vanadium Avian TRV

In an effort to refine the avian vanadium TRV for the BERA, the first step was to refine the list of studies in the vanadium EcoSSL document to wildlife studies more relevant to site receptors. Specifically, studies based on the domesticated chicken were not used because chickens appear to be much more sensitive to vanadium than wild species such as Japanese quail and mallard ducks (Rattner et al. 2006). All chicken studies had lower NOAEL estimates for reproduction endpoints than the NOAEL for these wild species, and 95 percent of the chicken studies had lower NOAEL estimates for growth endpoints. When chicken studies were eliminated from the list, only three studies with five endpoints were identified (shown in Table 3-10 excluding Rattner et al. 2006), and all reported only unbounded NOAELs. The range of NOAEL doses reported in the five studies was 9.6 to 46 mg/kg-day and for a species found on the TVA site, the mallard, was 12 mg/kg-day (Table 3-10).

A review of more recent literature identified one other relevant study that could help bound the LOAEL. Acute and chronic toxicity of sodium metavanadate to mallard drakes (Rattner et al. 2006) and acute toxicity to male Canada geese were studied after a die-off of geese was observed at a fly ash pond. Sodium metavanadate was selected because it is a form of vanadium likely to be associated with ash (Rattner et al. 2006). Although mallards lost weight in this study because they avoided eating the food laced with vanadium after 8 weeks, none died in the 9-week period in the chronic toxicity test (Table 3-9). They showed physiological effects at 37 mg/kg-day and no effects at 9 mg/kg-day. However, in the field many geese died of acute toxicity on a fly ash pond with high vanadium concentrations when most other water sources were frozen. From that event and their toxicity tests, Rattner et al. 2006 concluded that wildlife are at greater risk of acute rather than chronic toxicity and that geese are more sensitive than mallards. For mallards, Rattner et al. (2006) calculated an acute LD50 of 75 mg/kg-day body weight and suggested survival is first affected (LOAEL) at an acute dose of 26 mg/kg, a value that falls between the NOAEL and LOAEL of the chronic toxicity test results. Canada geese had a lower acute lethal dose (LD) for 50 percent of the population (LD50) of 37 mg/kg-day. Given the LD50 for geese is 49 percent of the LD50 for mallards, survival may be first affected (LOAEL) at an acute dose of 13 mg/kg-day for geese (49 percent of 26 mg/kg-day), which may represent the chronic LOAEL dose. The lowest dosed bird at 8 mg/kg-day (n=1) survived and showed relatively little liver and intestinal damage compared to birds more heavily dosed. After reviewing all these wild bird vanadium studies, and recognizing that birds can avoid hotspots of vanadium on the site, the refined TRV selected for vanadium for wild birds was 8 mg/kg-day and 13 mg/kg-day for the NOAEL and the LOAEL doses, respectively.

3.10 Polychlorinated Biphenyl Avian TRV*

After screening, the piscivorous avian receptors had HQs > 1 for polychlorinated biphenyl (PCBs) (PCBs were only evaluated in fish). Thus the avian PCB TRV was evaluated for refinement. The screening NOAEL TRV for PCBs is based upon a chicken (USEPA 2012), which is likely much more sensitive to PCBs than the piscivorous receptors (i.e., great blue heron or osprey) based on an indicator of PCB sensitivity, the Aryl hydrocarbon receptor. Therefore, the avian TRV for PCBs was refined for the heron and osprey models. The LOAEL for the American kestrel, which has the same Aryl receptor as the heron and osprey (Type 3B, personal communication, Sean Kennedy, University of Ottawa) that determines sensitivity to PCBs, is 7.0 mg/kg-day (Fernie et al. 2001). The NOAEL for a screech owl was 0.41 mg/kg-day (McLane and Hughes 1980). As such the refined avian TRVs for PCBs were set at 7.0 and 0.41 mg/kg-day for the LOAEL and NOAEL, respectively (Table 3-11).

* See response to agency comments provided in Attachment 8.

4. References

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Table 3-1
Avian Toxicity Reference Value Derivation for Antimony
Kingston Fossil Plant
Tennesse Valley Authority

Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Growth/Mortality	Antimony	100	Bobwhite quail	0/3/6%	% of 5 lead shot (350 mg of Pb) per week	no		FD	6	weeks	10	weeks	JV	both	WO	6%		yes	0.171	yes	0.014	**18**		Damron and Wilson, 1975

Selected TRV values are in bold.
LOAEL = lowest observed effect level
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = no observed effect level
NR = not reported
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings

Table 3-2
Toxicity Reference Value Derivation for Iron
Kingston Fossil Plant
Tennesse Valley Authority

Exposure																		Conversion to mg/kg bw/day				Result		
Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Response Site	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day) [a]	NOAEL Dose (mg/kg-day) [b]	LOAEL Dose (mg/kg-day) [c]	Reference
Avian Toxicity Reference Value																								
Growth	NR	100%	chicken	1600	mg/kg	NR	NR	FD	NR	NR	NR	NR	JV	NR	BDWT	1600	--	NR	0.5	NR	0.045	144.1	--	McGee et. al 1965
Growth	Ferrous sulfate	100%	chicken	4500	mg/kg			FD	3	weeks	1	day	JV	Both	BDWT	--	4,500	Yes	0.06	no	0.011	--	**790.5**	Deobald and Elvehjem 1935
Growth	Ferrous sulfate	100%	turkey	440	mg/kg			FD	6	weeks	1	week	JV	Both	BDWT	440	--	No	0.02	no	0.005	**109.3**	--	Woerpel and Balloun 1964
Mammalian Toxicity Reference Value																								
Growth	Ferrous sulfate	100%	cattle	400 & 1600	mg/kg	NR	NR	FD	NR	NR	NR	NR	AD	NR	BDWT	400	1600	235	235	no	4.6388	7.9	**31.6**	Standish et al 1969
Growth	Iron citrate	100%	cattle	6 levels (100 to 4,000)	mg/kg	NR	NR	FD	NR	NR	NR	NR	JV	NR	BDWT	1000	2,500	125	125	no	2.8458	**22.8**	56.9	Koong et al 1970

Selected TRV values are in bold.
BDWT = Body weight
FD = food
JV = juvenile
LOAEL = Lowest observed adverse effect level.
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = No observed adverse effect level.
NR = not reported
a. Nagy (2001) equation for All Birds or All Mammals.
b. NOAEL Dose = Study NOAEL x Ingestion Rate / Body Weight.
c. LOAEL Dose = Study LOAEL x Ingestion Rate / Body Weight.

Table 3-3
Avian Toxicity Reference Value Derivation for Strontium
Kingston Fossil Plant
Tennesse Valley Authority

Exposure																		Conversion to mg/kg bw/day				Result		
Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Growth	Strontium carbonate	59	Pekin duck (*Anas peking*)	0/11210	mg/kg diet	no		FD	3	weeks	NR	year	JV	NR	WO		11,210	yes	0.45	no	0.0422		1041	Wheeler, 1919
Growth	Strontium carbonate	100	Chicken (*Gallus domesticus*)	0/5000/10000/20000/40000	mg/kg diet	no		FD	4	weeks	1	year	LB	female	WO		10,000	yes	1.6	no	0.0999		624	Mraz et al., 1967
Reproduction	Strontium carbonate	100	Chicken (*Gallus domesticus*)	0/5000/10000/20000/40000	mg/kg diet	no		FD	4	days	1	year	LB	female	WO		20,000	yes	1.6	no	0.0999		1249	Mraz et al., 1967
Reproduction	Strontium carbonate	100	Chicken (*Gallus domesticus*)	0/5000/10000/20000/40000	mg/kg diet	no		FD	4	months	1	year	LB	female	WO	5,000		yes	1.6	no	0.0999	**312**		Mraz et al., 1967
Reproduction	Strontium carbonate	59	Pekin duck (*Anas peking*)	0/15930	mg/kg diet	no		FD	2.5-4.5	months	1	year	LB	female	WO		15930	yes	3.63	no	0.1751		769	Wheeler, 1919
Growth	NR (plus radioisotopes)	100	Chicken (*Gallus domesticus*)	0/2700/5400/8200/10900	mg/kg diet	NR		FD	3	weeks	225	days	JV	male	WO		10900	No	0.22	no	0.0257		1272	Mraz, 1961

Selected TRV values are in bold.
LOAEL = Lowest observed adverse effect level.
mg/kg = milligram per kilogram.
MW = molecular weight
NA = not applicable
NOAEL = No observed adverse effect level.
NR = not reported
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings

Table 3-4
Refined Toxicity Reference Value Derivation for Aluminum
Kingston Fossil Plant
Tennesse Valley Authority

Exposure																		Conversion to mg/kg bw/day				Result		
Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Mammalian Toxicity Reference Value																								
Decreased growth of offspring	Aluminum in drinking wat	100	Dobra Voda mice	NR (Note 1)	NR	NA	NA	DR	180-390	days	Note 2	NR (Note 2)	AD & JV	Mixed	WO	NR	NR	Yes	0.200	No	NR	1.93 / 5.8 (note 3)	19.30	Ondreicka et al., 1966
Decreased food intake (but no growth effect)	Aluminum in diet	100	Dobra Voda mice	355 & 170	ppm	No	NR	FD	40	days	NR	NR	AD	NR	WO	170.0	355	Yes	0.200	No	0.031	26.3 (note 4)	54.9 (note 4)	Ondreicka et al., 1966
Decreased food intake and decreased	Aluminum in diet	100	Wistar rats	2,835 & 170	ppm	No	NR	FD	8	days	NR	NR	NR	NR	WO	170	2835	Yes	0.200	Yes	0.015 & 0.020	**17.0**	**212.6**	Ondreicka et al., 1966
Mean																						**16.4**		
Standard deviation																						**10**		
Avian Toxicity Reference Value																								
Reproduction	Aluminum in diet	100	Ring dove (*Streptopelia risoria*)	1,000 & 0 (i.e, NR)	ppm	No	NR	FD	NR	NR	NR	NR	AD	Both	WO	1000	NA	No	0.155 (Note 5)	No	0.017 (Note 5)	**109.7**	NA	Carrière et al., 1986 (Note 7)
Growth	Aluminum in diet	100	Ring dove (*Streptopelia risoria*)	1,500; 1,000; 500 & 0 (i.e., NR)	ppm	No	NR	FD	63	days	21	days	JV	NR	WO	1500	NA	No	0.155 (Note 6)	No	0.017 (Note 6)	164.5	NA	Carrière et al., 1986 (Note 7)
Growth	Aluminum sulfate	100	chicken	0/2200/4400	mg/kg	No	NR	FD	3	weeks	1	day	JV	Both	BDWT	--	2,200	Yes	0.06	no	0.011	--	**386.5**	Deobald and Elvehjem 1935
Mean																						**137.1**	**386.5**	
Standard deviation																						**39**	**109.2**	

Selected TRV values are in bold.
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NR = not reported
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings

LOAEL = lowest observed effect level
NOAEL = no observed effect level

Note 1: Aluminum concentration in drinking water was not reported; but using average mouse weight and drinking rate used by Sample et al. (1996), the Al conc. would have been~64.3 milligrams per liter (mg/L).
Note 2: Adults and three generations of offspring, plus two generations of offspring of the first generation, were exposed (offspring starting at 4 weeks old).
Note 3: Sample et al. (1996) divided the LOAEL dose by 10 to estimate a NOAEL dose. We estimated the NOAEL to be ~5.8 mg/kg.
Note 4: NOAEL & LOAEL doses not reported; estimated using body weight = 0.022 kg and ingestion rate = 0.0034 kg/d for white-footed mouse in Table B.1 in Sample et al. (1996)
Note 5: Value assummed by Sample et al. (1996).
Note 6: Used same body wt. and ingestion rate as adults, meaning same food intake rate as a % of body wt as adults.
Note 7: Carriere et al. (1986) also reported a preliminary study in which the diet had a lower Ca:P:Al ratio. However, because that diet might have been Ca and/or Al deficient, it was not used

Table 3-5
Refined Avian Toxicity Reference Value Derivation for Arsenic
Kingston Fossil Plant
Tennesse Valley Authority

Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Reproduction	Arsenic oxide	100	Chicken (Gallus domesticus)	0/7.5/15.0/30.0	mg/kg diet	no	na	FD	19	days	49	weeks	LB	female	WO	30		No	1.6	yes	0.12	2.24		Holcman and Stibilj, 1997
Growth	Arsenic oxide	100	Chicken (*Gallus domesticus*)	0/7.5/15.0/30.0	mg/kg diet	no	na	FD	19	days	49	weeks	SM	female	WO	30.0		No	1.6	yes	0.12	2.24		Holcman and Stibilj, 1997
Growth	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	0/30/100/300	mg/kg diet	yes	12.1	FD	2	weeks	1	days	JV	female	WO		30.0	yes	0.160	yes	0.01		1.49	Camardese et al, 1990
Growth	Arsenic trichloride	100	Chicken (*Gallus domesticus*)	0/50	mg/kg diet	no	na	FD	21	days	1	days	JV	both	WO		50.0	No	0.564	no	0.04		3.55	Howell and Hill, 1978
Growth	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	0/200	mg/kg diet	no	6	FD	4	weeks	1	days	JV	both	WO		200	yes	0.384	no	0.03		17.3	Hoffman et al, 1992
Growth	Grasshoppers fed sodium	100	Muscovy duck (*Cairina moschata*)	0/1670	mg/kg diet	yes	69	FD	6	days	1	year	JV	NR	WO		1670		2.097	Yes	0.02		18.1	Whitehead, 1932
Survival	Arsenic oxide	100	Chicken (*Gallus domesticus*)	0/7.5/15.0/30.0	mg/kg diet	no	na	FD	19	days	49	weeks	SM	female	WO	30.0		No	1.6	yes	0.12	2.24		Holcman and Stibilj, 1997
Survival	Arsenic trichloride	100	Chicken (*Gallus domesticus*)	0/50	mg/kg diet	no	na	FD	21	days	1	days	JV	both	WO	50.0		No	0.564	no	0.04	3.55		Howell and Hill, 1978
Survival	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	0/30/100/300	mg/kg diet	yes	12.1	FD	10	weeks	1	days	JV	both	WO	300		yes	1.10	yes	0.01	3.72		Camardese et al, 1990
Survival	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	0/200	mg/kg diet	no	6	FD	4	weeks	1	days	JV	both	WO	200		yes	0.384	no	0.03	17.3		Hoffman et al, 1992
Survival	Grasshoppers fed arsenic oxide*	100	Red-winged blackbird (*Agelaius phoeniceus*)	0/2564*	mg/kg diet	yes	69	FD	4-6	days	10	days	JV	both	WO	2564		No	0.016	Yes	0.001	131.08		Whitehead, 1932

Selected TRV is described in text.
LOAEL = Lowest observed adverse effect level.
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = No observed adverse effect level.
NR = not reported
*0.3 mg As/grasshopper and each *Melanoplus bispinosus* grasshopper weighs 0.117 g. Endpoint was mortality of nestlings
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings
d. Ingestion rate per those reported in Heinz et al.1987.

Table 3-6
Refined Avian Toxicity Reference Value Derivation for Manganese
Kingston Fossil Plant
Tennesse Valley Authority

Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[d]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported	Body Weight (kg)	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Reproduction	Manganese sulfate monohydrate	100	Rat (*Rattus norvegicus*)	0/0.763/3.63/16.9/78.3	mg/kg bw/d	GV	9	days	NR	NR	GE	female	WO	78.3		Yes	0.281	No	0.024	78.3		USFDA, 1973
Reproduction	Manganese sulfate monohydrate	100	Mouse (*Mus musculus*)	0/1.25/5.81/27.0/125.0	mg/kg bw/d	GV	9	days	NR	NR	GE	female	WO	125		Yes	0.0407	No	0.005	125		USFDA, 1973
Reproduction	Manganese sulfate monohydrate	100	Hamster (*Mesocricetus auratus*)	0/1.36/6.32/29.3/136.0	mg/kg bw/d	GV	4	days	NR	NR	GE	female	WO	136		Yes	0.1265	No	0.013	136		USFDA, 1973
Reproduction	Manganese (II) chloride	43.66	Rat (*Rattus norvegicus*)	0/0.35/1.42	mg/g bw/d	DR	30	days	NR	NR	GE	female	WO	0.35	1.42	No	0.338	No	0.004	153	620	Pappas et al., 1997
Reproduction	Manganese (II) chloride	43.66	Rat (*Rattus norvegicus*)	0/0.18/0.30/0.45	g/d	DR	21	days	NR	NR	GE	female	WO	0.3	0.45	Yes	0.4738	Yes	0.030	276	415	Kontur and Fechter, 1985
Reproduction	Manganese oxide	100	Rat (*Rattus norvegicus*)	0/350/1050/3500	mg/kg diet	FD	43	days	NR	NR	GE	female	WO	3500		No	0.344	No	0.029	291		Laskey et al., 1982
Growth	Manganese (II) chloride	100	Rat (*Rattus norvegicus*)	0/75	mg/kg diet	FD	80	days	44	days	JV	male	WO	75		Yes	0.47	No	0.037	5.89		Gershbein et al., 1983
Growth	Manganese chloride	100	Rat (*Rattus norvegicus*)	0/43.8/82.4	mg/kg diet	FD	2	weeks	NR	NR	JV	both	WO	82.4		Yes	0.227	No	0.020	7.37		Lee and Johnson, 1988
Growth	Manganese chloride tetrahydrate	100	Rat (*Rattus norvegicus*)	0/6.9/13.8	mg/kg bw/d	GV	21	days	1	days	JV	both	WO	13.8		Yes	0.035	No	0.004	13.8		Kontur and Fechter, 1985
Growth	Manganese chloride (most toxic)	100	Rat (*Rattus norvegicus*)	0/10/20	mg/kg bw/d	GV	30	days	30	days	JV	male	WO	20		Yes	0.2752	No	0.024	20.0		Lipe et al., 1999
Growth	Manganese chloride tetrahydrate	100	Rat (*Rattus norvegicus*)	0/1/10/20	mg/kg bw/d	GV	24	days	1	days	JV	male	WO	20		Yes	0.07	No	0.008	20.0		Deskin, et al., 1981
Growth	Manganese Oxide (less toxic)	100	Rat (*Rattus norvegicus*)	0/21/71/214	mg/kg bw/d	GV	5	days	1	days	JV	both	WO	71	214	Yes	0.0295	No	0.002	71.0	214.0	Rehnberg et al., 1980
Growth	Manganese oxide (Mn3O4)	100	Rat (*Rattus norvegicus*)	0/71	mg/kg bw/d	GV	21	days	0	days	JV	male	WO	71		Yes	0.0529	No	0.006	71.0		Laskey et al., 1985
Growth	Manganese sulfate monohydrate	100	Rat (*Rattus norvegicus*)	0/0.763/3.63/16.9/78.3	mg/kg bw/d	GV	9	days	NR	months	GE	female	WO	78.3		Yes	0.281	No	0.024	78.3		USFDA, 1973
Growth	Manganese chloride tetrahydrate	100	Rat (*Rattus norvegicus*)	0/1	mg/ml	DR	65	weeks	6	weeks	JV	male	WO	1		Yes	0.739	No	0.075	102		Nachtman et al., 1986
Growth	Manganese sulfate monohydrate	100	Mouse (*Mus musculus*)	0/1.25/5.81/27.0/125.0	mg/kg bw/d	GV	9	days	NR	NR	GE	female	WO	125		Yes	0.0407	No	0.005	125		USFDA, 1973
Growth	Manganese sulfate monohydrate	100	Hamster (*Mesocricetus auratus*)	0/1.36/6.32/29.3/136.0	mg/kg bw/d	GV	4	days	NR	NR	GE	female	WO	136		Yes	0.1265	No	0.013	136		USFDA, 1973
Growth	Manganese (II) chloride (most toxic)	43.66	Rat (*Rattus norvegicus*)	0/0.18/0.30/0.45	g/d	DR	21	days	NR	NR	GE	female	WO	0.18	0.3	Yes	######	Yes	0.036	**162**	**271**	Kontur and Fechter, 1985
Growth	Manganese carbonate	100	Mouse (*Mus musculus*)	0/2	g/kg diet	FD	100	days	6	weeks	JV	male	WO	2		Yes	0.0282	Yes	0.004	262		Komura and Sakamoto, 1991
Growth	Manganese dioxide	100	Mouse (*Mus musculus*)	0/2	g/kg diet	FD	100	days	6	weeks	JV	male	WO	2		Yes	0.0282	Yes	0.004	270		Komura and Sakamoto, 1991
Growth	Manganese carbonate	100	Rat (*Rattus norvegicus*)	0/450/4550	mg/kg diet	FD	56	days	NR	NR	JV	male	WO	4550		Yes	0.272	No	0.024	394		Johnson and Kies, 1987
Growth	Manganese chloride tetrahydrate	100	Rat (*Rattus norvegicus*)	0/554	mg/kg bw/d	DR	11	weeks	3	weeks	JV	male	WO	554		Yes	0.445	Yes	0.027	554		Gaillard et al., 1996
Growth	Manganese acetate (most toxic)	100	Mouse (*Mus musculus*)	0/2	g/kg diet	FD	30	days	6	weeks	JV	male	WO		2	Yes	0.0282	Yes	0.004		284	Komura and Sakamoto, 1991
Growth	Manganese chloride tetrahydrate	100	Mouse (*Mus musculus*)	0/2	g/kg diet	FD	30	days	6	weeks	JV	male	WO		2	Yes	0.0282	Yes	0.004		284	Komura and Sakamoto, 1991
Survival	Manganese Oxide	100	Rat (*Rattus norvegicus*)	0/21/71/214	mg/kg bw/d	GV	17	days	1	days	JV	both	WO	71	214	Yes	0.0483	No	0.006	71	214	Rehnberg et al., 1980
Survival	Manganese sulfate monohydrate	100	Rat (*Rattus norvegicus*)	0/0.763/3.63/16.9/78.3	mg/kg bw/d	GV	9	days	NR	NR	GE	female	WO	78.3		Yes	0.281	No	0.024	78.3		USFDA, 1973
Survival	Manganese sulfate monohydrate	100	Mouse (*Mus musculus*)	0/1.25/5.81/27.0/125.0	mg/kg bw/d	GV	9	days	NR	NR	GE	female	WO	125		Yes	0.0407	No	0.005	125		USFDA, 1973
Survival	Manganese sulfate monohydrate	100	Hamster (*Mesocricetus auratus*)	0/1.36/6.32/29.3/136.0	mg/kg bw/d	GV	4	days	NR	NR	GE	female	WO	136		Yes	0.1265	No	0.013	136		USFDA, 1973

Selected TRV values are in bold.
LOAEL = Lowest observed adverse effect level.
mg/kg = milligram per kilogram
MW = molecular weight
NOAEL = No observed adverse effect level.
NR = not reported
a. DR = Drinking water; FD = food; OR = other oral
b. AD = adult; GE = gestation; IM = immature; JV = juvenile; LC = lactation; SM = Sexually mature; MA=mature; YO=young
c. BDWT = Body weight changes; DEYO= Development of young; FERT = fertility; GDPV = general development; GGRO=general growth; GDIX=gestation index; GMOR=general mortality; GMPH=general morphology;GREP=general reproductive effect;LFSP=lifespan;MORT=mortality;MUSC=muscle changes; ODVP=offspring development;ORWT=organ weight changes;PRFM=sexual performance;PROG=progeny numbers/counts;PRWT=progeny weight;RBEH=reproductive behavior changes;RHIS=reproductive organ histology;RPRD=reproductive capacity;RSEM=resorbed embryos;RSUC=reproductive success;SPCL=sperm cell counts;SPCV=sperm cell viability; SURV=survival;TDTH=time to death;TEDG=testes degeneration;TEWT=testes weight
d. BO = bone oviduct; EM=embryo;FM=Femur;GO=gonads;MT=multiple tissues; MU=muscle; NR=not reported; OV=ovary; PY=progeny; RT=reproductive tissue; SM=sperm; SV=seminal vesicle; TA=tail; TB=tibia; TE=testes; WO=whole organism

Table 3-7
Refined Avian Toxicity Reference Value Derivation for Selenium
Kingston Fossil Plant
Tennesse Valley Authority

Exposure					Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL	Study LOAEL	Conversion to mg/kg bw/day				Result		Reference
Endpoint	Chemical Form	MW%	Test Species	Conc/Doses														Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	
Reproduction	Seleno-DL-methionine	100	Mallard (*Anas platyrhynchos*)	0/1/2/4/8/16	mg/kg diet	yes	1		46	day	NR	NR	LB	BOTH	WO	4	8	yes[d]	1	yes[a]	0.100	**0.40**	0.80	Heinz et. al., 1989
Reproduction	Seleno-DL-cysteine	100	Mallard (*Anas platyrhynchos*)	0/16	mg/kg diet	yes	1		46	day	NR	NR	LB	BOTH	WO		16	yes	1	no	0.100		1.60	Heinz et. al., 1989
Reproduction	Seleno-DL-methionine	100	Mallard (*Anas platyrhynchos*)	0/10	mg/kg diet	yes	11		57	week	1	year	LB	female	WO	10	25	yes	0.906	yes	0.090	0.99	2.48	Heinz et al., 1987
Reproduction	Seleno-DL-methionine	100	Mallard (*Anas platyrhynchos*)	0/3.5/7	mg/kg diet	yes	1		121	day	1	year	LB	BOTH	WO	3.5	7	no	1	no	0.100	0.35	**0.70**	Stanley et al., 1996
Duckling growth	Seleno-DL-methionine	100	Mallard (*Anas platyrhynchos*)	0/10/20/40/80	mg/kg diet	yes	7		6	week	6	week	JV	NR	WO	10	20	yes	0.7	yes	0.157	2.24	4.49	Heinz et al., 1988
Reproduction	Seleno-DL-methionine	100	Mallard (*Anas platyrhynchos*)	0/19.8	mg/kg diet	yes	10	FD	21	week	NR	NR	LB	female	WO		19.8	yes	0.912	no	0.068		1.48	Heinz and Fitzgerald, 1993

Selected TRV is in bold.
LOAEL = Lowest observed adverse effect level.
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = No observed adverse effect level.
NR = not reported
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings
d. Ingestion rate per those reported in Heinz et al. 1987

Table 3-8
Avian Toxicity Reference Value Ranges for Selenium
Kingston Fossil Plant
Tennesse Valley Authority

Test Species	Receptor Group	Egg concentration Effect Level on hatchability (mg/kg egg) [a]	Study NOAEL in Diet (mg/kg food) [b]	Study LOAEL in Diet (mg/kg food) [b]	Body Weight (kg) [c]	Ingestion Rate (kg/day or L/day) [d]	NOAEL Dose (mg/kg-day) [e]	LOAEL Dose (mg/kg-day) [e]	Reference
mallard	omnivore	7.7-15	4	7	1.145	0.079	0.278	0.486	Heinz et al. 1989, Stanley et al. 1996
black-crowned night heron	carnivore (piscivore)	>16.5	10	*18*	0.8705	0.066	0.756	1.362	Janz et al. 2010, Smith et al. 1988
black-necked stilt	insectivore	21-31	*11*	*19*	0.178	0.022	1.324	2.383	Janz et al. 2010
red-winged blackbird	aerial insectivore	22	*11*	*20*	0.055	0.010	2.014	3.625	Janz et al. 2010
American kestrel	carnivore	>25	12	*21*	0.132	0.016	1.368	2.463	Janz et al. 2010, Santolo et al. 1999
screech owl	carnivore	13 < x < 37	10	30	0.2025	0.024	1.198	3.593	Janz et al. 2010, Wiemeyer & Hoffman 1996
killdeer[f]	insectivore	--	*23*	*31*	0.1	0.015	3.440	4.636	Janz et al. 2010
avocet	omnivore	60	*30*	55	0.3125	0.033	3.169	5.703	Janz et al. 2010
Mean							**1.69**	**3.03**	
Standard deviation							**1.11**	**1.71**	

BW = body weight
IR = Ingestion rate
Italic numbers are calculated.

mg/kg = milligram per kilogram
LOAEL = lowest observed effect level
NOAEL = no observed effect level

a. EC10 or NOAEL (if >) for all with the exception of avocet study that used lower bound of EC20 and screech owl study that reported concentration at 5% hatchability (adjusted to control eggs)
b. LOAEL concentration in diet was estimated for numbers in italics by multiplying the effect egg concentration by 0.91 (from Heinz et al.1989 egg/diet concentrations) and for the NOAEL by dividing the LOAEL by 1.8 (from mallard TRVs)
c. Body weights for receptors in BERA were averages reported in receptors profile (i.e., killdeer and mallard), for other, they were average of range from http://www.allaboutbirds.org/guide
d. Nagy (2001) equation for All Birds
e. TRV = NOAEL x IR / BW
f. Stilt, killdeer, and avocet had embryo deformity percentages of 28, 11, and 2% at egg concentrations around 45 mg/kg (Janz 2010) and thus the diet NOAEL and LOAEL for the killdeer was similarly interpolated between estimated NOAELs and LOAELs for stilt and avocet

Table 3-9
Mammalian Toxicity Reference Value Ranges for Selenium
Kingston Fossil Plant
Tennesse Valley Authority

Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Effect Measure[c]	Response Site[d]	Study NOAEL	Study LOAEL	Body Weight Reported	Body Weight (kg)	Ingestion Rate Reported?	Ingestion Rate (kg or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
EcoSSL List of Laboratory Studies																							
Growth	Sodium selenite or Se-yeast	100	Pig (*Sus scrofa*)	0/1.0/3.0/5.0/7.0/10.0	mg/kg diet	FD	12	weeks	NR	NR	JV	both	BDWT	WO	5	7	Yes	104	Yes	2.4682	0.112	0.157	Kim and Mahan, 2001b
Growth	L-Selenomethionine	100	Rat (*Rattus norvegicus*)	0/2	mg/kg diet	FD	110	days	30	days	JV	male	BDWT	WO		2	Yes	0.34	No	0.0283		0.166	Behne et al., 1992
Growth	Se in food (seleniferous wheat and corn)	100	Rat (*Rattus norvegicus*)	0/2.58/5.6/8.4	mg/kg diet	FD	4	weeks	NR	NR	JV	male	BDWT	WO		2.58	Yes	0.3372	No	0.0281		0.215	Goehring et al., 1984
Growth	Se in food (*Astragalus bisculatus*)	100	Pig (*Sus scrofa*)	0/18.7	mg/org/d	FD	9	weeks	8-14	weeks	JV	both	BDWT	WO		18.7	No	61	No	2.0160		0.307	Baker et al., 1989
Growth	Se in food (*Astragalus praelongus*)	100	Pig (*Sus scrofa*)	0/21.5	mg/org/d	FD	9	weeks	8-14	weeks	JV	both	BDWT	WO		21.5	No	61	No	2.0160		0.352	Baker et al., 1989
Growth	Selenocystine	47.27	Rat (*Rattus norvegicus*)	0/10/20	mg/kg diet	FD	5	weeks	NR	NR	JV	male	BDWT	WO		10	No	0.18	No	0.0168		0.441	Dausch and Fullerton, 1993
Growth	Se in food (selenium yeast)	100	Pig (*Sus scrofa*)	0/5/10/15/20	mg/kg diet	FD	12	weeks	8	weeks	JV	both	BDWT	WO	15	20	Yes	83	Yes	2.0300	0.367	0.489	Kim and Mahan, 2001a
Growth	Se in food	100	Pronghorn (*Antilocapra*	0/14	mg/kg diet	FD	164	days	6-96	months	JV	male	BDWT	WO		14	No	63	No	2.0700		0.493	Raisbeck et al., 1996
Growth	Se in food (seleniferous wheat)	100	Rat (*Rattus norvegicus*)	0/1.6/3.2/4.8/6.4/ 8.0/9.6/11.2	mg/kg diet	FD	6	weeks	NR	NR	JV	male	BDWT	WO	4.8	6.4	Yes	0.239	No	0.0224	0.450	0.600	Halverson et al., 1966
Growth	Se in food (seleniferous corn)	100	Rat (*Rattus norvegicus*)	0/7.8	ug/g diet	FD	4	weeks	NR	NR	JV	male	BDWT	WO		7.8	Yes	0.21596	No	0.0195		0.704	Palmer et al., 1983
Growth	Selenomethionine	100	Hamster (*Mesocricetus auratus*)	0/5.0/10.0	mg/kg diet	FD	21	days	4	weeks	JV	male	BDWT	WO	5	10	Yes	0.099	Yes	0.0074	0.374	0.747	Julius et al., 1983
Growth	Selenomethionine	100	Rat (*Rattus norvegicus*)	0/8.27	mg/kg diet	FD	4	weeks	NR	NR	JV	NR	BDWT	WO		8.27	Yes	0.153	No	0.0147		0.794	Palmer et al., 1982
Growth	Seleno-dl-methionine	100	Pig (*Sus scrofa*)	0/25	mg/org/d	FD	6	weeks	8-10	weeks	JV	both	BDWT	WO		25	No	31.5	No	1.1710		0.794	Panter et al., 1996
Growth	Se in food (seleniferous corn)	100	Rat (*Rattus norvegicus*)	0/8.28	mg/kg diet	FD	4	weeks	NR	NR	JV	NR	BDWT	WO		8.28	Yes	0.131	No	0.0129		0.817	Palmer et al., 1982
Growth	D-selenomethionine	100	Rat (*Rattus norvegicus*)	0/2.5/5/10	ug/g diet	FD	6	weeks	21	days	JV	male	BDWT	WO	5	10	No	0.267	No	0.0232	0.435	0.869	McAdam and Levander, 1987
Growth	L-selenomethionine	100	Rat (*Rattus norvegicus*)	0/2.5/5/10	ug/g diet	FD	6	weeks	21	days	JV	male	BDWT	WO	5	10	No	0.267	No	0.0232	0.435	0.869	McAdam and Levander, 1987
Growth	D-selenomethionine	100	Rat (*Rattus norvegicus*)	0/10/16	mg/kg diet	FD	8	weeks	NR	NR	JV	female	BDWT	WO	10	16	No	0.124	No	0.0124	0.996	1.59	Hermann, et.al., 1991
Growth	L-selenomethionine	100	Rat (*Rattus norvegicus*)	0/10/16	mg/kg diet	FD	8	weeks	NR	NR	JV	female	BDWT	WO	10	16	No	0.124	No	0.0124	0.996	1.59	Hermann, et.al., 1991
Growth	Se in food (seleniferous wheat and oats)	100	Pig (*Sus scrofa*)	0/2.58/5.60/8.4	mg/kg diet	FD	6	weeks	NR	NR	JV	both	BDWT	WO	8.4		Yes	31.08	Yes	0.9800	0.265		Goehring et al., 1984
Growth	Se in food (selenium yeast)	100	Pig (*Sus scrofa*)	0/3/7/10	mg/kg diet	FD	14	weeks	NR	NR	JV	female	BDWT	WO	10		Yes	101	Yes	2.3800	0.236		Kim and Mahan, 2001c
Growth	Selenomethionine	100	Rat (*Rattus norvegicus*)	0/0.5/2.5	ug/g diet	FD	6	weeks	NR	NR	JV	male	BDWT	WO	2.5		Yes	0.270	No	0.0234	0.217		Salbe and Levander, 1990
Growth	Selenomethionine	40.26	Rat (*Rattus norvegicus*)	0/10	mg/kg diet	FD	5	weeks	NR	NR	JV	male	BDWT	WO	10		No	0.18	No	0.0168	0.375		Dausch and Fullerton, 1993
Growth	Selenomethionine	100	Rat (*Rattus norvegicus*)	0/1/2/4	mg/kg diet	FD	9	weeks	NR	NR	JV	male	BDWT	WO	4		Yes	0.204	Yes	0.0250	0.490		Whanger and Butler, 1988
Growth	Selenomethionine	100	Mouse (*Mus musculus*)	0/0.26/0.63/1.96	mg/kg bw/d	DR	14	days	7-8	weeks	JV	male	BDWT	WO	1.96		Yes	0.0245	No	0.0035	1.96		Tsunoda et al., 2000
Field Studies/Observations																							
Reproduction	Se in food in field	100	Raccoon	0/32-122[a]	mg/kg water	FD,DR[b]	6->46	months	6->46	months	JV,AD	both (mostly female)	Repro. condition, condition index	WO	32 - 122		Yes	5.725	No	0.2617	1.35-5.09		Clark et al., 1989
Growth	Se in food in field	100	Raccoon	0/32-122[a]	mg/kg water	FD,DR[b]	6->46	months	6->46	months	JV,AD	both (mostly female)	BDWT	WO	32 - 122		Yes	5.725	No	0.2617	1.35-5.09		Clark et al., 1989
Rep, Growth	Se in food in field	100	Ornate shrew	0/59	mg/kg water	FD,DR[b]	NR	NR	NR	NR	AD	both	Repro. condition, condition index	WO	59		No	0.005675[d]	No	0.0012	13		Clark, 1987
Rep, Growth	Se in food in field	100	Western harvest mouse	0/4.29	mg/kg water	FD,DR[b]	NR	NR	NR	NR	AD	both	Repro. condition, condition index	WO	4.29		No	0.0086[e]	No	0.0017	0.852		Clark, 1987
Rep, Growth	Se in food in field	100	Mink (Mustela vison)	0/130[d]	mg/kg water	FD,DR[b]	NR	NR	NR	NR	NR	NR	potential extirpation	Rep		130	No	1.11	No	0.0735		8.61	Clark, 1987

Selected TRV is discussed in text

LOAEL = lowest observed effect level
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = no observed effect level
NR = not reported

a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; Rep= Reproduction; WI=wings
[a] Assumes plant material concentration similar to muskrat stomach material in Clark (1987) for low end, similar to plant tuber concentration reported in Clark et al. (1989) for high end.
Plant, invertebrates, and mammal diet assumed = 58, 39, and 3% (see exposure profiles) with shrew stomach content concentration and shrew whole body reported in Clark et al. (1987) used for invertebrate and mammal concentrations, respectively.
[b] Concentration in drinking water at Kesterson ignored
[c] CalEcotox exposure factors for ornate shrew
[d] Mosquitofish, invertebrates, plant, and mammal diet (no amphibians at site) assumed = 73, 10, 9, and 8% with shrew stomach content for invertebrate concentration, shrew whole body for mammal concentration, mice and vole stomach content for plant concentrations, and 170 mg/kg Se for mosquitofish (only fish at site, Kadlec and Knight 2000).
[e] Santolo et al. 2009

Table 3-10
Refined Avian Toxicity Reference Value Derivation for Vanadium
Kingston Fossil Plant
Tennessee Valley Authority

Exposure																		Conversion to mg/kg bw/day				Result		
Endpoint	Chemical Form	MW%	Test Species	Conc/Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Reproduction	Ammonium vanadate	100	Japanese Quail (*Coturnix japonica*)	0/50/100/200/300	mg/kg diet	no		FD	1	months	NR	NR	LB	female	WO	300		No	0.1	no	1.30E-02	39.0		Hafez and Kratzer 1976
Growth	Ammonium vanadate	100	Japanese Quail (*Coturnix japonica*)	0/50/100/200/300	mg/kg diet	no		FD	4	weeks	1	days	JV	male	WO	300		No	0.0618	no	9.50E-03	46.1		Hafez and Kratzer 1976
Growth	Sodium metavanadate	41.8	Duck *(Anas platyrhynchos)*	38.5/61.7/98.8/158/252/405 /647/1036/1657/2651	mg/kg diet	likely	5	FD	9	weeks	NR	NR	AD	male	WO	111	440	yes	1.15	yes	9.78E-02	9.42	37.4	Rattner et al. 2006
Survival	Ammonium vanadate	100	Japanese Quail (*Coturnix japonica*)	0/50/100/200/300	mg/kg diet	no		FD	4	weeks	1	days	JV	male	WO	300		No	0.0618	no	9.50E-03	46.1		Hafez and Kratzer 1976*
Survival	Sodium metavanadate	41.8	Duck *(Anas platyrhynchos)*	38.5/61.7/98.8/158/252/405 /647/1036/1657/2651	mg/kg diet	likely	5	FD	9	weeks	NR	NR	AD	male	WO	111		yes	1.15	yes	9.78E-02	9.42		Rattner et al. 2006
Survival	Vanadyl sulfate	100	Duck *(Anas platyrhynchos)*	0/1.87/2.84/10.36/110	mg/kg diet	yes		FD	12	weeks	1	years	AD	both	WO	116		yes	1.17	yes	1.21E-01	12		White and Dieter, 1978
Survival	Vanadate	100	Duck *(Anas sp.)*	0/100	mg/kg diet	no		FD	15	day	1	days	JV	male	WO	100		No	0.092	no	1.23E-02	13.4		Van Vleet et al, 1981

* The NOAEL reported for this study in the EcoSSL table was incorrectly calculated from body weight, diet NOAEL, and ingestion rate as 98 mg/kg-day but should be 46.1 as shown in this table.
Selected TRV is discussed in text.
LOAEL = Lowest observed adverse effect level.
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = No observed adverse effect level.
NR = not reported
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings

Table 3-11
Refined Avian Toxicity Reference Value Derivation for Polychlorinated Biphenyls
Kingston Fossil Plant
Tennessee Valley Authority

Exposure																		Conversion to mg/kg bw/day				Result		
Endpoint	Chemical Form	MW %	Test Species	Conc./ Doses	Conc/ Dose Units	Wet Weight Reported?	Percent Moisture	Route of Exposure[a]	Exposure Duration	Duration Units	Age	Age Units	Lifestage[b]	Sex	Response Site[c]	Study NOAEL (mg/kg diet)	Study LOAEL (mg/kg diet)	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate (kg/day or L/day)	NOAEL Dose (mg/kg-day)	LOAEL Dose (mg/kg-day)	Reference
Reproduction	Aroclors 1248:1254:1260 (1:1:1)	100	American Kestrel (*Falco sparverius*)	0/7	mg/kg-day	no	NR	FD	100	days	NR	NR	LB	Both	EGG*	NA	7	No	No	only in cockerels/ day	1.5 cock/day	NA	**7**	Fernie et al. 2001
Reproduction	Aroclor 1248	100	Screech owl (*Otus asio*)	0/3	mg/kg	no	NR	FD	2	years	NR	NR	LB	Both	EGG, Nestling	3.00		No	0.13	No	0.018	**0.41**		McLane and Hughes et al. 1980

*No effects on eggshell thinning or infertility reported but more yolk and less albumen in eggs with PCBs and more variability in clutch size.
Selected TRV values are in bold.
LOAEL = lowest observed effect level
mg/kg = milligram per kilogram
MW = molecular weight
NA = not applicable
NOAEL = no observed effect level
NR = not reported
a. FD = food; OR = other oral; DR = drinking water
b. AD-adult; IM=immature; JV=juvenile; LB=egg laying bird; MA=mature; SM= sexually mature
c. EGG=egg; EM=embryo; SL=shell; WO=whole organism; GO=gonads; HM=humerus; OD=oviduct; OV=ovary; TE=testes; WI=wings

Attachment 4

Screening Deterministic Risk Characterization Models per Reach and Receptor

Table 4-ER_A-1
Data Summaries
Risk Characterization
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates											
											Larval Mayfly (Whole Body)						Adult Mayfly					
	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)					(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																						
Aluminum	12/12	13800	-	76500	40823	14 / 16	0.0809	-	0.255	0.149	3/3	7540	-	8540	8540	m	6/18	3.9	-	17.6	6.57	
Antimony	4/12	1.27	-	1.8	1.8 m	1 / 16	0.00042	-	0.0004	0.00042 m	3/3	0.26	-	0.53	0.53	m	1/18	0.02	-	0.02	0.02 m	
Arsenic	12/12	5.02	-	32.3	18.72	16 / 16	0.00053	-	0.0025	0.00171	3/3	33.5	-	97	97	m	18/18	0.23	-	0.41	0.3	
Barium	12/12	84.5	-	245	169.8	16 / 16	0.0344	-	0.0487	0.0428	3/3	91.3	-	140	140	m	18/18	0.71	-	1.7	1.36	
Beryllium	11/12	0.59	-	2.19	1.52	0 / 16	0	-	0	0	3/3	0.77	-	0.96	0.96	m	0/18	0	-	0	0	
Boron	12/12	6.01	-	88	35.39	16 / 16	0.0143	-	0.0298	0.0224	3/3	5.4	-	8.7	8.7	m	18/18	0.42	-	3.3	1.38	
Cadmium	0/12	0	-	0	0	0 / 16	0	-	0	0	3/3	0.24	-	1.1	1.1	m	18/18	0.03	-	0.24	0.15	
Chromium	12/12	15.2	-	86	49.16	8 / 16	0.00037	-	0.0027	0.00084	3/3	10.8	-	12	12	m	9/18	0.13	-	0.29	0.22	
Cobalt	12/12	7.74	-	46.6	24.88	0 / 16	0	-	0	0	3/3	7.4	-	8.1	8.1	m	18/18	0.54	-	0.91	0.81	
Copper	12/12	6.08	-	31.7	22.06	16 / 16	0.00058	-	0.0021	0.00168	3/3	19.5	-	21.2	21.2	m	18/18	10.6	-	26.7	21.7	
Iron	12/12	13300	-	48200	39267	16 / 16	0.0776	-	0.22	0.121	3/3	8760	-	11600	11600	m	18/18	93.4	-	196	165	
Lead	12/12	12.5	-	126	67.89	1 / 16	0.00036	-	0.0004	0.00036 m	3/3	8.6	-	10.3	10.3	m	0/18	0	-	0	0	
Manganese	12/12	289	-	2910	1511	16 / 16	0.021	-	0.0393	0.0316	3/3	482	-	535	535	m	18/18	1.9	-	6.4	3.44	
Mercury	6/12	0.058	-	0.13	0.0865	2 / 16	0.00016	-	0.0002	0.00019 m	3/3	0.1	-	0.14	0.14	m	18/18	0.04	-	0.07	0.05	
Molybdenum	0/12	0	-	0	0	14 / 16	0.00054	-	0.0015	0.00111	3/3	1.6	-	2.9	2.9	m	18/18	0.33	-	0.85	0.68	
Nickel	12/12	7.42	-	40.6	25.41	16 / 16	0.00035	-	0.0007	0.00055	3/3	12.4	-	13.3	13.3	m	1/18	0.1	-	0.1	0.1 m	
Selenium	3/12	1.89	-	3.05	3.05 m	7 / 16	0.00035	-	0.0009	0.00048	3/3	6.3	-	11.9	11.9	m	18/18	5.6	-	8.2	7.35	
Silver	0/12	0	-	0	0	0 / 16	0	-	0	0	0/3	0	-	0	0		18/18	0.01	-	0.02	0.01	
Strontium	12/12	9.94	-	149	102.2	16 / 16	0.109	-	0.126	0.119	3/3	27.5	-	57.2	57.2	m	18/18	0.63	-	1.2	0.97	
Thallium	0/12	0	-	0	0	0 / 16	0	-	0	0	3/3	0.23	-	0.56	0.56	m	0/18	0	-	0	0	
Vanadium	12/12	24.2	-	80.1	55.44	10 / 16	0.0011	-	0.003	0.00208	3/3	19.1	-	25.5	25.5	m	18/18	0.07	-	0.2	0.17	
Zinc	12/12	27.3	-	132	74.73	2 / 16	0.00993	-	0.0137	0.0137 m	3/3	137	-	155	155	m	18/18	87.6	-	220	160	

Table 4-ER_A-1
Data Summaries
Risk Characterization
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	35.3	-	200.8	201	m	3/3	1670	-	1970	1970	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		0/3	0	-	0	0		0/40	0	-	0	0	
Arsenic	0/6	0	-	0	0		3/3	2	-	2.1	2.1	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	25.6	-	39.74	39.7	m	3/3	30	-	32	32	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		0/3	0	-	0	0		0/40	0	-	0	0	
Boron	6/6	9.69	-	60	60	m	1/3	1.9	-	1.9	1.9	m	0/40	0	-	0	0	
Cadmium	0/6	0	-	0	0		0/3	0	-	0	0		17/40	0.09	-	0.3406	0.14	
Chromium	1/6	0.46	-	0.4592	0.46	m	3/3	3.5	-	5.9	5.9	m	0/40	0	-	0	0	
Cobalt	6/6	0.09	-	0.5528	0.55	m	3/3	1.5	-	1.7	1.7	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	5.36	-	9.398	9.4	m	3/3	5.5	-	6	6	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	66.9	-	265.3	265	m	3/3	1610	-	2020	2020	m	34/40	99.1	-	532.7	238	
Lead	2/6	0.09	-	0.1224	0.12	m	3/3	1.7	-	2	2	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	48.5	-	333.8	334	m	3/3	144	-	149	149	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		3/3	0.061	-	0.1	0.1	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	5/6	0.58	-	1.282	1.28	m	0/3	0	-	0	0		7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.83	-	2.161	2.16	m	3/3	2.1	-	2.4	2.4	m	0/40	0	-	0	0	
Selenium	1/6	0.53	-	0.531	0.53	m	3/3	1.9	-	2.7	2.7	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		0/3	0	-	0	0		8/40	0.03	-	0.0927	0.04	
Strontium	6/6	27.1	-	69.23	69.2	m	3/3	47.6	-	52.6	52.6	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/3	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.28	-	0.2806	0.28	m	3/3	2.7	-	3.1	3.1	m	0/40	0	-	0	0	
Zinc	5/6	19.9	-	39.1	39.1	m	3/3	86.8	-	91.5	91.5	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-ER_A-2
Screening Risk Characterization for the Wood Duck
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	40,823		0.149		8,540	m	200.8	m	3.10E+02	109.7	3
Antimony	1.8	m	0.0004	m	0.53	m	0		1.74E-02	18	0.001
Arsenic	18.72		0.0017		97	m	0		2.66E+00	2.24	1
Barium	169.8		0.0428		140	m	39.74	m	6.27E+00	20.8	0.3
Beryllium	1.52		0		0.96	m	0		2.86E-02	0.532	0.05
Boron	35.39		0.0224		8.7	m	60	m	3.60E+00	28	0.1
Cadmium	0		0		1.1	m	0		2.98E-02	1.47	0.02
Chromium	49.16		0.0008		12	m	0.4592	m	4.32E-01	2.66	0.2
Cobalt	24.88		0		8.1	m	0.5528	m	2.91E-01	7.61	0.04
Copper	22.06		0.0017		21.2	m	9.398	m	1.13E+00	4.05	0.3
Iron	39,267		0.121		11,600	m	265.3	m	3.94E+02	109.3	4
Lead	67.89		0.0004	m	10.3	m	0.1224	m	3.98E-01	1.63	0.2
Manganese	1,511		0.0316		535	m	333.8	m	3.54E+01	179	0.2
Mercury	0.0865		0.0002	m	0.14	m	0		3.95E-03	0.45	0.009
Molybdenum	0		0.0011		2.9	m	1.282	m	1.49E-01	3.5	0.04
Nickel	25.41		0.0006		13.3	m	2.161	m	5.22E-01	6.71	0.08
Selenium	3.05	m	0.0005		11.9	m	0.531	m	3.57E-01	0.29	1
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	102.2		0.119		57.2	m	69.23	m	5.54E+00	312	0.02
Thallium	0		0		0.56	m	0		1.52E-02	0.35	0.04
Vanadium	55.44		0.0021		25.5	m	0.2806	m	7.99E-01	0.344	2
Zinc	74.73		0.0137	m	155	m	39.1	m	6.48E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-3
Screening Risk Characterization for the Mallard Duck
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	40,823		0.149		8,540	m	200.8	m	5.40E+02	109.7	5
Antimony	1.8	m	0.0004	m	0.53	m	0		3.16E-02	18	0.002
Arsenic	18.72		0.0017		97	m	0		5.07E+00	2.24	2
Barium	169.8		0.0428		140	m	39.74	m	8.34E+00	20.8	0.4
Beryllium	1.52		0		0.96	m	0		5.33E-02	0.532	0.1
Boron	35.39		0.0224		8.7	m	60	m	1.57E+00	28	0.06
Cadmium	0		0		1.1	m	0		5.70E-02	1.47	0.04
Chromium	49.16		0.0008		12	m	0.4592	m	7.43E-01	2.66	0.3
Cobalt	24.88		0		8.1	m	0.5528	m	4.86E-01	7.61	0.06
Copper	22.06		0.0017		21.2	m	9.398	m	1.31E+00	4.05	0.3
Iron	39,267		0.121		11,600	m	265.3	m	6.96E+02	109.3	6
Lead	67.89		0.0004	m	10.3	m	0.1224	m	6.91E-01	1.63	0.4
Manganese	1,511		0.0316		535	m	333.8	m	3.70E+01	179	0.2
Mercury	0.0865		0.0002	m	0.14	m	0		7.47E-03	0.45	0.02
Molybdenum	0		0.0011		2.9	m	1.282	m	1.73E-01	3.5	0.05
Nickel	25.41		0.0006		13.3	m	2.161	m	7.85E-01	6.71	0.1
Selenium	3.05	m	0.0005		11.9	m	0.531	m	6.33E-01	0.29	2
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	102.2		0.119		57.2	m	69.23	m	4.40E+00	312	0.01
Thallium	0		0		0.56	m	0		2.90E-02	0.35	0.08
Vanadium	55.44		0.0021		25.5	m	0.2806	m	1.45E+00	0.344	4
Zinc	74.73		0.0137	m	155	m	39.1	m	8.89E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-4
Screening Risk Characterization for the Killdeer
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	40,823		0.149		8,540	m	1.94E+03	109.7	18
Antimony	1.8	m	0.0004	m	0.53	m	1.09E-01	18	0.006
Arsenic	18.72		0.0017		97	m	1.50E+01	2.24	7
Barium	169.8		0.0428		140	m	2.40E+01	20.8	1
Beryllium	1.52		0		0.96	m	1.70E-01	0.532	0.3
Boron	35.39		0.0224		8.7	m	1.88E+00	28	0.07
Cadmium	0		0		1.1	m	1.67E-01	1.47	0.1
Chromium	49.16		0.0008		12	m	2.60E+00	2.66	1
Cobalt	24.88		0		8.1	m	1.62E+00	7.61	0.2
Copper	22.06		0.0017		21.2	m	3.57E+00	4.05	0.9
Iron	39,267		0.121		11,600	m	2.38E+03	109.3	22
Lead	67.89		0.0004	m	10.3	m	2.64E+00	1.63	2
Manganese	1,511		0.0316		535	m	1.05E+02	179	0.6
Mercury	0.0865		0.0002	m	0.14	m	2.27E-02	0.45	0.05
Molybdenum	0		0.0011		2.9	m	4.41E-01	3.5	0.1
Nickel	25.41		0.0006		13.3	m	2.42E+00	6.71	0.4
Selenium	3.05	m	0.0005		11.9	m	1.86E+00	0.29	6
Silver	0		0		0		0.00E+00	2.02	--
Strontium	102.2		0.119		57.2	m	1.03E+01	312	0.03
Thallium	0		0		0.56	m	8.51E-02	0.35	0.2
Vanadium	55.44		0.0021		25.5	m	4.75E+00	0.344	14
Zinc	74.73		0.0137	m	155	m	2.47E+01	66.1	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-5
Screening Risk Characterization for the Heron
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	40,823		0.149		8,540	m	1,970	m	1.41E+02	109.7	1
Antimony	1.8	m	0.00042	m	0.53	m	0		1.62E-03	18	0.00009
Arsenic	18.72		0.00171		97	m	2.1	m	2.35E-01	2.24	0.1
Barium	169.8		0.0428		140	m	32	m	2.01E+00	20.8	0.1
Beryllium	1.52		0		0.96	m	0		1.93E-03	0.532	0.004
Boron	35.39		0.0224		8.7	m	1.9	m	1.35E-01	28	0.005
Cadmium	0		0		1.1	m	0		1.23E-03	1.47	0.0008
Chromium	49.16		0.00084		12	m	5.9	m	3.65E-01	2.66	0.1
Cobalt	24.88		0		8.1	m	1.7	m	1.16E-01	7.61	0.02
Copper	22.06		0.00168		21.2	m	6	m	3.66E-01	4.05	0.09
Iron	39,267		0.121		11,600	m	2,020	m	1.46E+02	109.3	1
Lead	67.89		0.00036	m	10.3	m	2	m	1.60E-01	1.63	0.1
Manganese	1,511		0.0316		535	m	149	m	9.63E+00	179	0.05
Mercury	0.0865		0.00019	m	0.14	m	0.095	m	5.43E-03	0.45	0.01
Molybdenum	0		0.00111		2.9	m	0		3.30E-03	3.5	0.0009
Nickel	25.41		0.00055		13.3	m	2.4	m	1.61E-01	6.71	0.02
Selenium	3.05	m	0.00048		11.9	m	2.7	m	1.63E-01	0.29	0.6
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	102.2		0.119		57.2	m	52.6	m	3.02E+00	312	0.01
Thallium	0		0		0.56	m	0		6.28E-04	0.35	0.002
Vanadium	55.44		0.00208		25.5	m	3.1	m	2.30E-01	0.344	0.7
Zinc	74.73		0.0137	m	155	m	91.5	m	5.24E+00	66.1	0.08

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-6
Screening Risk Characterization for the Osprey
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.149		1,970	m	1.22E+02	109.7	1
Antimony	0.00042	m	0		2.10E-05	18	0.000001
Arsenic	0.00171		2.1	m	1.30E-01	2.24	0.06
Barium	0.0428		32	m	1.98E+00	20.8	0.1
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0224		1.9	m	1.18E-01	28	0.004
Cadmium	0		0		0.00E+00	1.47	--
Chromium	0.0008394		5.9	m	3.64E-01	2.66	0.1
Cobalt	0		1.7	m	1.05E-01	7.61	0.01
Copper	0.00168		6	m	3.70E-01	4.05	0.09
Iron	0.121		2,020	m	1.25E+02	109.3	1
Lead	0.00036	m	2	m	1.23E-01	1.63	0.08
Manganese	0.0316		149	m	9.20E+00	179	0.05
Mercury	0.00019	m	0.095	m	5.87E-03	0.45	0.01
Molybdenum	0.00111		0		5.54E-05	3.5	0.00002
Nickel	0.0005525		2.4	m	1.48E-01	6.71	0.02
Selenium	0.0004831		2.7	m	1.67E-01	0.29	0.6
Silver	0		0		0.00E+00	2.02	--
Strontium	0.119		52.6	m	3.25E+00	312	0.01
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00208		3.1	m	1.91E-01	0.344	0.6
Zinc	0.0137	m	91.5	m	5.65E+00	66.1	0.09

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-7
Screening Risk Characterization for the Muskrat
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	40,823		0.149		200.8	m	2.13E+02	1.93	110
Antimony	1.8	m	0.0004	m	0		8.98E-03	0.059	0.2
Arsenic	18.72		0.0017		0		9.32E-02	1.04	0.09
Barium	169.8		0.0428		39.74	m	2.95E+00	51.8	0.06
Beryllium	1.52		0		0		7.55E-03	0.532	0.01
Boron	35.39		0.0224		60	m	3.35E+00	28.8	0.1
Cadmium	0		0		0		0.00E+00	0.77	--
Chromium	49.16		0.0008		0.4592	m	2.69E-01	2.4	0.1
Cobalt	24.88		0		0.5528	m	1.53E-01	7.33	0.02
Copper	22.06		0.0017		9.398	m	6.07E-01	5.6	0.1
Iron	39,267		0.121		265.3	m	2.09E+02	22.8	9
Lead	67.89		0.0004	m	0.1224	m	3.44E-01	4.7	0.07
Manganese	1,511		0.0316		333.8	m	2.52E+01	51.5	0.5
Mercury	0.0865		0.0002	m	0		4.48E-04	1	0.0004
Molybdenum	0		0.0011		1.282	m	6.79E-02	0.26	0.3
Nickel	25.41		0.0006		2.161	m	2.41E-01	1.7	0.1
Selenium	3.05	m	0.0005		0.531	m	4.33E-02	0.143	0.3
Silver	0		0		0		0.00E+00	6.02	--
Strontium	102.2		0.119		69.23	m	4.18E+00	263	0.02
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	55.44		0.0021		0.2806	m	2.90E-01	4.16	0.07
Zinc	74.73		0.0137	m	39.1	m	2.44E+00	75.4	0.03

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-8
Screening Risk Characterization for the Raccoon
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	40,823		0.149		8,540	m	200.8	m	1,970	m	2.62E+02	1.93	140
Antimony	1.8	m	0.00042	m	0.53	m	0		0		1.35E-02	0.059	0.2
Arsenic	18.72		0.00171		97	m	0		2.1	m	1.42E+00	1.04	1
Barium	169.8		0.0428		140	m	39.74	m	32	m	3.38E+00	51.8	0.07
Beryllium	1.52		0		0.96	m	0		0		1.85E-02	0.532	0.03
Boron	35.39		0.0224		8.7	m	60	m	1.9	m	1.49E+00	28.8	0.05
Cadmium	0		0		1.1	m	0		0		1.53E-02	0.77	0.02
Chromium	49.16		0.00084		12	m	0.4592	m	5.9	m	3.48E-01	2.4	0.1
Cobalt	24.88		0		8.1	m	0.5528	m	1.7	m	2.10E-01	7.33	0.03
Copper	22.06		0.00168		21.2	m	9.398	m	6	m	5.71E-01	5.6	0.1
Iron	39,267		0.121		11,600	m	265.3	m	2,020	m	3.01E+02	22.8	13
Lead	67.89		0.00036	m	10.3	m	0.1224	m	2	m	3.76E-01	4.7	0.08
Manganese	1,511		0.0316		535	m	333.8	m	149	m	1.96E+01	51.5	0.4
Mercury	0.0865		0.00019	m	0.14	m	0		0.095	m	2.36E-03	1	0.002
Molybdenum	0		0.00111		2.9	m	1.282	m	0		6.71E-02	0.26	0.3
Nickel	25.41		0.00055		13.3	m	2.161	m	2.4	m	3.18E-01	1.7	0.2
Selenium	3.05	m	0.00048		11.9	m	0.531	m	2.7	m	1.90E-01	0.143	1
Silver	0		0		0		0		0		0.00E+00	6.02	--
Strontium	102.2		0.119		57.2	m	69.23	m	52.6	m	2.64E+00	263	0.01
Thallium	0		0		0.56	m	0		0		7.81E-03	0.015	0.5
Vanadium	55.44		0.00208		25.5	m	0.2806	m	3.1	m	5.51E-01	4.16	0.1
Zinc	74.73		0.0137	m	155	m	39.1	m	91.5	m	3.32E+00	75.4	0.04

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-9
Screening Risk Characterization for the Mink
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Exposure Point Concentration [a]														Toxicity Reference	Hazard
	Exposed		Surface		Invertebrate		Vegetation		Fish		Amphibian		Dietary		Value [c]	Quotient
	Sediment		Water		WB Larval Mayfly				WB Shad		Frogs		Ingestion [b]		NOAEL	(HQ) [d]
Constituent	(mg/kg)		(mg/L)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg-BW-day)		(mg/kg-BW-day)	NOAEL
Inorganics																
Aluminum	40,823		0.149		8,540	m	200.8	m	1,970	m	56.6		1.74E+02		1.93	90
Antimony	1.8	m	0.0004	m	0.53	m	0		0		0		4.82E-03		0.059	0.08
Arsenic	18.72		0.0017		97	m	0		2.1	m	0.8164	m	6.31E-01		1.04	0.6
Barium	169.8		0.0428		140	m	39.74	m	32	m	78.98		2.58E+00		51.8	0.05
Beryllium	1.52		0		0.96	m	0		0		0		6.79E-03		0.532	0.01
Boron	35.39		0.0224		8.7	m	60	m	1.9	m	0		4.57E-01		28.8	0.02
Cadmium	0		0		1.1	m	0		0		0.143		6.10E-03		0.77	0.008
Chromium	49.16		0.0008		12	m	0.4592	m	5.9	m	0		3.68E-01		2.4	0.2
Cobalt	24.88		0		8.1	m	0.5528	m	1.7	m	0.228		1.45E-01		7.33	0.02
Copper	22.06		0.0017		21.2	m	9.398	m	6	m	18.35		4.61E-01		5.6	0.08
Iron	39,267		0.121		11,600	m	265.3	m	2,020	m	237.9		1.91E+02		22.8	8
Lead	67.89		0.0004	m	10.3	m	0.1224	m	2	m	0.7493	m	2.14E-01		4.7	0.05
Manganese	1,511		0.0316		535	m	333.8	m	149	m	88.97		1.25E+01		51.5	0.2
Mercury	0.0865		0.0002	m	0.14	m	0		0.095	m	0.13		5.04E-03		1	0.005
Molybdenum	0		0.0011		2.9	m	1.282	m	0		0.32		2.23E-02		0.26	0.09
Nickel	25.41		0.0006		13.3	m	2.161	m	2.4	m	0		2.10E-01		1.7	0.1
Selenium	3.05	m	0.0005		11.9	m	0.531	m	2.7	m	2.066		1.86E-01		0.143	1
Silver	0		0		0		0		0		0.038		5.10E-05		6.02	0.000008
Strontium	102.2		0.119		57.2	m	69.23	m	52.6	m	77.81		3.08E+00		263	0.01
Thallium	0		0		0.56	m	0		0		0.34	m	3.46E-03		0.015	0.2
Vanadium	55.44		0.0021		25.5	m	0.2806	m	3.1	m	0		3.29E-01		4.16	0.08
Zinc	74.73		0.0137	m	155	m	39.1	m	91.5	m	145		5.15E+00		75.4	0.07

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-10
Screening Risk Characterization for the Tree Swallow
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.149		6.567		1.65E+00	109.7	0.02
Antimony	0.00042	m	0.017	m	4.28E-03	18	0.0002
Arsenic	0.00171		0.303		7.50E-02	2.24	0.03
Barium	0.0428		1.359		3.44E-01	20.8	0.02
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0224		1.382		3.45E-01	28	0.01
Cadmium	0		0.15		3.70E-02	1.47	0.03
Chromium	0.0008394		0.216		5.34E-02	2.66	0.02
Cobalt	0		0.812		2.00E-01	7.61	0.03
Copper	0.00168		21.67		5.34E+00	4.05	1
Iron	0.121		165		4.07E+01	109.3	0.4
Lead	0.00036	m	0		7.66E-05	1.63	0.00005
Manganese	0.0316		3.441		8.55E-01	179	0.005
Mercury	0.00019	m	0.0533		1.32E-02	0.45	0.03
Molybdenum	0.00111		0.678		1.67E-01	3.5	0.05
Nickel	0.0005525		0.1	m	2.48E-02	6.71	0.004
Selenium	0.0004831		7.349		1.81E+00	0.29	6
Silver	0		0.0132		3.25E-03	2.02	0.002
Strontium	0.119		0.973		2.65E-01	312	0.0008
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00208		0.17		4.23E-02	0.344	0.1
Zinc	0.0137	m	159.6		3.93E+01	66.1	0.6

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-11
Screening Risk Characterization for the Gray Bat
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.149		6.567		1.22E+00	1.93	0.6
Antimony	0.00042	m	0.017	m	3.15E-03	0.059	0.05
Arsenic	0.00171		0.303		5.53E-02	1.04	0.05
Barium	0.0428		1.359		2.53E-01	51.8	0.005
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0224		1.382		2.54E-01	28.8	0.009
Cadmium	0		0.15		2.72E-02	0.77	0.04
Chromium	0.00083938		0.216		3.93E-02	2.4	0.02
Cobalt	0		0.812		1.47E-01	7.33	0.02
Copper	0.00168		21.67		3.93E+00	5.6	0.7
Iron	0.121		165		3.00E+01	22.8	1
Lead	0.00036	m	0		5.68E-05	4.7	0.00001
Manganese	0.0316		3.441		6.30E-01	51.5	0.01
Mercury	0.00019	m	0.0533		9.70E-03	1	0.01
Molybdenum	0.00111		0.678		1.23E-01	0.26	0.5
Nickel	0.00055247		0.1	m	1.82E-02	1.7	0.01
Selenium	0.00048313		7.349		1.33E+00	0.143	9
Silver	0		0.0132		2.40E-03	6.02	0.0004
Strontium	0.119		0.973		1.95E-01	263	0.0007
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00208		0.17		3.12E-02	4.16	0.007
Zinc	0.0137	m	159.6		2.90E+01	75.4	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_A-12
Screening Risk Characterization Results Summary
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**3**	**5**	**18**	1	1	**110**	**140**	**90**	0.02	0.6
Antimony	0.001	0.002	0.006	0.00009	0.000001	0.2	0.2	0.08	0.0002	0.05
Arsenic	1	**2**	**7**	0.1	0.06	0.09	1	0.6	0.03	0.05
Barium	0.3	0.4	1	0.1	0.1	0.06	0.07	0.05	0.02	0.005
Beryllium	0.05	0.1	0.3	0.004	--	0.01	0.03	0.01	--	--
Boron	0.1	0.06	0.07	0.005	0.004	0.1	0.05	0.02	0.01	0.009
Cadmium	0.02	0.04	0.1	0.0008	--	--	0.02	0.008	0.03	0.04
Chromium	0.2	0.3	1	0.1	0.1	0.1	0.1	0.2	0.02	0.02
Cobalt	0.04	0.06	0.2	0.02	0.01	0.02	0.03	0.02	0.03	0.02
Copper	0.3	0.3	0.9	0.09	0.09	0.1	0.1	0.08	1	0.7
Iron	**4**	**6**	**22**	1	1	**9**	**13**	**8**	0.4	1
Lead	0.2	0.4	**2**	0.1	0.08	0.07	0.08	0.05	0.00005	0.00001
Manganese	0.2	0.2	0.6	0.05	0.05	0.5	0.4	0.2	0.005	0.01
Mercury	0.009	0.02	0.05	0.01	0.01	0.0004	0.002	0.005	0.03	0.01
Molybdenum	0.04	0.05	0.1	0.0009	0.00002	0.3	0.3	0.09	0.05	0.5
Nickel	0.08	0.1	0.4	0.02	0.02	0.1	0.2	0.1	0.004	0.01
Selenium	1	**2**	**6**	0.6	0.6	0.3	1	1	**6**	**9**
Silver	--	--	--	--	--	--	--	0.000008	0.002	0.0004
Strontium	0.02	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.0008	0.0007
Thallium	0.04	0.08	0.2	0.002	--	--	0.5	0.2	--	--
Vanadium	**2**	**4**	**14**	0.7	0.6	0.07	0.1	0.08	0.1	0.007
Zinc	0.1	0.1	0.4	0.08	0.09	0.03	0.04	0.07	0.6	0.4

Hazard quotients greater than one are in bold.

Table 4-ER_B-1
Data Summaries
Risk Characterization
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates											
											Larval Mayfly (Whole Body)					Adult Mayfly						
	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)					(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																						
Aluminum	18/18	3320	-	39400	21792	13 / 16	0.124	-	0.319	0.231	3/3	9050	-	10300	10300	m	11/18	4.3	-	27.1	9.38	
Antimony	2/18	1.39	-	2.26	2.26 m	0 / 16	0	-	0	0	3/3	0.2	-	0.22	0.22	m	2/18	0.02	-	0.04	0.04	m
Arsenic	17/18	3.15	-	62.4	31.33	16 / 16	0.00134	-	0.0028	0.002	3/3	13.1	-	17.6	17.6	m	18/18	0.35	-	0.62	0.5	
Barium	18/18	20.4	-	478	193.2	16 / 16	0.0374	-	0.054	0.049	3/3	84.9	-	93	93	m	18/18	0.91	-	1.8	1.52	
Beryllium	15/18	0.656	-	3.52	1.417	0 / 16	0	-	0	0	3/3	0.74	-	0.88	0.88	m	0/18	0	-	0	0	
Boron	12/18	5.31	-	51.8	20.81	16 / 16	0.0158	-	0.027	0.023	2/3	5	-	5.4	5.4	m	18/18	0.48	-	2.3	1.5	
Cadmium	0/18	0	-	0	0	0 / 16	0	-	0	0	3/3	0.45	-	0.68	0.68	m	18/18	0.02	-	0.15	0.09	
Chromium	18/18	5.27	-	42.4	27.62	4 / 16	0.00033	-	0.0005	5E-04 m	3/3	10.9	-	12.4	12.4	m	18/18	0.14	-	0.23	0.19	
Cobalt	18/18	2.59	-	38.1	18.42	0 / 16	0	-	0	0	3/3	8.9	-	9.8	9.8	m	18/18	0.37	-	0.79	0.66	
Copper	18/18	1.64	-	47.1	21.72	16 / 16	0.00065	-	0.0017	0.001	3/3	17.8	-	19.4	19.4	m	18/18	12.3	-	27.7	20.9	
Iron	18/18	3420	-	40000	26649	15 / 16	0.121	-	0.251	0.193	3/3	10200	-	11400	11400	m	18/18	101	-	233	170	
Lead	18/18	3.06	-	79.5	31.51	8 / 16	0.00033	-	0.0004	4E-04	3/3	8.8	-	9.7	9.7	m	0/18	0	-	0	0	
Manganese	18/18	43.6	-	4120	1381	16 / 16	0.00825	-	0.101	0.067	3/3	454	-	520	520	m	18/18	2	-	4.8	3.63	
Mercury	7/18	0.053	-	0.12	0.078	1 / 16	0.00019	-	0.0002	2E-04 m	3/3	0.076	-	0.078	0.078	m	18/18	0.03	-	0.04	0.03	
Molybdenum	0/18	0	-	0	0	14 / 16	0.00062	-	0.0013	0.001	3/3	1.2	-	1.4	1.4	m	18/18	0.34	-	1.4	0.88	
Nickel	18/18	4.2	-	54.7	25.82	16 / 16	0.00044	-	0.0009	6E-04	3/3	14.1	-	15.6	15.6	m	0/18	0	-	0	0	
Selenium	3/18	1.36	-	3.64	3.64 m	8 / 16	0.00033	-	0.0006	4E-04	3/3	6.6	-	7.2	7.2	m	18/18	6.5	-	8.4	7.83	
Silver	0/18	0	-	0	0	0 / 16	0	-	0	0	2/3	0.037	-	0.048	0.048	m	18/18	0.01	-	0.02	0.01	
Strontium	17/18	5.66	-	321	119.6	16 / 16	0.107	-	0.123	0.116	3/3	22.1	-	25	25	m	18/18	0.57	-	1.4	1.09	
Thallium	0/18	0	-	0	0	0 / 16	0	-	0	0	3/3	0.21	-	0.26	0.26	m	0/18	0	-	0	0	
Vanadium	18/18	5.08	-	78.6	39.47	15 / 16	0.00109	-	0.0022	0.002	3/3	17.3	-	19.7	19.7	m	18/18	0.11	-	0.25	0.2	
Zinc	18/18	15.8	-	113	57.66	0 / 16	0	-	0	0	3/3	174	-	187	187	m	18/18	82.5	-	246	180	

Table 4-ER_B-1
Data Summaries
Risk Characterization
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	19	-	167.3	167	m	6/6	44.6	-	2590	2590	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		2/6	0.097	-	0.12	0.12	m	0/40	0	-	0	0	
Arsenic	6/6	0.1	-	1.077	1.08	m	6/6	2	-	4.3	4.3	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	22.9	-	54.09	54.1	m	6/6	13.43	-	43.4	43.4	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		2/6	0.16	-	0.25	0.25	m	0/40	0	-	0	0	
Boron	6/6	8.92	-	28.57	28.6	m	2/6	2.2	-	2.2	2.2	m	0/40	0	-	0	0	
Cadmium	3/6	0.05	-	0.2889	0.29	m	4/6	0.05556	-	0.11	0.11	m	17/40	0.09	-	0.3406	0.14	
Chromium	1/6	0.44	-	0.4377	0.44	m	3/6	3	-	4	4	m	0/40	0	-	0	0	
Cobalt	6/6	0.14	-	0.553	0.55	m	6/6	0.216	-	2.2	2.2	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	3.7	-	6.05	6.05	m	6/6	5.7	-	9.1	9.1	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	59.5	-	235.7	236	m	6/6	101.4	-	2480	2480	m	34/40	99.1	-	532.7	238	
Lead	4/6	0.11	-	0.2222	0.22	m	6/6	0.1481	-	2.8	2.8	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	268	-	883.7	884	m	6/6	122	-	218	218	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		3/6	0.08	-	0.09	0.09	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.61	-	1.429	1.43	m	3/6	0.16	-	0.26	0.26	m	7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.71	-	1.779	1.78	m	2/6	4.2	-	6.5	6.5	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2.2	-	3.95	3.95	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		3/6	0.019	-	0.02	0.02	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	11.8	-	35.94	35.9	m	6/6	37.4	-	47.6	47.6	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.31	-	0.3064	0.31	m	6/6	0.3194	-	6.3	6.3	m	0/40	0	-	0	0	
Zinc	5/6	28.3	-	55.16	55.2	m	6/6	74.7	-	139	139	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-ER_B-2
Screening Risk Characterization for the Wood Duck
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	21,792		0.231		10,300	m	167.3	m	3.25E+02	109.7	3
Antimony	2.26	m	0		0.22	m	0		9.69E-03	18	0.0005
Arsenic	31.33		0.0022		17.6	m	1.077	m	5.89E-01	2.24	0.3
Barium	193.2		0.0492		93	m	54.09	m	5.82E+00	20.8	0.3
Beryllium	1.417		0		0.88	m	0		2.62E-02	0.532	0.05
Boron	20.81		0.0225		5.4	m	28.57	m	1.76E+00	28	0.06
Cadmium	0		0		0.68	m	0.2889	m	3.44E-02	1.47	0.02
Chromium	27.62		0.0005	m	12.4	m	0.4377	m	4.06E-01	2.66	0.2
Cobalt	18.42		0		9.8	m	0.553	m	3.27E-01	7.61	0.04
Copper	21.72		0.0013		19.4	m	6.05	m	8.96E-01	4.05	0.2
Iron	26,649		0.193		11,400	m	235.7	m	3.66E+02	109.3	3
Lead	31.51		0.0004		9.7	m	0.2222	m	3.27E-01	1.63	0.2
Manganese	1,381		0.0674		520	m	883.7	m	6.51E+01	179	0.4
Mercury	0.078		0.0002	m	0.078	m	0		2.26E-03	0.45	0.005
Molybdenum	0		0.001		1.4	m	1.429	m	1.17E-01	3.5	0.03
Nickel	25.82		0.0006		15.6	m	1.779	m	5.64E-01	6.71	0.08
Selenium	3.64	m	0.0004		7.2	m	0		2.01E-01	0.29	0.7
Silver	0		0		0.048	m	0		1.30E-03	2.02	0.0006
Strontium	119.6		0.116		25	m	35.94	m	2.86E+00	312	0.009
Thallium	0		0		0.26	m	0		7.06E-03	0.35	0.02
Vanadium	39.47		0.0017		19.7	m	0.3064	m	6.16E-01	0.344	2
Zinc	57.66		0		187	m	55.16	m	8.21E+00	66.1	0.1

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-3
Screening Risk Characterization for the Mallard Duck
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	21,792		0.231		10,300	m	167.3	m	5.87E+02	109.7	5
Antimony	2.26	m	0		0.22	m	0		1.66E-02	18	0.0009
Arsenic	31.33		0.0022		17.6	m	1.077	m	1.00E+00	2.24	0.4
Barium	193.2		0.0492		93	m	54.09	m	6.20E+00	20.8	0.3
Beryllium	1.417		0		0.88	m	0		4.89E-02	0.532	0.09
Boron	20.81		0.0225		5.4	m	28.57	m	8.23E-01	28	0.03
Cadmium	0		0		0.68	m	0.2889	m	4.03E-02	1.47	0.03
Chromium	27.62		0.0005	m	12.4	m	0.4377	m	7.14E-01	2.66	0.3
Cobalt	18.42		0		9.8	m	0.553	m	5.60E-01	7.61	0.07
Copper	21.72		0.0013		19.4	m	6.05	m	1.16E+00	4.05	0.3
Iron	26,649		0.193		11,400	m	235.7	m	6.56E+02	109.3	6
Lead	31.51		0.0004		9.7	m	0.2222	m	5.79E-01	1.63	0.4
Manganese	1,381		0.0674		520	m	883.7	m	4.54E+01	179	0.3
Mercury	0.078		0.0002	m	0.078	m	0		4.23E-03	0.45	0.009
Molybdenum	0		0.001		1.4	m	1.429	m	9.74E-02	3.5	0.03
Nickel	25.82		0.0006		15.6	m	1.779	m	8.99E-01	6.71	0.1
Selenium	3.64	m	0.0004		7.2	m	0		3.82E-01	0.29	1
Silver	0		0		0.048	m	0		2.49E-03	2.02	0.001
Strontium	119.6		0.116		25	m	35.94	m	2.20E+00	312	0.007
Thallium	0		0		0.26	m	0		1.35E-02	0.35	0.04
Vanadium	39.47		0.0017		19.7	m	0.3064	m	1.12E+00	0.344	3
Zinc	57.66		0		187	m	55.16	m	1.08E+01	66.1	0.2

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-4
Screening Risk Characterization for the Killdeer
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	21,792		0.231		10,300	m	1.91E+03	109.7	17
Antimony	2.26	m	0		0.22	m	6.92E-02	18	0.004
Arsenic	31.33		0.0022		17.6	m	3.17E+00	2.24	1
Barium	193.2		0.0492		93	m	1.72E+01	20.8	0.8
Beryllium	1.417		0		0.88	m	1.56E-01	0.532	0.3
Boron	20.81		0.0225		5.4	m	1.15E+00	28	0.04
Cadmium	0		0		0.68	m	1.03E-01	1.47	0.07
Chromium	27.62		0.0005	m	12.4	m	2.32E+00	2.66	0.9
Cobalt	18.42		0		9.8	m	1.78E+00	7.61	0.2
Copper	21.72		0.0013		19.4	m	3.29E+00	4.05	0.8
Iron	26,649		0.193		11,400	m	2.15E+03	109.3	20
Lead	31.51		0.0004		9.7	m	1.97E+00	1.63	1
Manganese	1,381		0.0674		520	m	1.01E+02	179	0.6
Mercury	0.078		0.0002	m	0.078	m	1.31E-02	0.45	0.03
Molybdenum	0		0.001		1.4	m	2.13E-01	3.5	0.06
Nickel	25.82		0.0006		15.6	m	2.78E+00	6.71	0.4
Selenium	3.64	m	0.0004		7.2	m	1.15E+00	0.29	4
Silver	0		0		0.048	m	7.30E-03	2.02	0.004
Strontium	119.6		0.116		25	m	5.70E+00	312	0.02
Thallium	0		0		0.26	m	3.95E-02	0.35	0.1
Vanadium	39.47		0.0017		19.7	m	3.62E+00	0.344	11
Zinc	57.66		0		187	m	2.93E+01	66.1	0.4

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-5
Screening Risk Characterization for the Heron
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	21,792		0.231		10,300	m	2,590	m	1.66E+02	109.7	2
Antimony	2.26	m	0		0.22	m	0.12	m	8.11E-03	18	0.0005
Arsenic	31.33		0.0022		17.6	m	4.3	m	2.74E-01	2.24	0.1
Barium	193.2		0.0492		93	m	43.4	m	2.60E+00	20.8	0.1
Beryllium	1.417		0		0.88	m	0.25	m	1.55E-02	0.532	0.03
Boron	20.81		0.0225		5.4	m	2.2	m	1.40E-01	28	0.005
Cadmium	0		0		0.68	m	0.11	m	6.81E-03	1.47	0.005
Chromium	27.62		0.0005	m	12.4	m	4	m	2.49E-01	2.66	0.09
Cobalt	18.42		0		9.8	m	2.2	m	1.42E-01	7.61	0.02
Copper	21.72		0.00125		19.4	m	9.1	m	5.34E-01	4.05	0.1
Iron	26,649		0.193		11,400	m	2,480	m	1.64E+02	109.3	2
Lead	31.51		0.00037		9.7	m	2.8	m	1.82E-01	1.63	0.1
Manganese	1,381		0.0674		520	m	218	m	1.33E+01	179	0.07
Mercury	0.078		0.00019	m	0.078	m	0.092	m	5.19E-03	0.45	0.01
Molybdenum	0		0.00101		1.4	m	0.26	m	1.59E-02	3.5	0.005
Nickel	25.82		0.00063		15.6	m	6.5	m	3.89E-01	6.71	0.06
Selenium	3.64	m	0.0004		7.2	m	3.951	m	2.27E-01	0.29	0.8
Silver	0		0		0.048	m	0.023	m	1.32E-03	2.02	0.0007
Strontium	119.6		0.116		25	m	47.6	m	2.72E+00	312	0.009
Thallium	0		0		0.26	m	0		2.92E-04	0.35	0.0008
Vanadium	39.47		0.00169		19.7	m	6.3	m	3.90E-01	0.344	1
Zinc	57.66		0		187	m	139	m	7.88E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-6
Screening Risk Characterization for the Osprey
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.231		2,590	m	1.60E+02	109.7	1
Antimony	0		0.12	m	7.41E-03	18	0.0004
Arsenic	0.0022		4.3	m	2.65E-01	2.24	0.1
Barium	0.0492		43.4	m	2.68E+00	20.8	0.1
Beryllium	0		0.25	m	1.54E-02	0.532	0.03
Boron	0.0225		2.2	m	1.37E-01	28	0.005
Cadmium	0		0.11	m	6.79E-03	1.47	0.005
Chromium	0.0005	m	4	m	2.47E-01	2.66	0.09
Cobalt	0		2.2	m	1.36E-01	7.61	0.02
Copper	0.00125		9.1	m	5.62E-01	4.05	0.1
Iron	0.193		2,480	m	1.53E+02	109.3	1
Lead	0.0003744		2.8	m	1.73E-01	1.63	0.1
Manganese	0.0674		218	m	1.35E+01	179	0.08
Mercury	0.00019	m	0.092	m	5.69E-03	0.45	0.01
Molybdenum	0.00101		0.26	m	1.61E-02	3.5	0.005
Nickel	0.0006287		6.5	m	4.01E-01	6.71	0.06
Selenium	0.0004047		3.951	m	2.44E-01	0.29	0.8
Silver	0		0.023	m	1.42E-03	2.02	0.0007
Strontium	0.116		47.6	m	2.94E+00	312	0.009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00169		6.3	m	3.89E-01	0.344	1
Zinc	0		139	m	8.58E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-7
Screening Risk Characterization for the Muskrat
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	21,792		0.231		167.3	m	1.17E+02	1.93	61
Antimony	2.26	m	0		0		1.12E-02	0.059	0.2
Arsenic	31.33		0.0022		1.077	m	2.13E-01	1.04	0.2
Barium	193.2		0.0492		54.09	m	3.82E+00	51.8	0.07
Beryllium	1.417		0		0		7.04E-03	0.532	0.01
Boron	20.81		0.0225		28.57	m	1.62E+00	28.8	0.06
Cadmium	0		0		0.2889	m	1.53E-02	0.77	0.02
Chromium	27.62		0.0005	m	0.4377	m	1.60E-01	2.4	0.07
Cobalt	18.42		0		0.553	m	1.21E-01	7.33	0.02
Copper	21.72		0.0013		6.05	m	4.28E-01	5.6	0.08
Iron	26,649		0.193		235.7	m	1.45E+02	22.8	6
Lead	31.51		0.0004		0.2222	m	1.68E-01	4.7	0.04
Manganese	1,381		0.0674		883.7	m	5.36E+01	51.5	1
Mercury	0.078		0.0002	m	0		4.06E-04	1	0.0004
Molybdenum	0		0.001		1.429	m	7.56E-02	0.26	0.3
Nickel	25.82		0.0006		1.779	m	2.22E-01	1.7	0.1
Selenium	3.64	m	0.0004		0		1.81E-02	0.143	0.1
Silver	0		0		0		0.00E+00	6.02	--
Strontium	119.6		0.116		35.94	m	2.51E+00	263	0.01
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	39.47		0.0017		0.3064	m	2.12E-01	4.16	0.05
Zinc	57.66		0		55.16	m	3.20E+00	75.4	0.04

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-8
Screening Risk Characterization for the Raccoon
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Exposure Point Concentration [a]																
	Exposed Sediment		Surface Water		Invertebrate WB Larval Mayfly		Vegetation		Fish WB Shad		Dietary Ingestion [b]	Toxicity Reference Value [c] NOAEL	Hazard Quotient (HQ) [d] NOAEL
Constituent	(mg/kg)		(mg/L)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg-BW-day)	(mg/kg-BW-day)	
Inorganics													
Aluminum	21,792		0.231		10,300	m	167.3	m	2,590	m	2.23E+02	1.93	120
Antimony	2.26	m	0		0.22	m	0		0.12	m	1.08E-02	0.059	0.2
Arsenic	31.33		0.0022		17.6	m	1.077	m	4.3	m	3.78E-01	1.04	0.4
Barium	193.2		0.0492		93	m	54.09	m	43.4	m	3.12E+00	51.8	0.06
Beryllium	1.417		0		0.88	m	0		0.25	m	1.73E-02	0.532	0.03
Boron	20.81		0.0225		5.4	m	28.57	m	2.2	m	7.42E-01	28.8	0.03
Cadmium	0		0		0.68	m	0.2889	m	0.11	m	1.56E-02	0.77	0.02
Chromium	27.62		0.0005	m	12.4	m	0.4377	m	4	m	2.79E-01	2.4	0.1
Cobalt	18.42		0		9.8	m	0.553	m	2.2	m	2.12E-01	7.33	0.03
Copper	21.72		0.00125		19.4	m	6.05	m	9.1	m	4.79E-01	5.6	0.09
Iron	26,649		0.193		11,400	m	235.7	m	2,480	m	2.56E+02	22.8	11
Lead	31.51		0.00037		9.7	m	0.2222	m	2.8	m	2.49E-01	4.7	0.05
Manganese	1,381		0.0674		520	m	883.7	m	218	m	3.04E+01	51.5	0.6
Mercury	0.078		0.00019	m	0.078	m	0		0.092	m	1.46E-03	1	0.001
Molybdenum	0		0.00101		1.4	m	1.429	m	0.26	m	4.95E-02	0.26	0.2
Nickel	25.82		0.00063		15.6	m	1.779	m	6.5	m	3.48E-01	1.7	0.2
Selenium	3.64	m	0.0004		7.2	m	0		3.951	m	1.17E-01	0.143	0.8
Silver	0		0		0.048	m	0		0.023	m	6.94E-04	6.02	0.0001
Strontium	119.6		0.116		25	m	35.94	m	47.6	m	1.56E+00	263	0.006
Thallium	0		0		0.26	m	0		0		3.62E-03	0.015	0.2
Vanadium	39.47		0.00169		19.7	m	0.3064	m	6.3	m	4.20E-01	4.16	0.1
Zinc	57.66		0		187	m	55.16	m	139	m	4.09E+00	75.4	0.05

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-9
Screening Risk Characterization for the Mink
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Exposure Point Concentration [a]																		
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Amphibian Frogs (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)		Hazard Quotient (HQ) [d] NOAEL	
Constituent																	
Inorganics																	
Aluminum	21,792		0.231		10,300	m	167.3	m	2,590	m	56.6		1.89E+02	1.93		98	
Antimony	2.26	m	0		0.22	m	0		0.12	m	0		8.67E-03	0.059		0.1	
Arsenic	31.33		0.0022		17.6	m	1.077	m	4.3	m	0.8164	m	3.16E-01	1.04		0.3	
Barium	193.2		0.0492		93	m	54.09	m	43.4	m	78.98		2.91E+00	51.8		0.06	
Beryllium	1.417		0		0.88	m	0		0.25	m	0		1.68E-02	0.532		0.03	
Boron	20.81		0.0225		5.4	m	28.57	m	2.2	m	0		2.84E-01	28.8		0.01	
Cadmium	0		0		0.68	m	0.2889	m	0.11	m	0.143		9.87E-03	0.77		0.01	
Chromium	27.62		0.0005	m	12.4	m	0.4377	m	4	m	0		2.67E-01	2.4		0.1	
Cobalt	18.42		0		9.8	m	0.553	m	2.2	m	0.228		1.68E-01	7.33		0.02	
Copper	21.72		0.0013		19.4	m	6.05	m	9.1	m	18.35		5.65E-01	5.6		0.1	
Iron	26,649		0.193		11,400	m	235.7	m	2,480	m	237.9		1.96E+02	22.8		9	
Lead	31.51		0.0004		9.7	m	0.2222	m	2.8	m	0.7493	m	2.06E-01	4.7		0.04	
Manganese	1,381		0.0674		520	m	883.7	m	218	m	88.97		1.79E+01	51.5		0.3	
Mercury	0.078		0.0002	m	0.078	m	0		0.092	m	0.13		4.57E-03	1		0.005	
Molybdenum	0		0.001		1.4	m	1.429	m	0.26	m	0.32		2.59E-02	0.26		0.1	
Nickel	25.82		0.0006		15.6	m	1.779	m	6.5	m	0		3.94E-01	1.7		0.2	
Selenium	3.64	m	0.0004		7.2	m	0		3.951	m	2.066		2.12E-01	0.143		1	
Silver	0		0		0.048	m	0		0.023	m	0.038		1.28E-03	6.02		0.0002	
Strontium	119.6		0.116		25	m	35.94	m	47.6	m	77.81		2.56E+00	263		0.01	
Thallium	0		0		0.26	m	0		0		0.34	m	1.85E-03	0.015		0.1	
Vanadium	39.47		0.0017		19.7	m	0.3064	m	6.3	m	0		4.15E-01	4.16		0.1	
Zinc	57.66		0		187	m	55.16	m	139	m	145		7.38E+00	75.4		0.1	

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-10
Screening Risk Characterization for the Tree Swallow
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.231		9.378		2.36E+00	109.7	0.02
Antimony	0		0.044	m	1.08E-02	18	0.0006
Arsenic	0.0022		0.5		1.24E-01	2.24	0.06
Barium	0.0492		1.519		3.85E-01	20.8	0.02
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0225		1.496		3.73E-01	28	0.01
Cadmium	0		0.0917		2.26E-02	1.47	0.02
Chromium	0.0005	m	0.187		4.62E-02	2.66	0.02
Cobalt	0		0.663		1.63E-01	7.61	0.02
Copper	0.00125		20.94		5.16E+00	4.05	1
Iron	0.193		170.1		4.20E+01	109.3	0.4
Lead	0.0003744		0		7.97E-05	1.63	0.00005
Manganese	0.0674		3.633		9.10E-01	179	0.005
Mercury	0.00019	m	0.0319		7.90E-03	0.45	0.02
Molybdenum	0.00101		0.881		2.17E-01	3.5	0.06
Nickel	0.0006287		0		1.34E-04	6.71	0.00002
Selenium	0.0004047		7.83		1.93E+00	0.29	7
Silver	0		0.0118		2.91E-03	2.02	0.001
Strontium	0.116		1.088		2.93E-01	312	0.0009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00169		0.199		4.94E-02	0.344	0.1
Zinc	0		180		4.44E+01	66.1	0.7

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-11
Screening Risk Characterization for the Gray Bat
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.231		9.378		1.74E+00	1.93	0.9
Antimony	0		0.044	m	7.99E-03	0.059	0.1
Arsenic	0.0022		0.5		9.11E-02	1.04	0.09
Barium	0.0492		1.519		2.83E-01	51.8	0.005
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0225		1.496		2.75E-01	28.8	0.01
Cadmium	0		0.0917		1.66E-02	0.77	0.02
Chromium	0.0005	m	0.187		3.40E-02	2.4	0.01
Cobalt	0		0.663		1.20E-01	7.33	0.02
Copper	0.00125		20.94		3.80E+00	5.6	0.7
Iron	0.193		170.1		3.09E+01	22.8	1
Lead	0.00037438		0		5.90E-05	4.7	0.00001
Manganese	0.0674		3.633		6.70E-01	51.5	0.01
Mercury	0.00019	m	0.0319		5.82E-03	1	0.006
Molybdenum	0.00101		0.881		1.60E-01	0.26	0.6
Nickel	0.00062873		0		9.92E-05	1.7	0.00006
Selenium	0.00040471		7.83		1.42E+00	0.143	10
Silver	0		0.0118		2.14E-03	6.02	0.0004
Strontium	0.116		1.088		2.16E-01	263	0.0008
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00169		0.199		3.64E-02	4.16	0.009
Zinc	0		180		3.27E+01	75.4	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_B-12
Screening Risk Characterization Results Summary
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**3**	**5**	**17**	**2**	1	**61**	**120**	**98**	0.02	0.9
Antimony	0.0005	0.0009	0.004	0.0005	0.0004	0.2	0.2	0.1	0.0006	0.1
Arsenic	0.3	0.4	1	0.1	0.1	0.2	0.4	0.3	0.06	0.09
Barium	0.3	0.3	0.8	0.1	0.1	0.07	0.06	0.06	0.02	0.005
Beryllium	0.05	0.09	0.3	0.03	0.03	0.01	0.03	0.03	--	--
Boron	0.06	0.03	0.04	0.005	0.005	0.06	0.03	0.01	0.01	0.01
Cadmium	0.02	0.03	0.07	0.005	0.005	0.02	0.02	0.01	0.02	0.02
Chromium	0.2	0.3	0.9	0.09	0.09	0.07	0.1	0.1	0.02	0.01
Cobalt	0.04	0.07	0.2	0.02	0.02	0.02	0.03	0.02	0.02	0.02
Copper	0.2	0.3	0.8	0.1	0.1	0.08	0.09	0.1	1	0.7
Iron	**3**	**6**	**20**	**2**	1	**6**	**11**	**9**	0.4	1
Lead	0.2	0.4	1	0.1	0.1	0.04	0.05	0.04	0.00005	0.00001
Manganese	0.4	0.3	0.6	0.07	0.08	1	0.6	0.3	0.005	0.01
Mercury	0.005	0.009	0.03	0.01	0.01	0.0004	0.001	0.005	0.02	0.006
Molybdenum	0.03	0.03	0.06	0.005	0.005	0.3	0.2	0.1	0.06	0.6
Nickel	0.08	0.1	0.4	0.06	0.06	0.1	0.2	0.2	0.00002	0.00006
Selenium	0.7	1	**4**	0.8	0.8	0.1	0.8	1	**7**	**10**
Silver	0.0006	0.001	0.004	0.0007	0.0007	--	0.0001	0.0002	0.001	0.0004
Strontium	0.009	0.007	0.02	0.009	0.009	0.01	0.006	0.01	0.0009	0.0008
Thallium	0.02	0.04	0.1	0.0008	--	--	0.2	0.1	--	--
Vanadium	**2**	**3**	**11**	1	1	0.05	0.1	0.1	0.1	0.009
Zinc	0.1	0.2	0.4	0.1	0.1	0.04	0.05	0.1	0.7	0.4

Hazard quotients greater than one are in bold.

Table 4-ER_C-1
Data Summaries
Risk Characterization
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water						Invertebrates															
													Larval Mayfly (Whole Body)						Adult Mayfly									
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)				
Inorganics																								
Aluminum	10/10	1900	-	27100	16255		6 / 8	0.0816	-	0.339	0.218		3/3	5330	-	6340	6340	m	1/6	27.1	-	27.1	27.1	m
Antimony	0/10	0	-	0	0		0 / 8	0	-	0	0		3/3	0.11	-	0.12	0.12	m	0/6	0	-	0	0	
Arsenic	7/10	1.79	-	5.17	3.285		8 / 8	0.00109	-	0.0026	0.002		3/3	6.8	-	8.1	8.1	m	6/6	0.35	-	0.53	0.53	m
Barium	10/10	17	-	447	239.2		8 / 8	0.0395	-	0.0544	0.054		3/3	54.2	-	63	63	m	6/6	0.91	-	1.8	1.8	m
Beryllium	3/10	0.541	-	1.09	1.09	m	0 / 8	0	-	0	0		3/3	0.4	-	0.5	0.5	m	0/6	0	-	0	0	
Boron	2/10	9.05	-	10.3	10.3	m	8 / 8	0.0166	-	0.0228	0.022		3/3	2.8	-	3.3	3.3	m	6/6	0.48	-	1.2	1.2	m
Cadmium	0/10	0	-	0	0		0 / 8	0	-	0	0		2/3	0.19	-	0.25	0.25	m	6/6	0.02	-	0.06	0.06	m
Chromium	10/10	3.18	-	24.3	16.28		1 / 8	0.00047	-	0.0005	5E-04	m	3/3	6.2	-	7.2	7.2	m	6/6	0.14	-	0.18	0.18	m
Cobalt	10/10	2.62	-	20.4	11.05		1 / 8	0.00046	-	0.0005	5E-04	m	3/3	5.1	-	6.1	6.1	m	6/6	0.37	-	0.41	0.41	m
Copper	10/10	2	-	13.2	8.035		8 / 8	0.00055	-	0.001	9E-04		3/3	11.5	-	13.1	13.1	m	6/6	13.5	-	27.7	27.7	m
Iron	10/10	3300	-	19100	12926		8 / 8	0.0971	-	0.316	0.227		3/3	6850	-	9220	9220	m	6/6	114	-	205	205	m
Lead	10/10	2.45	-	14	8.905		1 / 8	0.00058	-	0.0006	6E-04	m	3/3	5.9	-	6.3	6.3	m	0/6	0	-	0	0	
Manganese	10/10	34.4	-	2940	1345		8 / 8	0.06	-	0.225	0.177		3/3	246	-	407	407	m	6/6	2	-	4.8	4.8	m
Mercury	0/10	0	-	0	0		0 / 8	0	-	0	0		3/3	0.07	-	0.071	0.071	m	6/6	0.03	-	0.04	0.04	m
Molybdenum	0/10	0	-	0	0		7 / 8	0.00082	-	0.0011	1E-03		3/3	0.71	-	0.76	0.76	m	6/6	0.34	-	0.6	0.6	m
Nickel	10/10	2.85	-	22.4	12.65		8 / 8	0.0005	-	0.0008	7E-04		3/3	8.3	-	9.6	9.6	m	0/6	0	-	0	0	
Selenium	0/10	0	-	0	0		0 / 8	0	-	0	0		3/3	3.8	-	5	5	m	6/6	6.5	-	7.5	7.5	m
Silver	0/10	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		6/6	0.01	-	0.02	0.02	m
Strontium	4/10	6.35	-	19.9	19.9	m	8 / 8	0.0964	-	0.111	0.111	m	3/3	11.8	-	12.7	12.7	m	6/6	0.57	-	1.4	1.4	m
Thallium	0/10	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		0/6	0	-	0	0	
Vanadium	10/10	3.1	-	36.6	19.47		4 / 8	0.00111	-	0.0015	0.002	m	3/3	9.5	-	10.7	10.7	m	6/6	0.12	-	0.17	0.17	m
Zinc	10/10	12	-	84.8	50.19		0 / 8	0	-	0	0		3/3	153	-	217	217	m	6/6	82.5	-	246	246	m

Table 4-ER_C-1
Data Summaries
Risk Characterization
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	31.8	-	440.1	440	m	5/6	25.66	-	573	573	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/40	0	-	0	0	
Arsenic	2/6	0.24	-	0.2687	0.27	m	6/6	1.1	-	1.81	1.81	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	19.2	-	76.17	76.2	m	6/6	10.55	-	16.7	16.7	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/40	0	-	0	0	
Boron	6/6	10	-	50.58	50.6	m	0/6	0	-	0	0		0/40	0	-	0	0	
Cadmium	3/6	0.15	-	0.3691	0.37	m	3/6	0.046	-	0.06	0.06	m	17/40	0.09	-	0.3406	0.14	
Chromium	0/6	0	-	0	0		3/6	1.5	-	2	2	m	0/40	0	-	0	0	
Cobalt	6/6	0.07	-	1.208	1.21	m	6/6	0.2064	-	0.65	0.65	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	4.07	-	7.558	7.56	m	6/6	4.2	-	7.52	7.52	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	57.1	-	645.3	645	m	6/6	79.36	-	714	714	m	34/40	99.1	-	532.7	238	
Lead	6/6	0.1	-	0.5756	0.58	m	5/6	0.1991	-	0.71	0.71	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	247	-	1591	1591	m	6/6	99.08	-	153	153	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		3/6	0.056	-	0.06	0.06	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.28	-	1.687	1.69	m	0/6	0	-	0	0		7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.87	-	2.175	2.18	m	3/6	0.84	-	1	1	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	1.8	-	3.21	3.21	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		1/6	0.012	-	0.01	0.01	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	12.2	-	50.58	50.6	m	6/6	28.9	-	33.9	33.9	m	40/40	34.9	-	132.2	77.8	
Thallium	1/6	0.06	-	0.0571	0.06	m	0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	5/6	0.13	-	0.7558	0.76	m	5/6	0.2566	-	1	1	m	0/40	0	-	0	0	
Zinc	5/6	36.3	-	57.05	57.1	m	6/6	73.9	-	97.3	97.3	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-ER_C-2
Screening Risk Characterization for the Wood Duck
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	16,255		0.218		6,340	m	440.1	m	2.23E+02	109.7	2
Antimony	0		0		0.12	m	0		3.26E-03	18	0.0002
Arsenic	3.285		0.0023		8.1	m	0.2687	m	2.40E-01	2.24	0.1
Barium	239.2		0.0537		63	m	76.17	m	6.30E+00	20.8	0.3
Beryllium	1.09	m	0		0.5	m	0		1.54E-02	0.532	0.03
Boron	10.3	m	0.0216		3.3	m	50.58	m	2.89E+00	28	0.1
Cadmium	0		0		0.25	m	0.3691	m	2.71E-02	1.47	0.02
Chromium	16.28		0.0005	m	7.2	m	0		2.22E-01	2.66	0.08
Cobalt	11.05		0.0005	m	6.1	m	1.208	m	2.50E-01	7.61	0.03
Copper	8.035		0.0009		13.1	m	7.558	m	7.85E-01	4.05	0.2
Iron	12,926		0.227		9,220	m	645.3	m	3.07E+02	109.3	3
Lead	8.905		0.0006	m	6.3	m	0.5756	m	2.17E-01	1.63	0.1
Manganese	1,345		0.177		407	m	1,591	m	1.01E+02	179	0.6
Mercury	0		0		0.071	m	0		1.93E-03	0.45	0.004
Molybdenum	0		0.001		0.76	m	1.687	m	1.14E-01	3.5	0.03
Nickel	12.65		0.0007		9.6	m	2.175	m	4.01E-01	6.71	0.06
Selenium	0		0		5	m	0		1.36E-01	0.29	0.5
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	19.9	m	0.111	m	12.7	m	50.58	m	3.17E+00	312	0.01
Thallium	0		0		0		0.05705	m	3.14E-03	0.35	0.009
Vanadium	19.47		0.0015	m	10.7	m	0.7558	m	3.64E-01	0.344	1
Zinc	50.19		0		217	m	57.05	m	9.11E+00	66.1	0.1

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-3
Screening Risk Characterization for the Mallard Duck
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	16,255		0.218		6,340	m	440.1	m	3.74E+02	109.7	3
Antimony	0		0		0.12	m	0		6.22E-03	18	0.0003
Arsenic	3.285		0.0023		8.1	m	0.2687	m	4.32E-01	2.24	0.2
Barium	239.2		0.0537		63	m	76.17	m	5.13E+00	20.8	0.2
Beryllium	1.09	m	0		0.5	m	0		2.84E-02	0.532	0.05
Boron	10.3	m	0.0216		3.3	m	50.58	m	1.07E+00	28	0.04
Cadmium	0		0		0.25	m	0.3691	m	1.93E-02	1.47	0.01
Chromium	16.28		0.0005	m	7.2	m	0		4.11E-01	2.66	0.2
Cobalt	11.05		0.0005	m	6.1	m	1.208	m	3.62E-01	7.61	0.05
Copper	8.035		0.0009		13.1	m	7.558	m	8.28E-01	4.05	0.2
Iron	12,926		0.227		9,220	m	645.3	m	5.19E+02	109.3	5
Lead	8.905		0.0006	m	6.3	m	0.5756	m	3.57E-01	1.63	0.2
Manganese	1,345		0.177		407	m	1,591	m	5.17E+01	179	0.3
Mercury	0		0		0.071	m	0		3.68E-03	0.45	0.008
Molybdenum	0		0.001		0.76	m	1.687	m	6.86E-02	3.5	0.02
Nickel	12.65		0.0007		9.6	m	2.175	m	5.64E-01	6.71	0.08
Selenium	0		0		5	m	0		2.59E-01	0.29	0.9
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	19.9	m	0.111	m	12.7	m	50.58	m	1.58E+00	312	0.005
Thallium	0		0		0		0.05705	m	9.86E-04	0.35	0.003
Vanadium	19.47		0.0015	m	10.7	m	0.7558	m	6.13E-01	0.344	2
Zinc	50.19		0		217	m	57.05	m	1.24E+01	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-4
Screening Risk Characterization for the Killdeer
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	16,255		0.218		6,340	m	1.22E+03	109.7	11
Antimony	0		0		0.12	m	1.82E-02	18	0.001
Arsenic	3.285		0.0023		8.1	m	1.28E+00	2.24	0.6
Barium	239.2		0.0537		63	m	1.34E+01	20.8	0.6
Beryllium	1.09	m	0		0.5	m	9.32E-02	0.532	0.2
Boron	10.3	m	0.0216		3.3	m	6.67E-01	28	0.02
Cadmium	0		0		0.25	m	3.80E-02	1.47	0.03
Chromium	16.28		0.0005	m	7.2	m	1.35E+00	2.66	0.5
Cobalt	11.05		0.0005	m	6.1	m	1.10E+00	7.61	0.1
Copper	8.035		0.0009		13.1	m	2.12E+00	4.05	0.5
Iron	12,926		0.227		9,220	m	1.61E+03	109.3	15
Lead	8.905		0.0006	m	6.3	m	1.10E+00	1.63	0.7
Manganese	1,345		0.177		407	m	8.31E+01	179	0.5
Mercury	0		0		0.071	m	1.08E-02	0.45	0.02
Molybdenum	0		0.001		0.76	m	1.16E-01	3.5	0.03
Nickel	12.65		0.0007		9.6	m	1.66E+00	6.71	0.2
Selenium	0		0		5	m	7.60E-01	0.29	3
Silver	0		0		0		0.00E+00	2.02	--
Strontium	19.9	m	0.111	m	12.7	m	2.26E+00	312	0.007
Thallium	0		0		0		0.00E+00	0.35	--
Vanadium	19.47		0.0015	m	10.7	m	1.93E+00	0.344	6
Zinc	50.19		0		217	m	3.38E+01	66.1	0.5

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-5
Screening Risk Characterization for the Heron
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	16,255		0.218		6,340	m	573	m	4.77E+01	109.7	0.4
Antimony	0		0		0.12	m	0		1.35E-04	18	0.000007
Arsenic	3.285		0.00227		8.1	m	1.81	m	1.10E-01	2.24	0.05
Barium	239.2		0.0537		63	m	16.7	m	1.12E+00	20.8	0.05
Beryllium	1.09	m	0		0.5	m	0		1.17E-03	0.532	0.002
Boron	10.3	m	0.0216		3.3	m	0		1.04E-02	28	0.0004
Cadmium	0		0		0.25	m	0.059	m	3.52E-03	1.47	0.002
Chromium	16.28		0.00047	m	7.2	m	2	m	1.27E-01	2.66	0.05
Cobalt	11.05		0.00046	m	6.1	m	0.65	m	4.88E-02	7.61	0.006
Copper	8.035		0.0009		13.1	m	7.522	m	4.32E-01	4.05	0.1
Iron	12,926		0.227		9,220	m	714	m	5.68E+01	109.3	0.5
Lead	8.905		0.00058	m	6.3	m	0.71	m	5.11E-02	1.63	0.03
Manganese	1,345		0.177		407	m	153	m	9.62E+00	179	0.05
Mercury	0		0		0.071	m	0.059	m	3.32E-03	0.45	0.007
Molybdenum	0		0.00099		0.76	m	0		8.97E-04	3.5	0.0003
Nickel	12.65		0.0007		9.6	m	1	m	7.28E-02	6.71	0.01
Selenium	0		0		5	m	3.213	m	1.82E-01	0.29	0.6
Silver	0		0		0		0.012	m	6.59E-04	2.02	0.0003
Strontium	19.9	m	0.111	m	12.7	m	33.94	m	1.90E+00	312	0.006
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	19.47		0.00153	m	10.7	m	1	m	7.79E-02	0.344	0.2
Zinc	50.19		0		217	m	97.29	m	5.62E+00	66.1	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-6
Screening Risk Characterization for the Osprey
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.218		573	m	3.54E+01	109.7	0.3
Antimony	0		0		0.00E+00	18	--
Arsenic	0.00227		1.81	m	1.12E-01	2.24	0.05
Barium	0.0537		16.7	m	1.03E+00	20.8	0.05
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0216		0		1.08E-03	28	0.00004
Cadmium	0		0.059	m	3.64E-03	1.47	0.002
Chromium	0.00047	m	2	m	1.23E-01	2.66	0.05
Cobalt	0.00046	m	0.65	m	4.01E-02	7.61	0.005
Copper	0.0008999		7.522	m	4.64E-01	4.05	0.1
Iron	0.227		714	m	4.41E+01	109.3	0.4
Lead	0.00058	m	0.71	m	4.38E-02	1.63	0.03
Manganese	0.177		153	m	9.45E+00	179	0.05
Mercury	0		0.059	m	3.64E-03	0.45	0.008
Molybdenum	0.0009863		0		4.92E-05	3.5	0.00001
Nickel	0.0006951		1	m	6.17E-02	6.71	0.009
Selenium	0		3.213	m	1.98E-01	0.29	0.7
Silver	0		0.012	m	7.41E-04	2.02	0.0004
Strontium	0.111	m	33.94	m	2.10E+00	312	0.007
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00153	m	1	m	6.18E-02	0.344	0.2
Zinc	0		97.29	m	6.00E+00	66.1	0.09

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-7
Screening Risk Characterization for the Muskrat
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	16,255		0.218		440.1	m	1.04E+02	1.93	54
Antimony	0		0		0		0.00E+00	0.059	--
Arsenic	3.285		0.0023		0.2687	m	3.07E-02	1.04	0.03
Barium	239.2		0.0537		76.17	m	5.22E+00	51.8	0.1
Beryllium	1.09	m	0		0		5.42E-03	0.532	0.01
Boron	10.3	m	0.0216		50.58	m	2.73E+00	28.8	0.09
Cadmium	0		0		0.3691	m	1.95E-02	0.77	0.03
Chromium	16.28		0.0005	m	0		8.09E-02	2.4	0.03
Cobalt	11.05		0.0005	m	1.208	m	1.19E-01	7.33	0.02
Copper	8.035		0.0009		7.558	m	4.40E-01	5.6	0.08
Iron	12,926		0.227		645.3	m	9.84E+01	22.8	4
Lead	8.905		0.0006	m	0.5756	m	7.47E-02	4.7	0.02
Manganese	1,345		0.177		1,591	m	9.08E+01	51.5	2
Mercury	0		0		0		0.00E+00	1	--
Molybdenum	0		0.001		1.687	m	8.93E-02	0.26	0.3
Nickel	12.65		0.0007		2.175	m	1.78E-01	1.7	0.1
Selenium	0		0		0		0.00E+00	0.143	--
Silver	0		0		0		0.00E+00	6.02	--
Strontium	19.9	m	0.111	m	50.58	m	2.78E+00	263	0.01
Thallium	0		0		0.05705	m	3.02E-03	0.015	0.2
Vanadium	19.47		0.0015	m	0.7558	m	1.37E-01	4.16	0.03
Zinc	50.19		0		57.05	m	3.26E+00	75.4	0.04

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-8
Screening Risk Characterization for the Raccoon
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	16,255		0.218		6,340	m	440.1	m	573	m	1.53E+02	1.93	79
Antimony	0		0		0.12	m	0		0		1.67E-03	0.059	0.03
Arsenic	3.285		0.00227		8.1	m	0.2687	m	1.81	m	1.32E-01	1.04	0.1
Barium	239.2		0.0537		63	m	76.17	m	16.7	m	3.28E+00	51.8	0.06
Beryllium	1.09	m	0		0.5	m	0		0		1.06E-02	0.532	0.02
Boron	10.3	m	0.0216		3.3	m	50.58	m	0		1.13E+00	28.8	0.04
Cadmium	0		0		0.25	m	0.3691	m	0.059	m	1.12E-02	0.77	0.01
Chromium	16.28		0.00047	m	7.2	m	0		2	m	1.57E-01	2.4	0.07
Cobalt	11.05		0.00046	m	6.1	m	1.208	m	0.65	m	1.48E-01	7.33	0.02
Copper	8.035		0.0009		13.1	m	7.558	m	7.522	m	3.74E-01	5.6	0.07
Iron	12,926		0.227		9,220	m	645.3	m	714	m	1.86E+02	22.8	8
Lead	8.905		0.00058	m	6.3	m	0.5756	m	0.71	m	1.30E-01	4.7	0.03
Manganese	1,345		0.177		407	m	1,591	m	153	m	4.34E+01	51.5	0.8
Mercury	0		0		0.071	m	0		0.059	m	1.05E-03	1	0.001
Molybdenum	0		0.00099		0.76	m	1.687	m	0		4.56E-02	0.26	0.2
Nickel	12.65		0.0007		9.6	m	2.175	m	1	m	2.23E-01	1.7	0.1
Selenium	0		0		5	m	0		3.213	m	7.31E-02	0.143	0.5
Silver	0		0		0		0		0.012	m	1.29E-05	6.02	0.000002
Strontium	19.9	m	0.111	m	12.7	m	50.58	m	33.94	m	1.34E+00	263	0.005
Thallium	0		0		0		0.05705	m	0		1.18E-03	0.015	0.08
Vanadium	19.47		0.00153	m	10.7	m	0.7558	m	1	m	2.31E-01	4.16	0.06
Zinc	50.19		0		217	m	57.05	m	97.29	m	4.48E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-9
Screening Risk Characterization for the Mink
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

	Exposure Point Concentration [a]																Toxicity Reference	Hazard
	Exposed		Surface		Invertebrate		Vegetation		Fish		Amphibian		Dietary		Value [c]	Quotient
	Sediment		Water		WB Larval Mayfly				WB Shad		Frogs		Ingestion [b]		NOAEL	(HQ) [d]
Constituent	(mg/kg)		(mg/L)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg-BW-day)		(mg/kg-BW-day)	NOAEL
Inorganics																
Aluminum	16,255		0.218		6,340	m	440.1	m	573	m	56.6		7.79E+01		1.93	40
Antimony	0		0		0.12	m	0		0		0		6.44E-04		0.059	0.01
Arsenic	3.285		0.0023		8.1	m	0.2687	m	1.81	m	0.8164	m	1.26E-01		1.04	0.1
Barium	239.2		0.0537		63	m	76.17	m	16.7	m	78.98		1.78E+00		51.8	0.03
Beryllium	1.09	m	0		0.5	m	0		0		0		3.85E-03		0.532	0.007
Boron	10.3	m	0.0216		3.3	m	50.58	m	0		0		2.75E-01		28.8	0.01
Cadmium	0		0		0.25	m	0.3691	m	0.059	m	0.143		5.80E-03		0.77	0.008
Chromium	16.28		0.0005	m	7.2	m	0		2	m	0		1.40E-01		2.4	0.06
Cobalt	11.05		0.0005	m	6.1	m	1.208	m	0.65	m	0.228		7.82E-02		7.33	0.01
Copper	8.035		0.0009		13.1	m	7.558	m	7.522	m	18.35		4.57E-01		5.6	0.08
Iron	12,926		0.227		9,220	m	645.3	m	714	m	237.9		9.69E+01		22.8	4
Lead	8.905		0.0006	m	6.3	m	0.5756	m	0.71	m	0.7493	m	7.71E-02		4.7	0.02
Manganese	1,345		0.177		407	m	1,591	m	153	m	88.97		1.79E+01		51.5	0.3
Mercury	0		0		0.071	m	0		0.059	m	0.13		3.04E-03		1	0.003
Molybdenum	0		0.001		0.76	m	1.687	m	0		0.32		1.28E-02		0.26	0.05
Nickel	12.65		0.0007		9.6	m	2.175	m	1	m	0		1.18E-01		1.7	0.07
Selenium	0		0		5	m	0		3.213	m	2.066		1.65E-01		0.143	1
Silver	0		0		0		0		0.012	m	0.038		5.57E-04		6.02	0.00009
Strontium	19.9	m	0.111	m	12.7	m	50.58	m	33.94	m	77.81		1.88E+00		263	0.007
Thallium	0		0		0		0.05705	m	0		0.34	m	7.32E-04		0.015	0.05
Vanadium	19.47		0.0015	m	10.7	m	0.7558	m	1	m	0		1.24E-01		4.16	0.03
Zinc	50.19		0		217	m	57.05	m	97.29	m	145		5.79E+00		75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-10
Screening Risk Characterization for the Tree Swallow
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.218		27.1	m	6.72E+00	109.7	0.06
Antimony	0		0		0.00E+00	18	--
Arsenic	0.00227		0.53	m	1.31E-01	2.24	0.06
Barium	0.0537		1.8	m	4.55E-01	20.8	0.02
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0216		1.2	m	3.00E-01	28	0.01
Cadmium	0		0.055	m	1.36E-02	1.47	0.009
Chromium	0.00047	m	0.18	m	4.45E-02	2.66	0.02
Cobalt	0.00046	m	0.41	m	1.01E-01	7.61	0.01
Copper	0.0008999		27.7	m	6.83E+00	4.05	2
Iron	0.227		205	m	5.06E+01	109.3	0.5
Lead	0.00058	m	0		1.23E-04	1.63	0.00008
Manganese	0.177		4.8	m	1.22E+00	179	0.007
Mercury	0		0.037	m	9.12E-03	0.45	0.02
Molybdenum	0.0009863		0.6	m	1.48E-01	3.5	0.04
Nickel	0.0006951		0		1.48E-04	6.71	0.00002
Selenium	0		7.5	m	1.85E+00	0.29	6
Silver	0		0.018	m	4.44E-03	2.02	0.002
Strontium	0.111	m	1.4	m	3.69E-01	312	0.001
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00153	m	0.17	m	4.22E-02	0.344	0.1
Zinc	0		246	m	6.06E+01	66.1	0.9

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-11
Screening Risk Characterization for the Gray Bat
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.218		27.1	m	4.95E+00	1.93	3
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00227		0.53	m	9.66E-02	1.04	0.09
Barium	0.0537		1.8	m	3.35E-01	51.8	0.006
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0216		1.2	m	2.21E-01	28.8	0.008
Cadmium	0		0.055	m	9.98E-03	0.77	0.01
Chromium	0.00047	m	0.18	m	3.27E-02	2.4	0.01
Cobalt	0.00046	m	0.41	m	7.45E-02	7.33	0.01
Copper	0.00089991		27.7	m	5.03E+00	5.6	0.9
Iron	0.227		205	m	3.72E+01	22.8	2
Lead	0.00058	m	0		9.15E-05	4.7	0.00002
Manganese	0.177		4.8	m	8.99E-01	51.5	0.02
Mercury	0		0.037	m	6.72E-03	1	0.007
Molybdenum	0.00098626		0.6	m	1.09E-01	0.26	0.4
Nickel	0.00069508		0		1.10E-04	1.7	0.00006
Selenium	0		7.5	m	1.36E+00	0.143	10
Silver	0		0.018	m	3.27E-03	6.02	0.0005
Strontium	0.111	m	1.4	m	2.72E-01	263	0.001
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00153	m	0.17	m	3.11E-02	4.16	0.007
Zinc	0		246	m	4.47E+01	75.4	0.6

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_C-12
Screening Risk Characterization Results Summary
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**2**	**3**	**11**	0.4	0.3	**54**	**79**	**40**	0.06	**3**
Antimony	0.0002	0.0003	0.001	0.000007	--	--	0.03	0.01	--	--
Arsenic	0.1	0.2	0.6	0.05	0.05	0.03	0.1	0.1	0.06	0.09
Barium	0.3	0.2	0.6	0.05	0.05	0.1	0.06	0.03	0.02	0.006
Beryllium	0.03	0.05	0.2	0.002	--	0.01	0.02	0.007	--	--
Boron	0.1	0.04	0.02	0.0004	0.00004	0.09	0.04	0.01	0.01	0.008
Cadmium	0.02	0.01	0.03	0.002	0.002	0.03	0.01	0.008	0.009	0.01
Chromium	0.08	0.2	0.5	0.05	0.05	0.03	0.07	0.06	0.02	0.01
Cobalt	0.03	0.05	0.1	0.006	0.005	0.02	0.02	0.01	0.01	0.01
Copper	0.2	0.2	0.5	0.1	0.1	0.08	0.07	0.08	**2**	0.9
Iron	**3**	**5**	**15**	0.5	0.4	**4**	**8**	**4**	0.5	**2**
Lead	0.1	0.2	0.7	0.03	0.03	0.02	0.03	0.02	0.00008	0.00002
Manganese	0.6	0.3	0.5	0.05	0.05	**2**	0.8	0.3	0.007	0.02
Mercury	0.004	0.008	0.02	0.007	0.008	--	0.001	0.003	0.02	0.007
Molybdenum	0.03	0.02	0.03	0.0003	0.00001	0.3	0.2	0.05	0.04	0.4
Nickel	0.06	0.08	0.2	0.01	0.009	0.1	0.1	0.07	0.00002	0.00006
Selenium	0.5	0.9	**3**	0.6	0.7	--	0.5	1	**6**	**10**
Silver	--	--	--	0.0003	0.0004	--	0.000002	0.00009	0.002	0.0005
Strontium	0.01	0.005	0.007	0.006	0.007	0.01	0.005	0.007	0.001	0.001
Thallium	0.009	0.003	--	--	--	0.2	0.08	0.05	--	--
Vanadium	1	**2**	**6**	0.2	0.2	0.03	0.06	0.03	0.1	0.007
Zinc	0.1	0.2	0.5	0.08	0.09	0.04	0.06	0.08	0.9	0.6

Hazard quotients greater than one are in bold.

Table 4-ER_R-1
Data Summaries
Risk Characterization
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water						Invertebrates											
													Larval Mayfly (Whole Body)						Adult Mayfly					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)				
Inorganics																								
Aluminum	5/5	2480	-	14800	14800	m	0 / 8	0	-	0	0		6/6	4090	-	6380	6380	m	1/6	5.2	-	5.2	5.2	m
Antimony	0/5	0	-	0	0		0 / 8	0	-	0	0		6/6	0.06	-	0.085	0.085	m	0/6	0	-	0	0	
Arsenic	4/5	1.83	-	5.4	5.4	m	8 / 8	0.00038	-	0.0013	9E-04		6/6	2.8	-	4.5	4.5	m	6/6	0.11	-	0.14	0.14	m
Barium	5/5	22.6	-	90.4	90.4	m	8 / 8	0.0454	-	0.0531	0.051		6/6	43.2	-	58.6	58.6	m	6/6	0.54	-	0.68	0.68	m
Beryllium	1/5	0.769	-	0.769	0.769	m	0 / 8	0	-	0	0		6/6	0.19	-	0.29	0.29	m	0/6	0	-	0	0	
Boron	0/5	0	-	0	0		8 / 8	0.0172	-	0.0198	0.019		6/6	2.5	-	4	4	m	6/6	0.44	-	0.77	0.77	m
Cadmium	0/5	0	-	0	0		0 / 8	0	-	0	0		6/6	0.35	-	2.4	2.4	m	6/6	0.3	-	0.4	0.4	m
Chromium	5/5	3.21	-	13.8	13.8	m	1 / 8	0.00041	-	0.0004	4E-04	m	6/6	4.5	-	6.8	6.8	m	1/6	12.7	-	12.7	12.7	m
Cobalt	5/5	2.15	-	10.5	10.5	m	0 / 8	0	-	0	0		6/6	4.1	-	7.2	7.2	m	6/6	0.76	-	0.82	0.82	m
Copper	5/5	4.03	-	6.83	6.83	m	7 / 8	0.00033	-	0.0007	5E-04		6/6	9.5	-	12.8	12.8	m	6/6	26.3	-	27.9	27.9	m
Iron	5/5	3210	-	18500	18500	m	8 / 8	0.0554	-	0.133	0.106		6/6	5930	-	8430	8430	m	6/6	177	-	185	185	m
Lead	5/5	3.15	-	10.4	10.4	m	0 / 8	0	-	0	0		6/6	4.5	-	6.8	6.8	m	0/6	0	-	0	0	
Manganese	5/5	29.9	-	689	689	m	8 / 8	0.0262	-	0.196	0.128		6/6	378	-	1380	1380	m	6/6	2	-	2.9	2.9	m
Mercury	0/5	0	-	0	0		1 / 8	0.00017	-	0.0002	2E-04	m	6/6	0.05	-	0.066	0.066	m	6/6	0.1	-	0.13	0.13	m
Molybdenum	0/5	0	-	0	0		8 / 8	0.00045	-	0.0009	8E-04		6/6	0.5	-	0.72	0.72	m	6/6	0.34	-	0.37	0.37	m
Nickel	5/5	3.42	-	14.7	14.7	m	7 / 8	0.0004	-	0.0007	6E-04		6/6	5.3	-	7.4	7.4	m	0/6	0	-	0	0	
Selenium	0/5	0	-	0	0		1 / 8	0.00038	-	0.0004	4E-04	m	6/6	2.6	-	4.2	4.2	m	6/6	3.7	-	4.1	4.1	m
Silver	0/5	0	-	0	0		0 / 8	0	-	0	0		6/6	0.03	-	0.16	0.16	m	6/6	0.02	-	0.03	0.03	m
Strontium	3/5	5.31	-	16.3	16.3	m	8 / 8	0.0824	-	0.107	0.102		6/6	4.5	-	6.7	6.7	m	6/6	0.58	-	0.74	0.74	m
Thallium	0/5	0	-	0	0		0 / 8	0	-	0	0		0/6	0	-	0	0		0/6	0	-	0	0	
Vanadium	5/5	4.05	-	26.3	26.3	m	0 / 8	0	-	0	0		6/6	6.7	-	9.4	9.4	m	6/6	0.12	-	0.14	0.14	m
Zinc	5/5	15	-	54.1	54.1	m	0 / 8	0	-	0	0		6/6	167	-	316	316	m	6/6	88	-	98.7	98.7	m

Table 4-ER_R-1
Data Summaries
Risk Characterization
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	37.3	-	955	955	m	6/6	706	-	1970	1970	m	9/48	38.1	-	219.1	51.4	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Arsenic	3/6	0.14	-	0.5	0.5	m	6/6	1.2	-	1.4	1.4	m	7/48	0.25	-	0.3904	0.27	
Barium	6/6	17.3	-	120.9	121	m	6/6	19.1	-	42.4	42.4	m	48/48	24	-	148.1	66.5	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Boron	6/6	6.52	-	57.81	57.8	m	0/6	0	-	0	0		0/48	0	-	0	0	
Cadmium	5/6	0.13	-	0.3859	0.39	m	3/6	0.066	-	0.29	0.29	m	6/48	0.08	-	0.2155	0.1	
Chromium	4/6	0.5	-	1.4	1.4	m	6/6	2.6	-	6.6	6.6	m	1/48	29.7	-	29.74	29.7	m
Cobalt	6/6	0.2	-	1.4	1.4	m	4/6	1.3	-	2.1	2.1	m	39/48	0.13	-	0.6548	0.32	
Copper	6/6	2.76	-	11.96	12	m	6/6	5	-	37.5	37.5	m	48/48	4.64	-	46.37	17.6	
Iron	6/6	71.8	-	1080	1080	m	6/6	1190	-	2960	2960	m	45/48	107	-	419.7	229	
Lead	5/6	0.23	-	1.016	1.02	m	5/6	1.6	-	3.7	3.7	m	7/48	0.58	-	3.177	3.18	m
Manganese	6/6	207	-	535	535	m	6/6	180	-	443	443	m	48/48	23.9	-	189.7	83.2	
Mercury	0/6	0	-	0	0		6/6	0.056	-	0.08	0.08	m	1/48	0.09	-	0.0931	0.09	m
Molybdenum	6/6	0.19	-	0.9375	0.94	m	0/6	0	-	0	0		3/48	0.28	-	0.4217	0.42	m
Nickel	6/6	1	-	3.828	3.83	m	6/6	2	-	32	32	m	0/48	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	1.9	-	2.6	2.6	m	48/48	0.86	-	3.103	1.53	
Silver	1/6	0.08	-	0.0761	0.08	m	3/6	0.012	-	0.02	0.02	m	9/48	0.02	-	0.0854	0.03	
Strontium	6/6	7.77	-	57.81	57.8	m	6/6	23.4	-	46.1	46.1	m	48/48	18	-	99.28	55.1	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Vanadium	4/6	0.29	-	1.6	1.6	m	5/6	1.8	-	3.8	3.8	m	1/48	1.68	-	1.677	1.68	m
Zinc	6/6	32.8	-	76.63	76.6	m	6/6	69.5	-	91.5	91.5	m	48/48	87.8	-	311	146	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-ER_R-2
Screening Risk Characterization for the Wood Duck
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0		6,380	m	955	m	2.50E+02	109.7	2
Antimony	0		0		0.085	m	0		2.31E-03	18	0.0001
Arsenic	5.4	m	0.0009		4.5	m	0.5	m	1.59E-01	2.24	0.07
Barium	90.4	m	0.0505		58.6	m	120.9	m	8.40E+00	20.8	0.4
Beryllium	0.769	m	0		0.29	m	0		9.13E-03	0.532	0.02
Boron	0		0.0189		4	m	57.81	m	3.29E+00	28	0.1
Cadmium	0		0		2.4	m	0.3859	m	8.64E-02	1.47	0.06
Chromium	13.8	m	0.0004	m	6.8	m	1.4	m	2.84E-01	2.66	0.1
Cobalt	10.5	m	0		7.2	m	1.4	m	2.90E-01	7.61	0.04
Copper	6.83	m	0.0005		12.8	m	11.96	m	1.02E+00	4.05	0.3
Iron	18,500	m	0.106		8,430	m	1,080	m	3.19E+02	109.3	3
Lead	10.4	m	0		6.8	m	1.016	m	2.58E-01	1.63	0.2
Manganese	689	m	0.128		1,380	m	535	m	6.81E+01	179	0.4
Mercury	0		0.0002	m	0.066	m	0		1.80E-03	0.45	0.004
Molybdenum	0		0.0008		0.72	m	0.9375	m	7.12E-02	3.5	0.02
Nickel	14.7	m	0.0006		7.4	m	3.828	m	4.36E-01	6.71	0.06
Selenium	0		0.0004	m	4.2	m	0		1.14E-01	0.29	0.4
Silver	0		0		0.16	m	0.07609	m	8.53E-03	2.02	0.004
Strontium	16.3	m	0.102		6.7	m	57.81	m	3.40E+00	312	0.01
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		9.4	m	1.6	m	3.86E-01	0.344	1
Zinc	54.1	m	0		316	m	76.63	m	1.29E+01	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-3
Screening Risk Characterization for the Mallard Duck
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0		6,380	m	955	m	3.81E+02	109.7	3
Antimony	0		0		0.085	m	0		4.41E-03	18	0.0002
Arsenic	5.4	m	0.0009		4.5	m	0.5	m	2.54E-01	2.24	0.1
Barium	90.4	m	0.0505		58.6	m	120.9	m	5.34E+00	20.8	0.3
Beryllium	0.769	m	0		0.29	m	0		1.68E-02	0.532	0.03
Boron	0		0.0189		4	m	57.81	m	1.21E+00	28	0.04
Cadmium	0		0		2.4	m	0.3859	m	1.31E-01	1.47	0.09
Chromium	13.8	m	0.0004	m	6.8	m	1.4	m	4.08E-01	2.66	0.2
Cobalt	10.5	m	0		7.2	m	1.4	m	4.22E-01	7.61	0.06
Copper	6.83	m	0.0005		12.8	m	11.96	m	8.86E-01	4.05	0.2
Iron	18,500	m	0.106		8,430	m	1,080	m	4.98E+02	109.3	5
Lead	10.4	m	0		6.8	m	1.016	m	3.94E-01	1.63	0.2
Manganese	689	m	0.128		1,380	m	535	m	8.24E+01	179	0.5
Mercury	0		0.0002	m	0.066	m	0		3.43E-03	0.45	0.008
Molybdenum	0		0.0008		0.72	m	0.9375	m	5.36E-02	3.5	0.02
Nickel	14.7	m	0.0006		7.4	m	3.828	m	4.84E-01	6.71	0.07
Selenium	0		0.0004	m	4.2	m	0		2.18E-01	0.29	0.8
Silver	0		0		0.16	m	0.07609	m	9.61E-03	2.02	0.005
Strontium	16.3	m	0.102		6.7	m	57.81	m	1.39E+00	312	0.004
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		9.4	m	1.6	m	5.75E-01	0.344	2
Zinc	54.1	m	0		316	m	76.63	m	1.78E+01	66.1	0.3

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-4
Screening Risk Characterization for the Killdeer
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	14,800	m	0		6,380	m	1.20E+03	109.7	11
Antimony	0		0		0.085	m	1.29E-02	18	0.0007
Arsenic	5.4	m	0.0009		4.5	m	7.69E-01	2.24	0.3
Barium	90.4	m	0.0505		58.6	m	1.03E+01	20.8	0.5
Beryllium	0.769	m	0		0.29	m	5.62E-02	0.532	0.1
Boron	0		0.0189		4	m	6.10E-01	28	0.02
Cadmium	0		0		2.4	m	3.65E-01	1.47	0.2
Chromium	13.8	m	0.0004	m	6.8	m	1.25E+00	2.66	0.5
Cobalt	10.5	m	0		7.2	m	1.26E+00	7.61	0.2
Copper	6.83	m	0.0005		12.8	m	2.05E+00	4.05	0.5
Iron	18,500	m	0.106		8,430	m	1.57E+03	109.3	14
Lead	10.4	m	0		6.8	m	1.20E+00	1.63	0.7
Manganese	689	m	0.128		1,380	m	2.21E+02	179	1
Mercury	0		0.0002	m	0.066	m	1.01E-02	0.45	0.02
Molybdenum	0		0.0008		0.72	m	1.10E-01	3.5	0.03
Nickel	14.7	m	0.0006		7.4	m	1.36E+00	6.71	0.2
Selenium	0		0.0004	m	4.2	m	6.38E-01	0.29	2
Silver	0		0		0.16	m	2.43E-02	2.02	0.01
Strontium	16.3	m	0.102		6.7	m	1.29E+00	312	0.004
Thallium	0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		9.4	m	1.84E+00	0.344	5
Zinc	54.1	m	0		316	m	4.89E+01	66.1	0.7

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-5
Screening Risk Characterization for the Heron
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0		6,380	m	1,970	m	1.24E+02	109.7	1
Antimony	0		0		0.085	m	0		9.53E-05	18	0.000005
Arsenic	5.4	m	0.00089		4.5	m	1.4	m	8.50E-02	2.24	0.04
Barium	90.4	m	0.0505		58.6	m	42.4	m	2.45E+00	20.8	0.1
Beryllium	0.769	m	0		0.29	m	0		7.56E-04	0.532	0.001
Boron	0		0.0189		4	m	0		5.34E-03	28	0.0002
Cadmium	0		0		2.4	m	0.29	m	1.86E-02	1.47	0.01
Chromium	13.8	m	0.00041	m	6.8	m	6.6	m	3.78E-01	2.66	0.1
Cobalt	10.5	m	0		7.2	m	2.1	m	1.29E-01	7.61	0.02
Copper	6.83	m	0.0005		12.8	m	37.5	m	2.08E+00	4.05	0.5
Iron	18,500	m	0.106		8,430	m	2,960	m	1.82E+02	109.3	2
Lead	10.4	m	0		6.8	m	3.7	m	2.17E-01	1.63	0.1
Manganese	689	m	0.128		1,380	m	443	m	2.63E+01	179	0.1
Mercury	0		0.00017	m	0.066	m	0.079	m	4.42E-03	0.45	0.01
Molybdenum	0		0.00079		0.72	m	0		8.43E-04	3.5	0.0002
Nickel	14.7	m	0.00061		7.4	m	32	m	1.77E+00	6.71	0.3
Selenium	0		0.00038	m	4.2	m	2.6	m	1.48E-01	0.29	0.5
Silver	0		0		0.16	m	0.015	m	1.00E-03	2.02	0.0005
Strontium	16.3	m	0.102		6.7	m	46.1	m	2.55E+00	312	0.008
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		9.4	m	3.8	m	2.34E-01	0.344	0.7
Zinc	54.1	m	0		316	m	91.5	m	5.41E+00	66.1	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-6
Screening Risk Characterization for the Osprey
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0		1,970	m	1.22E+02	109.7	1
Antimony	0		0		0.00E+00	18	--
Arsenic	0.0008924		1.4	m	8.64E-02	2.24	0.04
Barium	0.0505		42.4	m	2.62E+00	20.8	0.1
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0189		0		9.43E-04	28	0.00003
Cadmium	0		0.29	m	1.79E-02	1.47	0.01
Chromium	0.00041	m	6.6	m	4.07E-01	2.66	0.2
Cobalt	0		2.1	m	1.30E-01	7.61	0.02
Copper	0.0005012		37.5	m	2.31E+00	4.05	0.6
Iron	0.106		2,960	m	1.83E+02	109.3	2
Lead	0		3.7	m	2.28E-01	1.63	0.1
Manganese	0.128		443	m	2.73E+01	179	0.2
Mercury	0.00017	m	0.079	m	4.88E-03	0.45	0.01
Molybdenum	0.0007864		0		3.92E-05	3.5	0.00001
Nickel	0.0006074		32	m	1.97E+00	6.71	0.3
Selenium	0.00038	m	2.6	m	1.60E-01	0.29	0.6
Silver	0		0.015	m	9.26E-04	2.02	0.0005
Strontium	0.102		46.1	m	2.85E+00	312	0.009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0		3.8	m	2.34E-01	0.344	0.7
Zinc	0		91.5	m	5.65E+00	66.1	0.09

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-7
Screening Risk Characterization for the Muskrat
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	14,800	m	0		955	m	1.24E+02	1.93	64
Antimony	0		0		0		0.00E+00	0.059	--
Arsenic	5.4	m	0.0009		0.5	m	5.33E-02	1.04	0.05
Barium	90.4	m	0.0505		120.9	m	6.84E+00	51.8	0.1
Beryllium	0.769	m	0		0		3.82E-03	0.532	0.007
Boron	0		0.0189		57.81	m	3.06E+00	28.8	0.1
Cadmium	0		0		0.3859	m	2.04E-02	0.77	0.03
Chromium	13.8	m	0.0004	m	1.4	m	1.43E-01	2.4	0.06
Cobalt	10.5	m	0		1.4	m	1.26E-01	7.33	0.02
Copper	6.83	m	0.0005		11.96	m	6.66E-01	5.6	0.1
Iron	18,500	m	0.106		1,080	m	1.49E+02	22.8	7
Lead	10.4	m	0		1.016	m	1.05E-01	4.7	0.02
Manganese	689	m	0.128		535	m	3.17E+01	51.5	0.6
Mercury	0		0.0002	m	0		1.66E-05	1	0.00002
Molybdenum	0		0.0008		0.9375	m	4.96E-02	0.26	0.2
Nickel	14.7	m	0.0006		3.828	m	2.75E-01	1.7	0.2
Selenium	0		0.0004	m	0		3.70E-05	0.143	0.0003
Silver	0		0		0.07609	m	4.02E-03	6.02	0.0007
Strontium	16.3	m	0.102		57.81	m	3.15E+00	263	0.01
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0		1.6	m	2.15E-01	4.16	0.05
Zinc	54.1	m	0		76.63	m	4.32E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-8
Screening Risk Characterization for the Raccoon
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	14,800	m	0		6,380	m	955	m	1,970	m	1.61E+02	1.93	83
Antimony	0		0		0.085	m	0		0		1.18E-03	0.059	0.02
Arsenic	5.4	m	0.00089		4.5	m	0.5	m	1.4	m	9.28E-02	1.04	0.09
Barium	90.4	m	0.0505		58.6	m	120.9	m	42.4	m	3.68E+00	51.8	0.07
Beryllium	0.769	m	0		0.29	m	0		0		6.63E-03	0.532	0.01
Boron	0		0.0189		4	m	57.81	m	0		1.26E+00	28.8	0.04
Cadmium	0		0		2.4	m	0.3859	m	0.29	m	4.18E-02	0.77	0.05
Chromium	13.8	m	0.00041	m	6.8	m	1.4	m	6.6	m	1.77E-01	2.4	0.07
Cobalt	10.5	m	0		7.2	m	1.4	m	2.1	m	1.67E-01	7.33	0.02
Copper	6.83	m	0.0005		12.8	m	11.96	m	37.5	m	4.90E-01	5.6	0.09
Iron	18,500	m	0.106		8,430	m	1,080	m	2,960	m	2.05E+02	22.8	9
Lead	10.4	m	0		6.8	m	1.016	m	3.7	m	1.55E-01	4.7	0.03
Manganese	689	m	0.128		1,380	m	535	m	443	m	3.31E+01	51.5	0.6
Mercury	0		0.00017	m	0.066	m	0		0.079	m	1.02E-03	1	0.001
Molybdenum	0		0.00079		0.72	m	0.9375	m	0		2.95E-02	0.26	0.1
Nickel	14.7	m	0.00061		7.4	m	3.828	m	32	m	2.66E-01	1.7	0.2
Selenium	0		0.00038	m	4.2	m	0		2.6	m	6.14E-02	0.143	0.4
Silver	0		0		0.16	m	0.07609	m	0.015	m	3.82E-03	6.02	0.0006
Strontium	16.3	m	0.102		6.7	m	57.81	m	46.1	m	1.40E+00	263	0.005
Thallium	0		0		0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0		9.4	m	1.6	m	3.8	m	2.57E-01	4.16	0.06
Zinc	54.1	m	0		316	m	76.63	m	91.5	m	6.27E+00	75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-9
Screening Risk Characterization for the Mink
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Exposure Point Concentration [a]												Toxicity Reference	Hazard
	Exposed		Surface	Invertebrate		Vegetation		Fish		Amphibian		Dietary	Value [c]	Quotient
	Sediment		Water	WB Larval Mayfly				WB Shad		Frogs		Ingestion [b]	NOAEL	(HQ) [d]
Constituent	(mg/kg)		(mg/L)	(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg-BW-day)	(mg/kg-BW-day)	NOAEL
Inorganics														
Aluminum	14,800	m	0	6,380	m	955	m	1,970	m	51.4		1.38E+02	1.93	71
Antimony	0		0	0.085	m	0		0		0		4.56E-04	0.059	0.008
Arsenic	5.4	m	0.0009	4.5	m	0.5	m	1.4	m	0.268		9.18E-02	1.04	0.09
Barium	90.4	m	0.0505	58.6	m	120.9	m	42.4	m	66.51		2.88E+00	51.8	0.06
Beryllium	0.769	m	0	0.29	m	0		0		0		2.38E-03	0.532	0.004
Boron	0		0.0189	4	m	57.81	m	0		0		3.03E-01	28.8	0.01
Cadmium	0		0	2.4	m	0.3859	m	0.29	m	0.095		2.71E-02	0.77	0.04
Chromium	13.8	m	0.0004	m	6.8	m	1.4	m	6.6	m	29.74	m	3.76E-01	2.4	0.2
Cobalt	10.5	m	0	7.2	m	1.4	m	2.1	m	0.324		1.46E-01	7.33	0.02
Copper	6.83	m	0.0005	12.8	m	11.96	m	37.5	m	17.55		1.74E+00	5.6	0.3
Iron	18,500	m	0.106	8,430	m	1,080	m	2,960	m	229.3		1.95E+02	22.8	9
Lead	10.4	m	0	6.8	m	1.016	m	3.7	m	3.177	m	2.13E-01	4.7	0.05
Manganese	689	m	0.128	1,380	m	535	m	443	m	83.21		2.95E+01	51.5	0.6
Mercury	0		0.0002	m	0.066	m	0		0.079	m	0.09309	m	3.83E-03	1	0.004
Molybdenum	0		0.0008	0.72	m	0.9375	m	0		0.4217	m	9.04E-03	0.26	0.03
Nickel	14.7	m	0.0006	7.4	m	3.828	m	32	m	0		1.42E+00	1.7	0.8
Selenium	0		0.0004	m	4.2	m	0		2.6	m	1.534		1.34E-01	0.143	0.9
Silver	0		0	0.16	m	0.07609	m	0.015	m	0.031		1.90E-03	6.02	0.0003
Strontium	16.3	m	0.102	6.7	m	57.81	m	46.1	m	55.11		2.36E+00	263	0.009
Thallium	0		0	0		0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0	9.4	m	1.6	m	3.8	m	1.677	m	2.49E-01	4.16	0.06
Zinc	54.1	m	0	316	m	76.63	m	91.5	m	146.2		6.18E+00	75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-10
Screening Risk Characterization for the Tree Swallow
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0		5.2	m	1.28E+00	109.7	0.01
Antimony	0		0		0.00E+00	18	--
Arsenic	0.0008924		0.14	m	3.47E-02	2.24	0.02
Barium	0.0505		0.68	m	1.78E-01	20.8	0.009
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0189		0.77	m	1.94E-01	28	0.007
Cadmium	0		0.4	m	9.86E-02	1.47	0.07
Chromium	0.00041	m	12.7	m	3.13E+00	2.66	1
Cobalt	0		0.82	m	2.02E-01	7.61	0.03
Copper	0.0005012		27.9	m	6.87E+00	4.05	2
Iron	0.106		185	m	4.56E+01	109.3	0.4
Lead	0		0		0.00E+00	1.63	--
Manganese	0.128		2.9	m	7.42E-01	179	0.004
Mercury	0.00017	m	0.13	m	3.21E-02	0.45	0.07
Molybdenum	0.0007864		0.37	m	9.13E-02	3.5	0.03
Nickel	0.0006074		0		1.29E-04	6.71	0.00002
Selenium	0.00038	m	4.1	m	1.01E+00	0.29	3
Silver	0		0.028	m	6.90E-03	2.02	0.003
Strontium	0.102		0.74	m	2.04E-01	312	0.0007
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0		0.14	m	3.45E-02	0.344	0.1
Zinc	0		98.7	m	2.43E+01	66.1	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-11
Screening Risk Characterization for the Gray Bat
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0		5.2	m	9.44E-01	1.93	0.5
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00089238		0.14	m	2.56E-02	1.04	0.02
Barium	0.0505		0.68	m	1.31E-01	51.8	0.003
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0189		0.77	m	1.43E-01	28.8	0.005
Cadmium	0		0.4	m	7.26E-02	0.77	0.09
Chromium	0.00041	m	12.7	m	2.31E+00	2.4	1
Cobalt	0		0.82	m	1.49E-01	7.33	0.02
Copper	0.00050124		27.9	m	5.06E+00	5.6	0.9
Iron	0.106		185	m	3.36E+01	22.8	1
Lead	0		0		0.00E+00	4.7	--
Manganese	0.128		2.9	m	5.47E-01	51.5	0.01
Mercury	0.00017	m	0.13	m	2.36E-02	1	0.02
Molybdenum	0.0007864		0.37	m	6.73E-02	0.26	0.3
Nickel	0.00060735		0		9.58E-05	1.7	0.00006
Selenium	0.00038	m	4.1	m	7.44E-01	0.143	5
Silver	0		0.028	m	5.08E-03	6.02	0.0008
Strontium	0.102		0.74	m	1.50E-01	263	0.0006
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0		0.14	m	2.54E-02	4.16	0.006
Zinc	0		98.7	m	1.79E+01	75.4	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-ER_R-12
Screening Risk Characterization Results Summary
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**2**	**3**	**11**	1	1	**64**	**83**	**71**	0.01	0.5
Antimony	0.0001	0.0002	0.0007	0.000005	--	--	0.02	0.008	--	--
Arsenic	0.07	0.1	0.3	0.04	0.04	0.05	0.09	0.09	0.02	0.02
Barium	0.4	0.3	0.5	0.1	0.1	0.1	0.07	0.06	0.009	0.003
Beryllium	0.02	0.03	0.1	0.001	--	0.007	0.01	0.004	--	--
Boron	0.1	0.04	0.02	0.0002	0.00003	0.1	0.04	0.01	0.007	0.005
Cadmium	0.06	0.09	0.2	0.01	0.01	0.03	0.05	0.04	0.07	0.09
Chromium	0.1	0.2	0.5	0.1	0.2	0.06	0.07	0.2	1	1
Cobalt	0.04	0.06	0.2	0.02	0.02	0.02	0.02	0.02	0.03	0.02
Copper	0.3	0.2	0.5	0.5	0.6	0.1	0.09	0.3	**2**	0.9
Iron	**3**	**5**	**14**	**2**	**2**	**7**	**9**	**9**	0.4	1
Lead	0.2	0.2	0.7	0.1	0.1	0.02	0.03	0.05	--	--
Manganese	0.4	0.5	1	0.1	0.2	0.6	0.6	0.6	0.004	0.01
Mercury	0.004	0.008	0.02	0.01	0.01	0.00002	0.001	0.004	0.07	0.02
Molybdenum	0.02	0.02	0.03	0.0002	0.00001	0.2	0.1	0.03	0.03	0.3
Nickel	0.06	0.07	0.2	0.3	0.3	0.2	0.2	0.8	0.00002	0.00006
Selenium	0.4	0.8	**2**	0.5	0.6	0.0003	0.4	0.9	**3**	**5**
Silver	0.004	0.005	0.01	0.0005	0.0005	0.0007	0.0006	0.0003	0.003	0.0008
Strontium	0.01	0.004	0.004	0.008	0.009	0.01	0.005	0.009	0.0007	0.0006
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	1	**2**	**5**	0.7	0.7	0.05	0.06	0.06	0.1	0.006
Zinc	0.2	0.3	0.7	0.08	0.09	0.06	0.08	0.08	0.4	0.2

Hazard quotients greater than one are in bold.

Table 4-CR_A-1
Risk Characterization
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates												
											Larval Mayfly (Whole Body)					Adult Mayfly							
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)				
Inorganics																								
Aluminum	12/12	7370	-	143000	70028		7 / 8	0.0656	-	0.214	0.155		3/3	6930	-	10900	10900	m	0/6	0	-	0	0	
Antimony	3/12	1.32	-	2.52	2.52	m	0 / 8	0	-	0	0		3/3	0.19	-	0.27	0.27	m	0/6	0	-	0	0	
Arsenic	12/12	5.2	-	63.4	28.62		8 / 8	0.00084	-	0.0015	0.0013		3/3	12.6	-	14.6	14.6	m	6/6	0.16	-	0.26	0.26	m
Barium	12/12	50.7	-	190	133.4		8 / 8	0.0356	-	0.0442	0.0415		3/3	75.9	-	104	104	m	6/6	0.39	-	0.72	0.72	m
Beryllium	10/12	0.623	-	4.39	2.525		0 / 8	0	-	0	0		3/3	0.55	-	0.84	0.84	m	0/6	0	-	0	0	
Boron	12/12	8.63	-	60.5	50.23		8 / 8	0.0149	-	0.0267	0.0221		3/3	6.6	-	9	9	m	5/6	0.48	-	0.78	0.78	m
Cadmium	0/12	0	-	0	0		0 / 8	0	-	0	0		3/3	1.1	-	2.1	2.1	m	6/6	0.58	-	0.7	0.7	m
Chromium	12/12	14.8	-	125	69.36		2 / 8	0.00036	-	0.0005	0.0005	m	3/3	8.7	-	13.4	13.4	m	6/6	0.23	-	0.32	0.32	m
Cobalt	12/12	4.52	-	18	13.27		1 / 8	0.00033	-	0.0003	0.0003	m	3/3	5.7	-	8.3	8.3	m	6/6	0.82	-	1	1	m
Copper	12/12	5.52	-	90.4	36.85		8 / 8	0.00092	-	0.002	0.0016		3/3	18.6	-	23.4	23.4	m	6/6	17	-	27.5	27.5	m
Iron	12/12	14500	-	93800	51886		8 / 8	0.0678	-	0.15	0.117		3/3	7180	-	11900	11900	m	6/6	104	-	177	177	m
Lead	12/12	12.1	-	102	47.71		1 / 8	0.00037	-	0.0004	0.0004	m	3/3	6.7	-	10.5	10.5	m	0/6	0	-	0	0	
Manganese	12/12	160	-	1700	1016		8 / 8	0.025	-	0.0326	0.0311		3/3	733	-	959	959	m	6/6	1.8	-	3.7	3.7	m
Mercury	10/12	0.07	-	0.39	0.204		1 / 8	0.00023	-	0.0002	0.0002	m	3/3	0.27	-	0.31	0.31	m	6/6	0.04	-	0.06	0.06	m
Molybdenum	0/12	0	-	0	0		8 / 8	0.00053	-	0.001	0.0009		3/3	1.5	-	1.6	1.6	m	6/6	0.32	-	0.5	0.5	m
Nickel	12/12	3.24	-	135	45.88		7 / 8	0.00035	-	0.0008	0.0006		3/3	9.6	-	14.1	14.1	m	0/6	0	-	0	0	
Selenium	0/12	0	-	0	0		3 / 8	0.00036	-	0.0008	0.0008	m	3/3	6.5	-	6.6	6.6	m	6/6	5.2	-	6.7	6.7	m
Silver	0/12	0	-	0	0		0 / 8	0	-	0	0		3/3	0.05	-	0.08	0.08	m	6/6	0.01	-	0.01	0.01	m
Strontium	12/12	6.27	-	43.6	27.56		8 / 8	0.108	-	0.123	0.119		3/3	22.9	-	31	31	m	6/6	0.44	-	0.83	0.83	m
Thallium	0/12	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		0/6	0	-	0	0	
Vanadium	12/12	21.1	-	193	89.27		8 / 8	0.00102	-	0.002	0.0016		3/3	13.6	-	20.7	20.7	m	6/6	0.16	-	0.25	0.25	m
Zinc	12/12	27.5	-	460	307.8		0 / 8	0	-	0	0		3/3	175	-	194	194	m	6/6	80.1	-	205	205	m

Table 4-CR_A-1
Risk Characterization
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	26.2	-	450.8	451	m	6/6	441	-	3074	3074	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		4/6	0.064	-	0.11	0.11	m	0/40	0	-	0	0	
Arsenic	4/6	0.2	-	0.7661	0.77	m	6/6	1.6	-	5.12	5.12	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	7.67	-	44.92	44.9	m	6/6	18.1	-	43.3	43.3	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		3/6	0.162	-	0.27	0.27	m	0/40	0	-	0	0	
Boron	6/6	8.83	-	67.01	67	m	2/6	1.982	-	2.37	2.37	m	0/40	0	-	0	0	
Cadmium	2/6	0.03	-	0.0518	0.05	m	6/6	0.0463	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	1/6	0.73	-	0.7254	0.73	m	5/6	1.6	-	4.65	4.65	m	0/40	0	-	0	0	
Cobalt	5/6	0.05	-	0.4404	0.44	m	6/6	0.47	-	2.05	2.05	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	5.3	-	11.11	11.1	m	6/6	5.4	-	14.8	14.8	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	54	-	435.2	435	m	6/6	448	-	1395	1395	m	34/40	99.1	-	532.7	238	
Lead	6/6	0.1	-	1.244	1.24	m	6/6	0.75	-	3.21	3.21	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	19.4	-	386.6	387	m	6/6	140	-	327	327	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		6/6	0.06	-	0.15	0.15	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.95	-	1.711	1.71	m	2/6	0.1613	-	0.18	0.18	m	7/40	0.29	-	0.4814	0.32	
Nickel	5/6	0.42	-	1.551	1.55	m	6/6	1.2	-	12.4	12.4	m	0/40	0	-	0	0	
Selenium	3/6	0.4	-	0.7487	0.75	m	6/6	2	-	3.44	3.44	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		5/6	0.014	-	0.04	0.04	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	12.3	-	55.61	55.6	m	6/6	37.3	-	46.5	46.5	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.83	-	0.829	0.83	m	6/6	1.1	-	6.98	6.98	m	0/40	0	-	0	0	
Zinc	6/6	29.3	-	53.8	53.8	m	6/6	73.7	-	131	131	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-CR_A-2
Screening Risk Characterization for the Wood Duck
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.155		10,900	m	450.8	m	4.36E+02	109.7	4
Antimony	2.52	m	0		0.27	m	0		1.15E-02	18	0.0006
Arsenic	28.62		0.0013		14.6	m	0.7661	m	4.86E-01	2.24	0.2
Barium	133.4		0.0415		104	m	44.92	m	5.52E+00	20.8	0.3
Beryllium	2.525		0		0.84	m	0		2.69E-02	0.532	0.05
Boron	50.23		0.0221		9	m	67.01	m	4.02E+00	28	0.1
Cadmium	0		0		2.1	m	0.05181	m	5.98E-02	1.47	0.04
Chromium	69.36		0.0005	m	13.4	m	0.7254	m	5.18E-01	2.66	0.2
Cobalt	13.27		0.0003	m	8.3	m	0.4404	m	2.71E-01	7.61	0.04
Copper	36.85		0.0016		23.4	m	11.11	m	1.31E+00	4.05	0.3
Iron	51,886		0.117		11,900	m	435.2	m	4.32E+02	109.3	4
Lead	47.71		0.0004	m	10.5	m	1.244	m	4.32E-01	1.63	0.3
Manganese	1,016		0.0311		959	m	386.6	m	4.90E+01	179	0.3
Mercury	0.204		0.0002	m	0.31	m	0		8.76E-03	0.45	0.02
Molybdenum	0		0.0009		1.6	m	1.711	m	1.38E-01	3.5	0.04
Nickel	45.88		0.0006		14.1	m	1.551	m	5.44E-01	6.71	0.08
Selenium	0		0.0008	m	6.6	m	0.7487	m	2.20E-01	0.29	0.8
Silver	0		0		0.08	m	0		2.17E-03	2.02	0.001
Strontium	27.56		0.119		31	m	55.61	m	3.96E+00	312	0.01
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	89.27		0.0016		20.7	m	0.829	m	7.54E-01	0.344	2
Zinc	307.8		0		194	m	53.8	m	8.73E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-3
Screening Risk Characterization for the Mallard Duck
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.155		10,900	m	450.8	m	7.33E+02	109.7	7
Antimony	2.52	m	0		0.27	m	0		1.98E-02	18	0.001
Arsenic	28.62		0.0013		14.6	m	0.7661	m	8.36E-01	2.24	0.4
Barium	133.4		0.0415		104	m	44.92	m	6.48E+00	20.8	0.3
Beryllium	2.525		0		0.84	m	0		4.93E-02	0.532	0.09
Boron	50.23		0.0221		9	m	67.01	m	1.74E+00	28	0.06
Cadmium	0		0		2.1	m	0.05181	m	1.10E-01	1.47	0.07
Chromium	69.36		0.0005	m	13.4	m	0.7254	m	8.66E-01	2.66	0.3
Cobalt	13.27		0.0003	m	8.3	m	0.4404	m	4.68E-01	7.61	0.06
Copper	36.85		0.0016		23.4	m	11.11	m	1.49E+00	4.05	0.4
Iron	51,886		0.117		11,900	m	435.2	m	7.43E+02	109.3	7
Lead	47.71		0.0004	m	10.5	m	1.244	m	6.75E-01	1.63	0.4
Manganese	1,016		0.0311		959	m	386.6	m	5.87E+01	179	0.3
Mercury	0.204		0.0002	m	0.31	m	0		1.66E-02	0.45	0.04
Molybdenum	0		0.0009		1.6	m	1.711	m	1.13E-01	3.5	0.03
Nickel	45.88		0.0006		14.1	m	1.551	m	8.63E-01	6.71	0.1
Selenium	0		0.0008	m	6.6	m	0.7487	m	3.55E-01	0.29	1
Silver	0		0		0.08	m	0		4.15E-03	2.02	0.002
Strontium	27.56		0.119		31	m	55.61	m	2.64E+00	312	0.008
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	89.27		0.0016		20.7	m	0.829	m	1.29E+00	0.344	4
Zinc	307.8		0		194	m	53.8	m	1.17E+01	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-4
Screening Risk Characterization for the Killdeer
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	70,028		0.155		10,900	m	2.76E+03	109.7	25
Antimony	2.52	m	0		0.27	m	8.09E-02	18	0.004
Arsenic	28.62		0.0013		14.6	m	2.67E+00	2.24	1
Barium	133.4		0.0415		104	m	1.79E+01	20.8	0.9
Beryllium	2.525		0		0.84	m	1.68E-01	0.532	0.3
Boron	50.23		0.0221		9	m	2.16E+00	28	0.08
Cadmium	0		0		2.1	m	3.19E-01	1.47	0.2
Chromium	69.36		0.0005	m	13.4	m	3.13E+00	2.66	1
Cobalt	13.27		0.0003	m	8.3	m	1.47E+00	7.61	0.2
Copper	36.85		0.0016		23.4	m	4.14E+00	4.05	1
Iron	51,886		0.117		11,900	m	2.63E+03	109.3	24
Lead	47.71		0.0004	m	10.5	m	2.35E+00	1.63	1
Manganese	1,016		0.0311		959	m	1.62E+02	179	0.9
Mercury	0.204		0.0002	m	0.31	m	5.04E-02	0.45	0.1
Molybdenum	0		0.0009		1.6	m	2.43E-01	3.5	0.07
Nickel	45.88		0.0006		14.1	m	2.87E+00	6.71	0.4
Selenium	0		0.0008	m	6.6	m	1.00E+00	0.29	3
Silver	0		0		0.08	m	1.22E-02	2.02	0.006
Strontium	27.56		0.119		31	m	5.16E+00	312	0.02
Thallium	0		0		0		0.00E+00	0.35	--
Vanadium	89.27		0.0016		20.7	m	4.56E+00	0.344	13
Zinc	307.8		0		194	m	3.43E+01	66.1	0.5

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-5
Screening Risk Characterization for the Heron
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.155		10,900	m	3,074	m	2.20E+02	109.7	2
Antimony	2.52	m	0		0.27	m	0.107	m	7.59E-03	18	0.0004
Arsenic	28.62		0.00125		14.6	m	5.116	m	3.14E-01	2.24	0.1
Barium	133.4		0.0415		104	m	43.26	m	2.57E+00	20.8	0.1
Beryllium	2.525		0		0.84	m	0.2698	m	1.72E-02	0.532	0.03
Boron	50.23		0.0221		9	m	2.372	m	1.70E-01	28	0.006
Cadmium	0		0		2.1	m	0.09	m	7.30E-03	1.47	0.005
Chromium	69.36		0.00046	m	13.4	m	4.651	m	3.09E-01	2.66	0.1
Cobalt	13.27		0.00033	m	8.3	m	2.047	m	1.29E-01	7.61	0.02
Copper	36.85		0.00161		23.4	m	14.75	m	8.57E-01	4.05	0.2
Iron	51,886		0.117		11,900	m	1,395	m	1.19E+02	109.3	1
Lead	47.71		0.00037	m	10.5	m	3.209	m	2.15E-01	1.63	0.1
Manganese	1,016		0.0311		959	m	326.7	m	1.96E+01	179	0.1
Mercury	0.204		0.00023	m	0.31	m	0.1475	m	8.58E-03	0.45	0.02
Molybdenum	0		0.00089		1.6	m	0.1814	m	1.18E-02	3.5	0.003
Nickel	45.88		0.00058		14.1	m	12.44	m	7.25E-01	6.71	0.1
Selenium	0		0.00076	m	6.6	m	3.442	m	1.97E-01	0.29	0.7
Silver	0		0		0.08	m	0.0386	m	2.21E-03	2.02	0.001
Strontium	27.56		0.119		31	m	46.54	m	2.61E+00	312	0.008
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	89.27		0.00162		20.7	m	6.977	m	4.57E-01	0.344	1
Zinc	307.8		0		194	m	130.9	m	7.58E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-6
Screening Risk Characterization for the Osprey
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.155		3,074	m	1.90E+02	109.7	2
Antimony	0		0.107	m	6.60E-03	18	0.0004
Arsenic	0.00125		5.116	m	3.16E-01	2.24	0.1
Barium	0.0415		43.26	m	2.67E+00	20.8	0.1
Beryllium	0		0.2698	m	1.66E-02	0.532	0.03
Boron	0.0221		2.372	m	1.47E-01	28	0.005
Cadmium	0		0.09	m	5.55E-03	1.47	0.004
Chromium	0.00046	m	4.651	m	2.87E-01	2.66	0.1
Cobalt	0.00033	m	2.047	m	1.26E-01	7.61	0.02
Copper	0.00161		14.75	m	9.10E-01	4.05	0.2
Iron	0.117		1,395	m	8.61E+01	109.3	0.8
Lead	0.00037	m	3.209	m	1.98E-01	1.63	0.1
Manganese	0.0311		326.7	m	2.02E+01	179	0.1
Mercury	0.00023	m	0.1475	m	9.11E-03	0.45	0.02
Molybdenum	0.0008924		0.1814	m	1.12E-02	3.5	0.003
Nickel	0.0005833		12.44	m	7.68E-01	6.71	0.1
Selenium	0.00076	m	3.442	m	2.12E-01	0.29	0.7
Silver	0		0.0386	m	2.38E-03	2.02	0.001
Strontium	0.119		46.54	m	2.88E+00	312	0.009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00162		6.977	m	4.31E-01	0.344	1
Zinc	0		130.9	m	8.08E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-7
Screening Risk Characterization for the Muskrat
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	70,028		0.155		450.8	m	3.72E+02	1.93	190
Antimony	2.52	m	0		0		1.25E-02	0.059	0.2
Arsenic	28.62		0.0013		0.7661	m	1.83E-01	1.04	0.2
Barium	133.4		0.0415		44.92	m	3.04E+00	51.8	0.06
Beryllium	2.525		0		0		1.25E-02	0.532	0.02
Boron	50.23		0.0221		67.01	m	3.79E+00	28.8	0.1
Cadmium	0		0		0.05181	m	2.74E-03	0.77	0.004
Chromium	69.36		0.0005	m	0.7254	m	3.83E-01	2.4	0.2
Cobalt	13.27		0.0003	m	0.4404	m	8.92E-02	7.33	0.01
Copper	36.85		0.0016		11.11	m	7.70E-01	5.6	0.1
Iron	51,886		0.117		435.2	m	2.81E+02	22.8	12
Lead	47.71		0.0004	m	1.244	m	3.03E-01	4.7	0.06
Manganese	1,016		0.0311		386.6	m	2.55E+01	51.5	0.5
Mercury	0.204		0.0002	m	0		1.04E-03	1	0.001
Molybdenum	0		0.0009		1.711	m	9.05E-02	0.26	0.3
Nickel	45.88		0.0006		1.551	m	3.10E-01	1.7	0.2
Selenium	0		0.0008	m	0.7487	m	3.96E-02	0.143	0.3
Silver	0		0		0		0.00E+00	6.02	--
Strontium	27.56		0.119		55.61	m	3.09E+00	263	0.01
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	89.27		0.0016		0.829	m	4.88E-01	4.16	0.1
Zinc	307.8		0		53.8	m	4.37E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-8
Screening Risk Characterization for the Raccoon
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	70,028		0.155		10,900	m	450.8	m	3,074	m	4.00E+02	1.93	210
Antimony	2.52	m	0		0.27	m	0		0.107	m	1.23E-02	0.059	0.2
Arsenic	28.62		0.00125		14.6	m	0.7661	m	5.116	m	3.21E-01	1.04	0.3
Barium	133.4		0.0415		104	m	44.92	m	43.26	m	2.88E+00	51.8	0.06
Beryllium	2.525		0		0.84	m	0		0.2698	m	2.05E-02	0.532	0.04
Boron	50.23		0.0221		9	m	67.01	m	2.372	m	1.69E+00	28.8	0.06
Cadmium	0		0		2.1	m	0.05181	m	0.09	m	3.04E-02	0.77	0.04
Chromium	69.36		0.00046	m	13.4	m	0.7254	m	4.651	m	4.40E-01	2.4	0.2
Cobalt	13.27		0.00033	m	8.3	m	0.4404	m	2.047	m	1.72E-01	7.33	0.02
Copper	36.85		0.00161		23.4	m	11.11	m	14.75	m	6.96E-01	5.6	0.1
Iron	51,886		0.117		11,900	m	435.2	m	1,395	m	3.51E+02	22.8	15
Lead	47.71		0.00037	m	10.5	m	1.244	m	3.209	m	3.36E-01	4.7	0.07
Manganese	1,016		0.0311		959	m	386.6	m	326.7	m	2.51E+01	51.5	0.5
Mercury	0.204		0.00023	m	0.31	m	0		0.1475	m	5.18E-03	1	0.005
Molybdenum	0		0.00089		1.6	m	1.711	m	0.1814	m	5.80E-02	0.26	0.2
Nickel	45.88		0.00058		14.1	m	1.551	m	12.44	m	3.96E-01	1.7	0.2
Selenium	0		0.00076	m	6.6	m	0.7487	m	3.442	m	1.11E-01	0.143	0.8
Silver	0		0		0.08	m	0		0.0386	m	1.16E-03	6.02	0.0002
Strontium	27.56		0.119		31	m	55.61	m	46.54	m	1.74E+00	263	0.007
Thallium	0		0		0		0		0		0.00E+00	0.015	--
Vanadium	89.27		0.00162		20.7	m	0.829	m	6.977	m	6.13E-01	4.16	0.1
Zinc	307.8		0		194	m	53.8	m	130.9	m	4.99E+00	75.4	0.07

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-9
Screening Risk Characterization for the Mink
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Amphibian Frogs (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics															
Aluminum	70,028		0.155		10,900	m	450.8	m	3,074	m	56.6		2.66E+02	1.93	140
Antimony	2.52	m	0		0.27	m	0		0.107	m	0		8.66E-03	0.059	0.1
Arsenic	28.62		0.0013		14.6	m	0.7661	m	5.116	m	0.8164	m	3.30E-01	1.04	0.3
Barium	133.4		0.0415		104	m	44.92	m	43.26	m	78.98		2.85E+00	51.8	0.06
Beryllium	2.525		0		0.84	m	0		0.2698	m	0		1.86E-02	0.532	0.03
Boron	50.23		0.0221		9	m	67.01	m	2.372	m	0		5.28E-01	28.8	0.02
Cadmium	0		0		2.1	m	0.05181	m	0.09	m	0.143		1.55E-02	0.77	0.02
Chromium	69.36		0.0005	m	13.4	m	0.7254	m	4.651	m	0		3.46E-01	2.4	0.1
Cobalt	13.27		0.0003	m	8.3	m	0.4404	m	2.047	m	0.228		1.48E-01	7.33	0.02
Copper	36.85		0.0016		23.4	m	11.11	m	14.75	m	18.35		8.65E-01	5.6	0.2
Iron	51,886		0.117		11,900	m	435.2	m	1,395	m	237.9		1.81E+02	22.8	8
Lead	47.71		0.0004	m	10.5	m	1.244	m	3.209	m	0.7493	m	2.50E-01	4.7	0.05
Manganese	1,016		0.0311		959	m	386.6	m	326.7	m	88.97		2.20E+01	51.5	0.4
Mercury	0.204		0.0002	m	0.31	m	0		0.1475	m	0.13		8.30E-03	1	0.008
Molybdenum	0		0.0009		1.6	m	1.711	m	0.1814	m	0.32		2.50E-02	0.26	0.1
Nickel	45.88		0.0006		14.1	m	1.551	m	12.44	m	0		6.57E-01	1.7	0.4
Selenium	0		0.0008	m	6.6	m	0.7487	m	3.442	m	2.066		1.87E-01	0.143	1
Silver	0		0		0.08	m	0		0.0386	m	0.038		2.11E-03	6.02	0.0004
Strontium	27.56		0.119		31	m	55.61	m	46.54	m	77.81		2.54E+00	263	0.01
Thallium	0		0		0		0		0		0.34	m	4.56E-04	0.015	0.03
Vanadium	89.27		0.0016		20.7	m	0.829	m	6.977	m	0		5.05E-01	4.16	0.1
Zinc	307.8		0		194	m	53.8	m	130.9	m	145		7.34E+00	75.4	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-10
Screening Risk Characterization for the Tree Swallow
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.155		0		3.30E-02	109.7	0.0003
Antimony	0		0		0.00E+00	18	--
Arsenic	0.00125		0.26	m	6.43E-02	2.24	0.03
Barium	0.0415		0.72	m	1.86E-01	20.8	0.009
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0221		0.78	m	1.97E-01	28	0.007
Cadmium	0		0.7	m	1.72E-01	1.47	0.1
Chromium	0.00046	m	0.32	m	7.89E-02	2.66	0.03
Cobalt	0.00033	m	1	m	2.46E-01	7.61	0.03
Copper	0.00161		27.5	m	6.78E+00	4.05	2
Iron	0.117		177	m	4.36E+01	109.3	0.4
Lead	0.00037	m	0		7.87E-05	1.63	0.00005
Manganese	0.0311		3.7	m	9.18E-01	179	0.005
Mercury	0.00023	m	0.055	m	1.36E-02	0.45	0.03
Molybdenum	0.0008924		0.5	m	1.23E-01	3.5	0.04
Nickel	0.0005833		0		1.24E-04	6.71	0.00002
Selenium	0.00076	m	6.7	m	1.65E+00	0.29	6
Silver	0		0.0098	m	2.41E-03	2.02	0.001
Strontium	0.119		0.83	m	2.30E-01	312	0.0007
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00162		0.25	m	6.19E-02	0.344	0.2
Zinc	0		205	m	5.05E+01	66.1	0.8

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-11
Screening Risk Characterization for the Gray Bat
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.155		0		2.44E-02	1.93	0.01
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00125		0.26	m	4.74E-02	1.04	0.05
Barium	0.0415		0.72	m	1.37E-01	51.8	0.003
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0221		0.78	m	1.45E-01	28.8	0.005
Cadmium	0		0.7	m	1.27E-01	0.77	0.2
Chromium	0.00046	m	0.32	m	5.82E-02	2.4	0.02
Cobalt	0.00033	m	1	m	1.82E-01	7.33	0.02
Copper	0.00161		27.5	m	4.99E+00	5.6	0.9
Iron	0.117		177	m	3.21E+01	22.8	1
Lead	0.00037	m	0		5.84E-05	4.7	0.00001
Manganese	0.0311		3.7	m	6.76E-01	51.5	0.01
Mercury	0.00023	m	0.055	m	1.00E-02	1	0.01
Molybdenum	0.00089236		0.5	m	9.09E-02	0.26	0.3
Nickel	0.00058332		0		9.20E-05	1.7	0.00005
Selenium	0.00076	m	6.7	m	1.22E+00	0.143	9
Silver	0		0.0098	m	1.78E-03	6.02	0.0003
Strontium	0.119		0.83	m	1.69E-01	263	0.0006
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00162		0.25	m	4.56E-02	4.16	0.01
Zinc	0		205	m	3.72E+01	75.4	0.5

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_A-12
Screening Risk Characterization Results Summary
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**4**	**7**	**25**	**2**	**2**	**190**	**210**	**140**	0.0003	0.01
Antimony	0.0006	0.001	0.004	0.0004	0.0004	0.2	0.2	0.1	--	--
Arsenic	0.2	0.4	1	0.1	0.1	0.2	0.3	0.3	0.03	0.05
Barium	0.3	0.3	0.9	0.1	0.1	0.06	0.06	0.06	0.009	0.003
Beryllium	0.05	0.09	0.3	0.03	0.03	0.02	0.04	0.03	--	--
Boron	0.1	0.06	0.08	0.006	0.005	0.1	0.06	0.02	0.007	0.005
Cadmium	0.04	0.07	0.2	0.005	0.004	0.004	0.04	0.02	0.1	0.2
Chromium	0.2	0.3	1	0.1	0.1	0.2	0.2	0.1	0.03	0.02
Cobalt	0.04	0.06	0.2	0.02	0.02	0.01	0.02	0.02	0.03	0.02
Copper	0.3	0.4	1	0.2	0.2	0.1	0.1	0.2	**2**	0.9
Iron	**4**	**7**	**24**	1	0.8	**12**	**15**	**8**	0.4	1
Lead	0.3	0.4	1	0.1	0.1	0.06	0.07	0.05	0.00005	0.00001
Manganese	0.3	0.3	0.9	0.1	0.1	0.5	0.5	0.4	0.005	0.01
Mercury	0.02	0.04	0.1	0.02	0.02	0.001	0.005	0.008	0.03	0.01
Molybdenum	0.04	0.03	0.07	0.003	0.003	0.3	0.2	0.1	0.04	0.3
Nickel	0.08	0.1	0.4	0.1	0.1	0.2	0.2	0.4	0.00002	0.00005
Selenium	0.8	1	**3**	0.7	0.7	0.3	0.8	1	**6**	**9**
Silver	0.001	0.002	0.006	0.001	0.001	--	0.0002	0.0004	0.001	0.0003
Strontium	0.01	0.008	0.02	0.008	0.009	0.01	0.007	0.01	0.0007	0.0006
Thallium	--	--	--	--	--	--	--	0.03	--	--
Vanadium	**2**	**4**	**13**	1	1	0.1	0.1	0.1	0.2	0.01
Zinc	0.1	0.2	0.5	0.1	0.1	0.06	0.07	0.1	0.8	0.5

Hazard quotients greater than one are in bold.

Table 4-CR_B-1
Data Summaries
Risk Characterization
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates										
											Larval Mayfly (Whole Body)					Adult Mayfly					
	FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		
Constituent		(mg/kg)					(mg/L)					(mg/kg)					(mg/kg)				
Inorganics																					
Aluminum	13/13	9870	- 59400	34331		7 / 9	0.0794	- 0.139	0.125		3/3	8440	- 9120	9120	m	0/9	0	- 0	0		
Antimony	3/13	1.3	- 1.73	1.73	m	0 / 9	0	- 0	0		3/3	0.23	- 0.25	0.25	m	0/9	0	- 0	0		
Arsenic	13/13	7.31	- 82.6	42.61		8 / 9	0.00054	- 0.002	0.0013		3/3	13.6	- 16.4	16.4	m	9/9	0.19	- 0.28	0.25		
Barium	13/13	50.2	- 216	138.9		8 / 9	0.0352	- 0.0415	0.0395		3/3	92.5	- 96.9	96.9	m	9/9	0.56	- 0.92	0.81		
Beryllium	8/13	0.498	- 1.7	1.029		0 / 9	0	- 0	0		3/3	0.72	- 0.77	0.77	m	0/9	0	- 0	0		
Boron	12/13	8.02	- 45.7	35.3		7 / 9	0.0142	- 0.024	0.0196		3/3	6.2	- 7.2	7.2	m	8/9	0.46	- 1.4	0.99		
Cadmium	0/13	0	- 0	0		0 / 9	0	- 0	0		3/3	0.76	- 1.2	1.2	m	9/9	0.2	- 0.37	0.33		
Chromium	13/13	13.4	- 71.3	47.97		1 / 9	0.00039	- 0.0004	0.0004	m	3/3	10.8	- 11.7	11.7	m	7/9	0.21	- 0.29	0.26		
Cobalt	13/13	4.55	- 23.8	17.89		0 / 9	0	- 0	0		3/3	7.3	- 7.7	7.7	m	9/9	0.67	- 0.89	0.81		
Copper	13/13	7.2	- 46.8	22.84		8 / 9	0.00077	- 0.0026	0.0018		3/3	20.4	- 21	21	m	9/9	11.8	- 28.5	23.8		
Iron	13/13	14800	- 49200	34139		8 / 9	0.0696	- 0.133	0.119		3/3	9160	- 9560	9560	m	9/9	94.6	- 189	159		
Lead	13/13	12.3	- 86.7	39.23		0 / 9	0	- 0	0		3/3	8.6	- 8.9	8.9	m	0/9	0	- 0	0		
Manganese	13/13	145	- 3540	1655		9 / 10	0.0259	- 0.0391	0.0342		3/3	759	- 807	807	m	9/9	2	- 3.4	3.13		
Mercury	11/13	0.065	- 1	0.679		0 / 9	0	- 0	0		3/3	0.26	- 0.3	0.3	m	9/9	0.06	- 0.08	0.07		
Molybdenum	0/13	0	- 0	0		8 / 9	0.00056	- 0.001	0.0009		3/3	1.5	- 1.6	1.6	m	9/9	0.41	- 0.69	0.59		
Nickel	13/13	5.81	- 36.9	20.06		7 / 9	0.00042	- 0.0006	0.0005		3/3	11.9	- 12.4	12.4	m	1/9	0.33	- 0.33	0.33	m	
Selenium	1/13	1.77	- 1.77	1.77	m	4 / 9	0.00034	- 0.0004	0.0004	m	3/3	6.6	- 7.4	7.4	m	9/9	5.8	- 6.6	6.4		
Silver	0/13	0	- 0	0		0 / 9	0	- 0	0		3/3	0.06	- 0.065	0.065	m	9/9	0.01	- 0.02	0.01		
Strontium	13/13	7.27	- 42.1	23.22		8 / 9	0.109	- 0.116	0.115		3/3	26.1	- 31.1	31.1	m	9/9	0.61	- 0.94	0.78		
Thallium	3/13	1.35	- 3.11	3.11	m	0 / 9	0	- 0	0		0/3	0	- 0	0		0/9	0	- 0	0		
Vanadium	13/13	22.9	- 63.5	48.85		5 / 9	0.00107	- 0.0022	0.0016		3/3	17.1	- 18.9	18.9	m	9/9	0.17	- 0.25	0.23		
Zinc	13/13	30.3	- 194	87.05		0 / 9	0	- 0	0		3/3	172	- 182	182	m	9/9	91.4	- 212	198		

Table 4-CR_B-1
Data Summaries
Risk Characterization
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Autho

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	25.9	-	154.1	154	m	6/6	602.7	-	1560	1560	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		2/6	0.065	-	0.08	0.08	m	0/40	0	-	0	0	
Arsenic	1/6	0.25	-	0.2523	0.25	m	6/6	1.9	-	3.1	3.1	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	12	-	45.97	46	m	6/6	16.89	-	25.7	25.7	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		2/6	0.1	-	0.13	0.13	m	0/40	0	-	0	0	
Boron	6/6	11.3	-	50.34	50.3	m	0/6	0	-	0	0		0/40	0	-	0	0	
Cadmium	5/6	0.03	-	0.0688	0.07	m	6/6	0.05023	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	2/6	0.61	-	0.7798	0.78	m	6/6	1.142	-	4.2	4.2	m	0/40	0	-	0	0	
Cobalt	6/6	0.09	-	0.4037	0.4	m	6/6	0.6818	-	1.6	1.6	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	6.42	-	12.55	12.6	m	6/6	5.1	-	9.55	9.55	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	55.2	-	168.3	168	m	6/6	616.4	-	1870	1870	m	34/40	99.1	-	532.7	238	
Lead	5/6	0.09	-	0.3394	0.34	m	6/6	0.6849	-	3.2	3.2	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	98.2	-	600.7	601	m	6/6	133.8	-	233	233	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		4/6	0.05479	-	0.11	0.11	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.26	-	4.319	4.32	m	2/6	0.15	-	0.19	0.19	m	7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.6	-	2.836	2.84	m	6/6	1.05	-	5.7	5.7	m	0/40	0	-	0	0	
Selenium	1/6	0.39	-	0.3899	0.39	m	6/6	1.6	-	3.35	3.35	m	40/40	0.87	-	3.858	2.07	
Silver	1/6	0.02	-	0.0174	0.02	m	4/6	0.014	-	0.02	0.02	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	16	-	37.41	37.4	m	6/6	29.3	-	42.8	42.8	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.33	-	0.3257	0.33	m	6/6	1.826	-	3.8	3.8	m	0/40	0	-	0	0	
Zinc	6/6	18.4	-	41.5	41.5	m	6/6	50.2	-	111	111	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-CR_B-2
Screening Risk Characterization for the Wood Duck
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	34,331		0.125		9,120	m	154.1	m	3.12E+02	109.7	3
Antimony	1.73	m	0		0.25	m	0		9.63E-03	18	0.0005
Arsenic	42.61		0.0013		16.4	m	0.2523	m	5.29E-01	2.24	0.2
Barium	138.9		0.0395		96.9	m	45.97	m	5.39E+00	20.8	0.3
Beryllium	1.029		0		0.77	m	0		2.26E-02	0.532	0.04
Boron	35.3		0.0196		7.2	m	50.34	m	3.03E+00	28	0.1
Cadmium	0		0		1.2	m	0.06881	m	3.64E-02	1.47	0.02
Chromium	47.97		0.0004	m	11.7	m	0.7798	m	4.39E-01	2.66	0.2
Cobalt	17.89		0		7.7	m	0.4037	m	2.61E-01	7.61	0.03
Copper	22.84		0.0018		21	m	12.55	m	1.30E+00	4.05	0.3
Iron	34,139		0.119		9,560	m	168.3	m	3.25E+02	109.3	3
Lead	39.23		0		8.9	m	0.3394	m	3.25E-01	1.63	0.2
Manganese	1,655		0.0342		807	m	600.7	m	5.77E+01	179	0.3
Mercury	0.679		0		0.3	m	0		9.26E-03	0.45	0.02
Molybdenum	0		0.0009		1.6	m	4.319	m	2.81E-01	3.5	0.08
Nickel	20.06		0.0005		12.4	m	2.836	m	5.26E-01	6.71	0.08
Selenium	1.77	m	0.0004	m	7.4	m	0.3899	m	2.25E-01	0.29	0.8
Silver	0		0		0.065	m	0.01741	m	2.72E-03	2.02	0.001
Strontium	23.22		0.115		31.1	m	37.41	m	2.95E+00	312	0.009
Thallium	3.11	m	0		0		0		5.11E-03	0.35	0.01
Vanadium	48.85		0.0016		18.9	m	0.3257	m	6.11E-01	0.344	2
Zinc	87.05		0		182	m	41.5	m	7.37E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-3
Screening Risk Characterization for the Mallard Duck
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	34,331		0.125		9,120	m	154.1	m	5.54E+02	109.7	5
Antimony	1.73	m	0		0.25	m	0		1.69E-02	18	0.0009
Arsenic	42.61		0.0013		16.4	m	0.2523	m	9.52E-01	2.24	0.4
Barium	138.9		0.0395		96.9	m	45.97	m	6.14E+00	20.8	0.3
Beryllium	1.029		0		0.77	m	0		4.23E-02	0.532	0.08
Boron	35.3		0.0196		7.2	m	50.34	m	1.33E+00	28	0.05
Cadmium	0		0		1.2	m	0.06881	m	6.34E-02	1.47	0.04
Chromium	47.97		0.0004	m	11.7	m	0.7798	m	7.30E-01	2.66	0.3
Cobalt	17.89		0		7.7	m	0.4037	m	4.47E-01	7.61	0.06
Copper	22.84		0.0018		21	m	12.55	m	1.36E+00	4.05	0.3
Iron	34,139		0.119		9,560	m	168.3	m	5.77E+02	109.3	5
Lead	39.23		0		8.9	m	0.3394	m	5.57E-01	1.63	0.3
Manganese	1,655		0.0342		807	m	600.7	m	5.60E+01	179	0.3
Mercury	0.679		0		0.3	m	0		1.71E-02	0.45	0.04
Molybdenum	0		0.0009		1.6	m	4.319	m	1.58E-01	3.5	0.05
Nickel	20.06		0.0005		12.4	m	2.836	m	7.38E-01	6.71	0.1
Selenium	1.77	m	0.0004	m	7.4	m	0.3899	m	3.95E-01	0.29	1
Silver	0		0		0.065	m	0.01741	m	3.67E-03	2.02	0.002
Strontium	23.22		0.115		31.1	m	37.41	m	2.32E+00	312	0.007
Thallium	3.11	m	0		0		0		7.10E-03	0.35	0.02
Vanadium	48.85		0.0016		18.9	m	0.3257	m	1.10E+00	0.344	3
Zinc	87.05		0		182	m	41.5	m	1.04E+01	66.1	0.2

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-4
Screening Risk Characterization for the Killdeer
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	34,331		0.125		9,120	m	1.93E+03	109.7	18
Antimony	1.73	m	0		0.25	m	6.53E-02	18	0.004
Arsenic	42.61		0.0013		16.4	m	3.17E+00	2.24	1
Barium	138.9		0.0395		96.9	m	1.69E+01	20.8	0.8
Beryllium	1.029		0		0.77	m	1.33E-01	0.532	0.3
Boron	35.3		0.0196		7.2	m	1.65E+00	28	0.06
Cadmium	0		0		1.2	m	1.82E-01	1.47	0.1
Chromium	47.97		0.0004	m	11.7	m	2.54E+00	2.66	1
Cobalt	17.89		0		7.7	m	1.45E+00	7.61	0.2
Copper	22.84		0.0018		21	m	3.55E+00	4.05	0.9
Iron	34,139		0.119		9,560	m	1.99E+03	109.3	18
Lead	39.23		0		8.9	m	1.97E+00	1.63	1
Manganese	1,655		0.0342		807	m	1.49E+02	179	0.8
Mercury	0.679		0		0.3	m	5.63E-02	0.45	0.1
Molybdenum	0		0.0009		1.6	m	2.43E-01	3.5	0.07
Nickel	20.06		0.0005		12.4	m	2.20E+00	6.71	0.3
Selenium	1.77	m	0.0004	m	7.4	m	1.15E+00	0.29	4
Silver	0		0		0.065	m	9.88E-03	2.02	0.005
Strontium	23.22		0.115		31.1	m	5.11E+00	312	0.02
Thallium	3.11	m	0		0		4.92E-02	0.35	0.1
Vanadium	48.85		0.0016		18.9	m	3.64E+00	0.344	11
Zinc	87.05		0		182	m	2.90E+01	66.1	0.4

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-5
Screening Risk Characterization for the Heron
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	34,331		0.125		9,120	m	1,560	m	1.15E+02	109.7	1
Antimony	1.73	m	0		0.25	m	0.084	m	5.87E-03	18	0.0003
Arsenic	42.61		0.00125		16.4	m	3.1	m	2.13E-01	2.24	0.09
Barium	138.9		0.0395		96.9	m	25.7	m	1.60E+00	20.8	0.08
Beryllium	1.029		0		0.77	m	0.13	m	8.58E-03	0.532	0.02
Boron	35.3		0.0196		7.2	m	0		2.87E-02	28	0.001
Cadmium	0		0		1.2	m	0.094	m	6.51E-03	1.47	0.004
Chromium	47.97		0.00039	m	11.7	m	4.2	m	2.71E-01	2.66	0.1
Cobalt	17.89		0		7.7	m	1.6	m	1.07E-01	7.61	0.01
Copper	22.84		0.00182		21	m	9.545	m	5.61E-01	4.05	0.1
Iron	34,139		0.119		9,560	m	1,870	m	1.33E+02	109.3	1
Lead	39.23		0		8.9	m	3.2	m	2.08E-01	1.63	0.1
Manganese	1,655		0.0342		807	m	233	m	1.46E+01	179	0.08
Mercury	0.679		0		0.3	m	0.11	m	6.76E-03	0.45	0.02
Molybdenum	0		0.00093		1.6	m	0.19	m	1.23E-02	3.5	0.004
Nickel	20.06		0.00054		12.4	m	5.7	m	3.38E-01	6.71	0.05
Selenium	1.77	m	0.00038	m	7.4	m	3.349	m	1.93E-01	0.29	0.7
Silver	0		0		0.065	m	0.01591	m	9.47E-04	2.02	0.0005
Strontium	23.22		0.115		31.1	m	42.79	m	2.40E+00	312	0.008
Thallium	3.11	m	0		0		0		1.74E-03	0.35	--
Vanadium	48.85		0.00161		18.9	m	3.8	m	2.57E-01	0.344	0.7
Zinc	87.05		0		182	m	111.2	m	6.36E+00	66.1	0.1

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-6
Screening Risk Characterization for the Osprey
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.125		1,560	m	9.63E+01	109.7	0.9
Antimony	0		0.084	m	5.18E-03	18	0.0003
Arsenic	0.00125		3.1	m	1.91E-01	2.24	0.09
Barium	0.0395		25.7	m	1.59E+00	20.8	0.08
Beryllium	0		0.13	m	8.02E-03	0.532	0.02
Boron	0.0196		0		9.78E-04	28	0.00003
Cadmium	0		0.094	m	5.80E-03	1.47	0.004
Chromium	0.00039	m	4.2	m	2.59E-01	2.66	0.1
Cobalt	0		1.6	m	9.87E-02	7.61	0.01
Copper	0.00182		9.545	m	5.89E-01	4.05	0.1
Iron	0.119		1,870	m	1.15E+02	109.3	1
Lead	0		3.2	m	1.97E-01	1.63	0.1
Manganese	0.0342		233	m	1.44E+01	179	0.08
Mercury	0		0.11	m	6.79E-03	0.45	0.02
Molybdenum	0.0009272		0.19	m	1.18E-02	3.5	0.003
Nickel	0.0005432		5.7	m	3.52E-01	6.71	0.05
Selenium	0.00038	m	3.349	m	2.07E-01	0.29	0.7
Silver	0		0.01591	m	9.82E-04	2.02	0.0005
Strontium	0.115		42.79	m	2.65E+00	312	0.008
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00161		3.8	m	2.35E-01	0.344	0.7
Zinc	0		111.2	m	6.86E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-7
Screening Risk Characterization for the Muskrat
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	34,331		0.125		154.1	m	1.79E+02	1.93	93
Antimony	1.73	m	0		0		8.60E-03	0.059	0.1
Arsenic	42.61		0.0013		0.2523	m	2.25E-01	1.04	0.2
Barium	138.9		0.0395		45.97	m	3.12E+00	51.8	0.06
Beryllium	1.029		0		0		5.11E-03	0.532	0.01
Boron	35.3		0.0196		50.34	m	2.84E+00	28.8	0.1
Cadmium	0		0		0.06881	m	3.64E-03	0.77	0.005
Chromium	47.97		0.0004	m	0.7798	m	2.80E-01	2.4	0.1
Cobalt	17.89		0		0.4037	m	1.10E-01	7.33	0.02
Copper	22.84		0.0018		12.55	m	7.77E-01	5.6	0.1
Iron	34,139		0.119		168.3	m	1.79E+02	22.8	8
Lead	39.23		0		0.3394	m	2.13E-01	4.7	0.05
Manganese	1,655		0.0342		600.7	m	4.00E+01	51.5	0.8
Mercury	0.679		0		0		3.37E-03	1	0.003
Molybdenum	0		0.0009		4.319	m	2.28E-01	0.26	0.9
Nickel	20.06		0.0005		2.836	m	2.50E-01	1.7	0.1
Selenium	1.77	m	0.0004	m	0.3899	m	2.94E-02	0.143	0.2
Silver	0		0		0.01741	m	9.20E-04	6.02	0.0002
Strontium	23.22		0.115		37.41	m	2.10E+00	263	0.008
Thallium	3.11	m	0		0		1.55E-02	0.015	1
Vanadium	48.85		0.0016		0.3257	m	2.60E-01	4.16	0.06
Zinc	87.05		0		41.5	m	2.63E+00	75.4	0.03

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-8
Screening Risk Characterization for the Raccoon
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	34,331		0.125		9,120	m	154.1	m	1,560	m	2.47E+02	1.93	130
Antimony	1.73	m	0		0.25	m	0		0.084	m	9.39E-03	0.059	0.2
Arsenic	42.61		0.00125		16.4	m	0.2523	m	3.1	m	3.80E-01	1.04	0.4
Barium	138.9		0.0395		96.9	m	45.97	m	25.7	m	2.80E+00	51.8	0.05
Beryllium	1.029		0		0.77	m	0		0.13	m	1.43E-02	0.532	0.03
Boron	35.3		0.0196		7.2	m	50.34	m	0		1.26E+00	28.8	0.04
Cadmium	0		0		1.2	m	0.06881	m	0.094	m	1.83E-02	0.77	0.02
Chromium	47.97		0.00039	m	11.7	m	0.7798	m	4.2	m	3.45E-01	2.4	0.1
Cobalt	17.89		0		7.7	m	0.4037	m	1.6	m	1.78E-01	7.33	0.02
Copper	22.84		0.00182		21	m	12.55	m	9.545	m	6.40E-01	5.6	0.1
Iron	34,139		0.119		9,560	m	168.3	m	1,870	m	2.53E+02	22.8	11
Lead	39.23		0		8.9	m	0.3394	m	3.2	m	2.66E-01	4.7	0.06
Manganese	1,655		0.0342		807	m	600.7	m	233	m	2.95E+01	51.5	0.6
Mercury	0.679		0		0.3	m	0		0.11	m	6.58E-03	1	0.007
Molybdenum	0		0.00093		1.6	m	4.319	m	0.19	m	1.12E-01	0.26	0.4
Nickel	20.06		0.00054		12.4	m	2.836	m	5.7	m	3.05E-01	1.7	0.2
Selenium	1.77	m	0.00038	m	7.4	m	0.3899	m	3.349	m	1.21E-01	0.143	0.8
Silver	0		0		0.065	m	0.01741	m	0.01591	m	1.28E-03	6.02	0.0002
Strontium	23.22		0.115		31.1	m	37.41	m	42.79	m	1.34E+00	263	0.005
Thallium	3.11	m	0		0		0		0		1.04E-02	0.015	0.7
Vanadium	48.85		0.00161		18.9	m	0.3257	m	3.8	m	4.39E-01	4.16	0.1
Zinc	87.05		0		182	m	41.5	m	111.2	m	3.81E+00	75.4	0.05

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-9
Screening Risk Characterization for the Mink
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Exposure Point Concentration [a]																							
	Exposed Sediment		Surface Water		Invertebrate WB Larval Mayfly		Vegetation		Fish WB Shad		Amphibian Frogs		Dietary Ingestion [b]	Toxicity Reference Value [c] NOAEL	Hazard Quotient (HQ) [d]
Constituent	(mg/kg)		(mg/L)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg-BW-day)	(mg/kg-BW-day)	NOAEL
Inorganics															
Aluminum	34,331		0.125		9,120	m	154.1	m	1,560	m	56.6		1.52E+02	1.93	79
Antimony	1.73	m	0		0.25	m	0		0.084	m	0		6.74E-03	0.059	0.1
Arsenic	42.61		0.0013		16.4	m	0.2523	m	3.1	m	0.8164	m	2.67E-01	1.04	0.3
Barium	138.9		0.0395		96.9	m	45.97	m	25.7	m	78.98		2.08E+00	51.8	0.04
Beryllium	1.029		0		0.77	m	0		0.13	m	0		1.07E-02	0.532	0.02
Boron	35.3		0.0196		7.2	m	50.34	m	0		0		3.22E-01	28.8	0.01
Cadmium	0		0		1.2	m	0.06881	m	0.094	m	0.143		1.09E-02	0.77	0.01
Chromium	47.97		0.0004	m	11.7	m	0.7798	m	4.2	m	0		2.95E-01	2.4	0.1
Cobalt	17.89		0		7.7	m	0.4037	m	1.6	m	0.228		1.30E-01	7.33	0.02
Copper	22.84		0.0018		21	m	12.55	m	9.545	m	18.35		6.25E-01	5.6	0.1
Iron	34,139		0.119		9,560	m	168.3	m	1,870	m	237.9		1.68E+02	22.8	7
Lead	39.23		0		8.9	m	0.3394	m	3.2	m	0.7493	m	2.27E-01	4.7	0.05
Manganese	1,655		0.0342		807	m	600.7	m	233	m	88.97		1.90E+01	51.5	0.4
Mercury	0.679		0		0.3	m	0		0.11	m	0.13		7.15E-03	1	0.007
Molybdenum	0		0.0009		1.6	m	4.319	m	0.19	m	0.32		3.80E-02	0.26	0.1
Nickel	20.06		0.0005		12.4	m	2.836	m	5.7	m	0		3.42E-01	1.7	0.2
Selenium	1.77	m	0.0004	m	7.4	m	0.3899	m	3.349	m	2.066		1.87E-01	0.143	1
Silver	0		0		0.065	m	0.01741	m	0.01591	m	0.038		1.15E-03	6.02	0.0002
Strontium	23.22		0.115		31.1	m	37.41	m	42.79	m	77.81		2.29E+00	263	0.009
Thallium	3.11	m	0		0		0		0		0.34	m	3.80E-03	0.015	0.3
Vanadium	48.85		0.0016		18.9	m	0.3257	m	3.8	m	0		3.16E-01	4.16	0.08
Zinc	87.05		0		182	m	41.5	m	111.2	m	145		6.15E+00	75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-10
Screening Risk Characterization for the Tree Swallow
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.125		0		2.66E-02	109.7	0.0002
Antimony	0		0		0.00E+00	18	--
Arsenic	0.00125		0.249		6.16E-02	2.24	0.03
Barium	0.0395		0.805		2.07E-01	20.8	0.01
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0196		0.99		2.48E-01	28	0.009
Cadmium	0		0.329		8.11E-02	1.47	0.06
Chromium	0.00039	m	0.264		6.51E-02	2.66	0.02
Cobalt	0		0.813		2.00E-01	7.61	0.03
Copper	0.00182		23.81		5.87E+00	4.05	1
Iron	0.119		158.8		3.92E+01	109.3	0.4
Lead	0		0		0.00E+00	1.63	--
Manganese	0.0342		3.133		7.79E-01	179	0.004
Mercury	0		0.0715		1.76E-02	0.45	0.04
Molybdenum	0.0009272		0.585		1.44E-01	3.5	0.04
Nickel	0.0005432		0.33	m	8.14E-02	6.71	0.01
Selenium	0.00038	m	6.402		1.58E+00	0.29	5
Silver	0		0.0135		3.33E-03	2.02	0.002
Strontium	0.115		0.784		2.18E-01	312	0.0007
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00161		0.229		5.68E-02	0.344	0.2
Zinc	0		198.2		4.88E+01	66.1	0.7

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-11
Screening Risk Characterization for the Gray Bat
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.125		0		1.97E-02	1.93	0.01
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00125		0.249		4.54E-02	1.04	0.04
Barium	0.0395		0.805		1.52E-01	51.8	0.003
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0196		0.99		1.83E-01	28.8	0.006
Cadmium	0		0.329		5.97E-02	0.77	0.08
Chromium	0.00039	m	0.264		4.80E-02	2.4	0.02
Cobalt	0		0.813		1.48E-01	7.33	0.02
Copper	0.00182		23.81		4.32E+00	5.6	0.8
Iron	0.119		158.8		2.88E+01	22.8	1
Lead	0		0		0.00E+00	4.7	--
Manganese	0.0342		3.133		5.74E-01	51.5	0.01
Mercury	0		0.0715		1.30E-02	1	0.01
Molybdenum	0.0009272		0.585		1.06E-01	0.26	0.4
Nickel	0.00054319		0.33	m	6.00E-02	1.7	0.04
Selenium	0.00038	m	6.402		1.16E+00	0.143	8
Silver	0		0.0135		2.45E-03	6.02	0.0004
Strontium	0.115		0.784		1.60E-01	263	0.0006
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00161		0.229		4.18E-02	4.16	0.01
Zinc	0		198.2		3.60E+01	75.4	0.5

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_B-12
Screening Risk Characterization Results Summary
Clinch River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**3**	**5**	**18**	1	0.9	**93**	**130**	**79**	0.0002	0.01
Antimony	0.0005	0.0009	0.004	0.0003	0.0003	0.1	0.2	0.1	--	--
Arsenic	0.2	0.4	1	0.09	0.09	0.2	0.4	0.3	0.03	0.04
Barium	0.3	0.3	0.8	0.08	0.08	0.06	0.05	0.04	0.01	0.003
Beryllium	0.04	0.08	0.3	0.02	0.02	0.01	0.03	0.02	--	--
Boron	0.1	0.05	0.06	0.001	0.00003	0.1	0.04	0.01	0.009	0.006
Cadmium	0.02	0.04	0.1	0.004	0.004	0.005	0.02	0.01	0.06	0.08
Chromium	0.2	0.3	1	0.1	0.1	0.1	0.1	0.1	0.02	0.02
Cobalt	0.03	0.06	0.2	0.01	0.01	0.02	0.02	0.02	0.03	0.02
Copper	0.3	0.3	0.9	0.1	0.1	0.1	0.1	0.1	1	0.8
Iron	**3**	**5**	**18**	1	1	**8**	**11**	**7**	0.4	1
Lead	0.2	0.3	1	0.1	0.1	0.05	0.06	0.05	--	--
Manganese	0.3	0.3	0.8	0.08	0.08	0.8	0.6	0.4	0.004	0.01
Mercury	0.02	0.04	0.1	0.02	0.02	0.003	0.007	0.007	0.04	0.01
Molybdenum	0.08	0.05	0.07	0.004	0.003	0.9	0.4	0.1	0.04	0.4
Nickel	0.08	0.1	0.3	0.05	0.05	0.1	0.2	0.2	0.01	0.04
Selenium	0.8	1	**4**	0.7	0.7	0.2	0.8	1	**5**	**8**
Silver	0.001	0.002	0.005	0.0005	0.0005	0.0002	0.0002	0.0002	0.002	0.0004
Strontium	0.009	0.007	0.02	0.008	0.008	0.008	0.005	0.009	0.0007	0.0006
Thallium	0.01	0.02	0.1	--	--	1	0.7	0.3	--	--
Vanadium	**2**	**3**	**11**	0.7	0.7	0.06	0.1	0.08	0.2	0.01
Zinc	0.1	0.2	0.4	0.1	0.1	0.03	0.05	0.08	0.7	0.5

Hazard quotients greater than one are in bold.

Table 4-CR_R-1
Data Summaries
Risk Characterization
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water						Invertebrates											
													Larval Mayfly (Whole Body)						Adult Mayfly					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)				
Inorganics																								
Aluminum	5/5	2480	-	14800	14800	m	8 / 9	0.0618	-	0.107	0.092		3/3	6610	-	7620	7620	m	1/6	5.2	-	5.2	5.2	m
Antimony	0/5	0	-	0	0		0 / 9	0	-	0	0		3/3	0.09	-	0.098	0.098	m	0/6	0	-	0	0	
Arsenic	4/5	1.83	-	5.4	5.4	m	9 / 9	0.00036	-	0.0006	5E-04		3/3	4.7	-	5.2	5.2	m	6/6	0.11	-	0.14	0.14	m
Barium	5/5	22.6	-	90.4	90.4	m	9 / 9	0.0339	-	0.0375	0.036		3/3	56.4	-	59.8	59.8	m	6/6	0.54	-	0.68	0.68	m
Beryllium	1/5	0.769	-	0.769	0.769	m	0 / 9	0	-	0	0		3/3	0.33	-	0.36	0.36	m	0/6	0	-	0	0	
Boron	0/5	0	-	0	0		9 / 9	0.0131	-	0.0192	0.017		3/3	5.7	-	7.9	7.9	m	6/6	0.44	-	0.77	0.77	m
Cadmium	0/5	0	-	0	0		0 / 9	0	-	0	0		3/3	0.74	-	0.95	0.95	m	6/6	0.3	-	0.4	0.4	m
Chromium	5/5	3.21	-	13.8	13.8	m	2 / 9	0.00035	-	0.0005	5E-04	m	3/3	9	-	9.9	9.9	m	1/6	12.7	-	12.7	12.7	m
Cobalt	5/5	2.15	-	10.5	10.5	m	0 / 9	0	-	0	0		3/3	5.7	-	6.2	6.2	m	6/6	0.76	-	0.82	0.82	m
Copper	5/5	4.03	-	6.83	6.83	m	9 / 9	0.00044	-	0.0016	1E-03		3/3	18.3	-	19.3	19.3	m	6/6	26.3	-	27.9	27.9	m
Iron	5/5	3210	-	18500	18500	m	9 / 9	0.077	-	0.126	0.126	m	3/3	8640	-	9230	9230	m	6/6	177	-	185	185	m
Lead	5/5	3.15	-	10.4	10.4	m	1 / 9	0.00034	-	0.0003	3E-04	m	3/3	9.2	-	9.8	9.8	m	0/6	0	-	0	0	
Manganese	5/5	29.9	-	689	689	m	9 / 9	0.0245	-	0.0351	0.035	m	3/3	905	-	1040	1040	m	6/6	2	-	2.9	2.9	m
Mercury	0/5	0	-	0	0		0 / 9	0	-	0	0		3/3	0.81	-	1.2	1.2	m	6/6	0.1	-	0.13	0.13	m
Molybdenum	0/5	0	-	0	0		9 / 9	0.00035	-	0.0009	8E-04		3/3	0.67	-	0.79	0.79	m	6/6	0.34	-	0.37	0.37	m
Nickel	5/5	3.42	-	14.7	14.7	m	6 / 9	0.00033	-	0.0007	7E-04	m	3/3	9.6	-	10.4	10.4	m	0/6	0	-	0	0	
Selenium	0/5	0	-	0	0		1 / 9	0.00043	-	0.0004	4E-04	m	3/3	4.2	-	4.6	4.6	m	6/6	3.7	-	4.1	4.1	m
Silver	0/5	0	-	0	0		0 / 9	0	-	0	0		0/3	0	-	0	0		6/6	0.02	-	0.03	0.03	m
Strontium	3/5	5.31	-	16.3	16.3	m	9 / 9	0.108	-	0.116	0.114		3/3	8.9	-	9.4	9.4	m	6/6	0.58	-	0.74	0.74	m
Thallium	0/5	0	-	0	0		0 / 9	0	-	0	0		0/3	0	-	0	0		0/6	0	-	0	0	
Vanadium	5/5	4.05	-	26.3	26.3	m	0 / 9	0	-	0	0		3/3	10.9	-	11.9	11.9	m	6/6	0.12	-	0.14	0.14	m
Zinc	5/5	15	-	54.1	54.1	m	0 / 9	0	-	0	0		3/3	168	-	197	197	m	6/6	88	-	98.7	98.7	m

Table 4-CR_R-1
Data Summaries
Risk Characterization
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	26.4	-	506.8	507	m	6/6	101.7	-	645	645	m	9/48	38.1	-	219.1	51.4	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Arsenic	2/6	0.23	-	0.5285	0.53	m	6/6	1.8	-	2.1	2.1	m	7/48	0.25	-	0.3904	0.27	
Barium	6/6	10.5	-	44.59	44.6	m	6/6	10.68	-	21.5	21.5	m	48/48	24	-	148.1	66.5	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Boron	6/6	12.6	-	55.93	55.9	m	0/6	0	-	0	0		0/48	0	-	0	0	
Cadmium	2/6	0.03	-	0.1382	0.14	m	6/6	0.04054	-	0.06	0.06	m	6/48	0.08	-	0.2155	0.1	
Chromium	0/6	0	-	0	0		3/6	0.87	-	2	2	m	1/48	29.7	-	29.74	29.7	m
Cobalt	5/6	0.07	-	0.6341	0.63	m	6/6	0.312	-	0.6	0.6	m	39/48	0.13	-	0.6548	0.32	
Copper	6/6	5.78	-	11.86	11.9	m	6/6	4	-	10	10	m	48/48	4.64	-	46.37	17.6	
Iron	6/6	49.7	-	478	478	m	6/6	166.7	-	712	712	m	45/48	107	-	419.7	229	
Lead	4/6	0.11	-	0.7881	0.79	m	6/6	0.2564	-	1.1	1.1	m	7/48	0.58	-	3.177	3.18	m
Manganese	6/6	67.9	-	400.8	401	m	6/6	117.5	-	203	203	m	48/48	23.9	-	189.7	83.2	
Mercury	0/6	0	-	0	0		3/6	0.066	-	0.11	0.11	m	1/48	0.09	-	0.0931	0.09	m
Molybdenum	6/6	0.28	-	1.429	1.43	m	0/6	0	-	0	0		3/48	0.28	-	0.4217	0.42	m
Nickel	6/6	0.58	-	5.07	5.07	m	3/6	0.61	-	4.4	4.4	m	0/48	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2.432	-	3.5	3.5	m	48/48	0.86	-	3.103	1.53	
Silver	0/6	0	-	0	0		1/6	0.01441	-	0.01	0.01	m	9/48	0.02	-	0.0854	0.03	
Strontium	6/6	11.3	-	58.68	58.7	m	6/6	32.91	-	58.6	58.6	m	48/48	18	-	99.28	55.1	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Vanadium	3/6	0.39	-	1.017	1.02	m	6/6	0.3718	-	1.5	1.5	m	1/48	1.68	-	1.677	1.68	m
Zinc	6/6	30.7	-	80.49	80.5	m	6/6	82.5	-	109	109	m	48/48	87.8	-	311	146	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-CR_R-2
Screening Risk Characterization for the Wood Duck
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	2.59E+02	109.7	2
Antimony	0		0		0.098	m	0		2.66E-03	18	0.0001
Arsenic	5.4	m	0.0005		5.2	m	0.5285	m	1.79E-01	2.24	0.08
Barium	90.4	m	0.0362		59.8	m	44.59	m	4.23E+00	20.8	0.2
Beryllium	0.769	m	0		0.36	m	0		1.10E-02	0.532	0.02
Boron	0		0.017		7.9	m	55.93	m	3.30E+00	28	0.1
Cadmium	0		0		0.95	m	0.1382	m	3.34E-02	1.47	0.02
Chromium	13.8	m	0.0005	m	9.9	m	0		2.91E-01	2.66	0.1
Cobalt	10.5	m	0		6.2	m	0.6341	m	2.20E-01	7.61	0.03
Copper	6.83	m	0.001		19.3	m	11.86	m	1.19E+00	4.05	0.3
Iron	18,500	m	0.126	m	9,230	m	478	m	3.07E+02	109.3	3
Lead	10.4	m	0.0003	m	9.8	m	0.7881	m	3.26E-01	1.63	0.2
Manganese	689	m	0.0351	m	1,040	m	400.8	m	5.14E+01	179	0.3
Mercury	0		0		1.2	m	0		3.26E-02	0.45	0.07
Molybdenum	0		0.0008		0.79	m	1.429	m	1.00E-01	3.5	0.03
Nickel	14.7	m	0.0007	m	10.4	m	5.07	m	5.86E-01	6.71	0.09
Selenium	0		0.0004	m	4.6	m	0		1.25E-01	0.29	0.4
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	16.3	m	0.114		9.4	m	58.68	m	3.52E+00	312	0.01
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		11.9	m	1.017	m	4.22E-01	0.344	1
Zinc	54.1	m	0		197	m	80.49	m	9.87E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-3
Screening Risk Characterization for the Mallard Duck
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	4.38E+02	109.7	4
Antimony	0		0		0.098	m	0		5.08E-03	18	0.0003
Arsenic	5.4	m	0.0005		5.2	m	0.5285	m	2.91E-01	2.24	0.1
Barium	90.4	m	0.0362		59.8	m	44.59	m	4.08E+00	20.8	0.2
Beryllium	0.769	m	0		0.36	m	0		2.04E-02	0.532	0.04
Boron	0		0.017		7.9	m	55.93	m	1.38E+00	28	0.05
Cadmium	0		0		0.95	m	0.1382	m	5.17E-02	1.47	0.04
Chromium	13.8	m	0.0005	m	9.9	m	0		5.45E-01	2.66	0.2
Cobalt	10.5	m	0		6.2	m	0.6341	m	3.56E-01	7.61	0.05
Copper	6.83	m	0.001		19.3	m	11.86	m	1.22E+00	4.05	0.3
Iron	18,500	m	0.126	m	9,230	m	478	m	5.29E+02	109.3	5
Lead	10.4	m	0.0003	m	9.8	m	0.7881	m	5.46E-01	1.63	0.3
Manganese	689	m	0.0351	m	1,040	m	400.8	m	6.24E+01	179	0.3
Mercury	0		0		1.2	m	0		6.22E-02	0.45	0.1
Molybdenum	0		0.0008		0.79	m	1.429	m	6.57E-02	3.5	0.02
Nickel	14.7	m	0.0007	m	10.4	m	5.07	m	6.61E-01	6.71	0.1
Selenium	0		0.0004	m	4.6	m	0		2.39E-01	0.29	0.8
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	16.3	m	0.114		9.4	m	58.68	m	1.55E+00	312	0.005
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		11.9	m	1.017	m	6.95E-01	0.344	2
Zinc	54.1	m	0		197	m	80.49	m	1.17E+01	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-4
Screening Risk Characterization for the Killdeer
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	14,800	m	0.0918		7,620	m	1.39E+03	109.7	13
Antimony	0		0		0.098	m	1.49E-02	18	0.0008
Arsenic	5.4	m	0.0005		5.2	m	8.76E-01	2.24	0.4
Barium	90.4	m	0.0362		59.8	m	1.05E+01	20.8	0.5
Beryllium	0.769	m	0		0.36	m	6.69E-02	0.532	0.1
Boron	0		0.017		7.9	m	1.20E+00	28	0.04
Cadmium	0		0		0.95	m	1.44E-01	1.47	0.1
Chromium	13.8	m	0.0005	m	9.9	m	1.72E+00	2.66	0.6
Cobalt	10.5	m	0		6.2	m	1.11E+00	7.61	0.1
Copper	6.83	m	0.001		19.3	m	3.04E+00	4.05	0.8
Iron	18,500	m	0.126	m	9,230	m	1.70E+03	109.3	16
Lead	10.4	m	0.0003	m	9.8	m	1.65E+00	1.63	1
Manganese	689	m	0.0351	m	1,040	m	1.69E+02	179	0.9
Mercury	0		0		1.2	m	1.82E-01	0.45	0.4
Molybdenum	0		0.0008		0.79	m	1.20E-01	3.5	0.03
Nickel	14.7	m	0.0007	m	10.4	m	1.81E+00	6.71	0.3
Selenium	0		0.0004	m	4.6	m	6.99E-01	0.29	2
Silver	0		0		0		0.00E+00	2.02	--
Strontium	16.3	m	0.114		9.4	m	1.70E+00	312	0.005
Thallium	0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		11.9	m	2.22E+00	0.344	6
Zinc	54.1	m	0		197	m	3.08E+01	66.1	0.5

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-5
Screening Risk Characterization for the Heron
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0.0918		7,620	m	645	m	5.23E+01	109.7	0.5
Antimony	0		0		0.098	m	0		1.10E-04	18	0.000006
Arsenic	5.4	m	0.00055		5.2	m	2.1	m	1.24E-01	2.24	0.06
Barium	90.4	m	0.0362		59.8	m	21.5	m	1.30E+00	20.8	0.06
Beryllium	0.769	m	0		0.36	m	0		8.35E-04	0.532	0.002
Boron	0		0.017		7.9	m	0		9.62E-03	28	0.0003
Cadmium	0		0		0.95	m	0.063	m	4.53E-03	1.47	0.003
Chromium	13.8	m	0.00051	m	9.9	m	2	m	1.29E-01	2.66	0.05
Cobalt	10.5	m	0		6.2	m	0.6	m	4.58E-02	7.61	0.006
Copper	6.83	m	0.001		19.3	m	10	m	5.75E-01	4.05	0.1
Iron	18,500	m	0.126	m	9,230	m	712	m	5.98E+01	109.3	0.5
Lead	10.4	m	0.00034	m	9.8	m	1.1	m	7.73E-02	1.63	0.05
Manganese	689	m	0.0351	m	1,040	m	203	m	1.27E+01	179	0.07
Mercury	0		0		1.2	m	0.11	m	7.39E-03	0.45	0.02
Molybdenum	0		0.00078		0.79	m	0		9.21E-04	3.5	0.0003
Nickel	14.7	m	0.00065	m	10.4	m	4.4	m	2.62E-01	6.71	0.04
Selenium	0		0.00043	m	4.6	m	3.5	m	1.97E-01	0.29	0.7
Silver	0		0		0		0.01441	m	7.92E-04	2.02	0.0004
Strontium	16.3	m	0.114		9.4	m	58.56	m	3.24E+00	312	0.01
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0		11.9	m	1.5	m	1.10E-01	0.344	0.3
Zinc	54.1	m	0		197	m	109	m	6.24E+00	66.1	0.09

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-6
Screening Risk Characterization for the Osprey
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.0918		645	m	3.98E+01	109.7	0.4
Antimony	0		0		0.00E+00	18	--
Arsenic	0.0005483		2.1	m	1.30E-01	2.24	0.06
Barium	0.0362		21.5	m	1.33E+00	20.8	0.06
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.017		0		8.48E-04	28	0.00003
Cadmium	0		0.063	m	3.89E-03	1.47	0.003
Chromium	0.00051	m	2	m	1.23E-01	2.66	0.05
Cobalt	0		0.6	m	3.70E-02	7.61	0.005
Copper	0.0009996		10	m	6.17E-01	4.05	0.2
Iron	0.126	m	712	m	4.39E+01	109.3	0.4
Lead	0.00034	m	1.1	m	6.79E-02	1.63	0.04
Manganese	0.0351	m	203	m	1.25E+01	179	0.07
Mercury	0		0.11	m	6.79E-03	0.45	0.02
Molybdenum	0.0007838		0		3.91E-05	3.5	0.00001
Nickel	0.00065	m	4.4	m	2.72E-01	6.71	0.04
Selenium	0.00043	m	3.5	m	2.16E-01	0.29	0.7
Silver	0		0.01441	m	8.89E-04	2.02	0.0004
Strontium	0.114		58.56	m	3.62E+00	312	0.01
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0		1.5	m	9.26E-02	0.344	0.3
Zinc	0		109	m	6.73E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-7
Screening Risk Characterization for the Muskrat
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	14,800	m	0.0918		506.8	m	1.00E+02	1.93	52
Antimony	0		0		0		0.00E+00	0.059	--
Arsenic	5.4	m	0.0005		0.5285	m	5.48E-02	1.04	0.05
Barium	90.4	m	0.0362		44.59	m	2.81E+00	51.8	0.05
Beryllium	0.769	m	0		0		3.82E-03	0.532	0.007
Boron	0		0.017		55.93	m	2.96E+00	28.8	0.1
Cadmium	0		0		0.1382	m	7.30E-03	0.77	0.009
Chromium	13.8	m	0.0005	m	0		6.86E-02	2.4	0.03
Cobalt	10.5	m	0		0.6341	m	8.57E-02	7.33	0.01
Copper	6.83	m	0.001		11.86	m	6.61E-01	5.6	0.1
Iron	18,500	m	0.126	m	478	m	1.17E+02	22.8	5
Lead	10.4	m	0.0003	m	0.7881	m	9.34E-02	4.7	0.02
Manganese	689	m	0.0351	m	400.8	m	2.46E+01	51.5	0.5
Mercury	0		0		0		0.00E+00	1	--
Molybdenum	0		0.0008		1.429	m	7.56E-02	0.26	0.3
Nickel	14.7	m	0.0007	m	5.07	m	3.41E-01	1.7	0.2
Selenium	0		0.0004	m	0		4.19E-05	0.143	0.0003
Silver	0		0		0		0.00E+00	6.02	--
Strontium	16.3	m	0.114		58.68	m	3.19E+00	263	0.01
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0		1.017	m	1.84E-01	4.16	0.04
Zinc	54.1	m	0		80.49	m	4.52E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-8
Screening Risk Characterization for the Raccoon
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	645	m	1.67E+02	1.93	87
Antimony	0		0		0.098	m	0		0		1.37E-03	0.059	0.02
Arsenic	5.4	m	0.00055		5.2	m	0.5285	m	2.1	m	1.04E-01	1.04	0.1
Barium	90.4	m	0.0362		59.8	m	44.59	m	21.5	m	2.09E+00	51.8	0.04
Beryllium	0.769	m	0		0.36	m	0		0		7.60E-03	0.532	0.01
Boron	0		0.017		7.9	m	55.93	m	0		1.27E+00	28.8	0.04
Cadmium	0		0		0.95	m	0.1382	m	0.063	m	1.62E-02	0.77	0.02
Chromium	13.8	m	0.00051	m	9.9	m	0		2	m	1.87E-01	2.4	0.08
Cobalt	10.5	m	0		6.2	m	0.6341	m	0.6	m	1.35E-01	7.33	0.02
Copper	6.83	m	0.001		19.3	m	11.86	m	10	m	5.49E-01	5.6	0.1
Iron	18,500	m	0.126	m	9,230	m	478	m	712	m	2.01E+02	22.8	9
Lead	10.4	m	0.00034	m	9.8	m	0.7881	m	1.1	m	1.89E-01	4.7	0.04
Manganese	689	m	0.0351	m	1,040	m	400.8	m	203	m	2.53E+01	51.5	0.5
Mercury	0		0		1.2	m	0		0.11	m	1.68E-02	1	0.02
Molybdenum	0		0.00078		0.79	m	1.429	m	0		4.07E-02	0.26	0.2
Nickel	14.7	m	0.00065	m	10.4	m	5.07	m	4.4	m	3.04E-01	1.7	0.2
Selenium	0		0.00043	m	4.6	m	0		3.5	m	6.79E-02	0.143	0.5
Silver	0		0		0		0		0.01441	m	1.55E-05	6.02	0.000003
Strontium	16.3	m	0.114		9.4	m	58.68	m	58.56	m	1.47E+00	263	0.006
Thallium	0		0		0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0		11.9	m	1.017	m	1.5	m	2.77E-01	4.16	0.07
Zinc	54.1	m	0		197	m	80.49	m	109	m	4.71E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-9
Screening Risk Characterization for the Mink
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Amphibian Frogs (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics															
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	645	m	51.4		8.65E+01	1.93	45
Antimony	0		0		0.098	m	0		0		0		5.26E-04	0.059	0.009
Arsenic	5.4	m	0.0005		5.2	m	0.5285	m	2.1	m	0.268		1.25E-01	1.04	0.1
Barium	90.4	m	0.0362		59.8	m	44.59	m	21.5	m	66.51		1.63E+00	51.8	0.03
Beryllium	0.769	m	0		0.36	m	0		0		0		2.76E-03	0.532	0.005
Boron	0		0.017		7.9	m	55.93	m	0		0		3.14E-01	28.8	0.01
Cadmium	0		0		0.95	m	0.1382	m	0.063	m	0.095		8.55E-03	0.77	0.01
Chromium	13.8	m	0.0005	m	9.9	m	0		2	m	29.74	m	1.92E-01	2.4	0.08
Cobalt	10.5	m	0		6.2	m	0.6341	m	0.6	m	0.324		7.33E-02	7.33	0.01
Copper	6.83	m	0.001		19.3	m	11.86	m	10	m	17.55		6.13E-01	5.6	0.1
Iron	18,500	m	0.126	m	9,230	m	478	m	712	m	229.3		1.02E+02	22.8	4
Lead	10.4	m	0.0003	m	9.8	m	0.7881	m	1.1	m	3.177	m	1.18E-01	4.7	0.03
Manganese	689	m	0.0351	m	1,040	m	400.8	m	203	m	83.21		1.69E+01	51.5	0.3
Mercury	0		0		1.2	m	0		0.11	m	0.09309	m	1.12E-02	1	0.01
Molybdenum	0		0.0008		0.79	m	1.429	m	0		0.4217	m	1.18E-02	0.26	0.05
Nickel	14.7	m	0.0007	m	10.4	m	5.07	m	4.4	m	0		2.82E-01	1.7	0.2
Selenium	0		0.0004	m	4.6	m	0		3.5	m	1.534		1.74E-01	0.143	1
Silver	0		0		0		0		0.01441	m	0.031		6.49E-04	6.02	0.0001
Strontium	16.3	m	0.114		9.4	m	58.68	m	58.56	m	55.11		2.90E+00	263	0.01
Thallium	0		0		0		0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0		11.9	m	1.017	m	1.5	m	1.677	m	1.63E-01	4.16	0.04
Zinc	54.1	m	0		197	m	80.49	m	109	m	146.2		6.29E+00	75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-10
Screening Risk Characterization for the Tree Swallow
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.0918		5.2	m	1.30E+00	109.7	0.01
Antimony	0		0		0.00E+00	18	--
Arsenic	0.0005483		0.14	m	3.46E-02	2.24	0.02
Barium	0.0362		0.68	m	1.75E-01	20.8	0.008
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.017		0.77	m	1.93E-01	28	0.007
Cadmium	0		0.4	m	9.86E-02	1.47	0.07
Chromium	0.00051	m	12.7	m	3.13E+00	2.66	1
Cobalt	0		0.82	m	2.02E-01	7.61	0.03
Copper	0.0009996		27.9	m	6.87E+00	4.05	2
Iron	0.126	m	185	m	4.56E+01	109.3	0.4
Lead	0.00034	m	0		7.24E-05	1.63	0.00004
Manganese	0.0351	m	2.9	m	7.22E-01	179	0.004
Mercury	0		0.13	m	3.20E-02	0.45	0.07
Molybdenum	0.0007838		0.37	m	9.13E-02	3.5	0.03
Nickel	0.00065	m	0		1.38E-04	6.71	0.00002
Selenium	0.00043	m	4.1	m	1.01E+00	0.29	3
Silver	0		0.028	m	6.90E-03	2.02	0.003
Strontium	0.114		0.74	m	2.07E-01	312	0.0007
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0		0.14	m	3.45E-02	0.344	0.1
Zinc	0		98.7	m	2.43E+01	66.1	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-11
Screening Risk Characterization for the Gray Bat
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.0918		5.2	m	9.58E-01	1.93	0.5
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00054829		0.14	m	2.55E-02	1.04	0.02
Barium	0.0362		0.68	m	1.29E-01	51.8	0.002
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.017		0.77	m	1.42E-01	28.8	0.005
Cadmium	0		0.4	m	7.26E-02	0.77	0.09
Chromium	0.00051	m	12.7	m	2.31E+00	2.4	1
Cobalt	0		0.82	m	1.49E-01	7.33	0.02
Copper	0.00099961		27.9	m	5.06E+00	5.6	0.9
Iron	0.126	m	185	m	3.36E+01	22.8	1
Lead	0.00034	m	0		5.36E-05	4.7	0.00001
Manganese	0.0351	m	2.9	m	5.32E-01	51.5	0.01
Mercury	0		0.13	m	2.36E-02	1	0.02
Molybdenum	0.00078376		0.37	m	6.73E-02	0.26	0.3
Nickel	0.00065	m	0		1.03E-04	1.7	0.00006
Selenium	0.00043	m	4.1	m	7.44E-01	0.143	5
Silver	0		0.028	m	5.08E-03	6.02	0.0008
Strontium	0.114		0.74	m	1.52E-01	263	0.0006
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0		0.14	m	2.54E-02	4.16	0.006
Zinc	0		98.7	m	1.79E+01	75.4	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-CR_R-12
Screening Risk Characterization Results Summary
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**2**	**4**	**13**	0.5	0.4	**52**	**87**	**45**	0.01	0.5
Antimony	0.0001	0.0003	0.0008	0.000006	--	--	0.02	0.009	--	--
Arsenic	0.08	0.1	0.4	0.06	0.06	0.05	0.1	0.1	0.02	0.02
Barium	0.2	0.2	0.5	0.06	0.06	0.05	0.04	0.03	0.008	0.002
Beryllium	0.02	0.04	0.1	0.002	--	0.007	0.01	0.005	--	--
Boron	0.1	0.05	0.04	0.0003	0.00003	0.1	0.04	0.01	0.007	0.005
Cadmium	0.02	0.04	0.1	0.003	0.003	0.009	0.02	0.01	0.07	0.09
Chromium	0.1	0.2	0.6	0.05	0.05	0.03	0.08	0.08	1	1
Cobalt	0.03	0.05	0.1	0.006	0.005	0.01	0.02	0.01	0.03	0.02
Copper	0.3	0.3	0.8	0.1	0.2	0.1	0.1	0.1	**2**	0.9
Iron	**3**	**5**	**16**	0.5	0.4	**5**	**9**	**4**	0.4	1
Lead	0.2	0.3	1	0.05	0.04	0.02	0.04	0.03	0.00004	0.00001
Manganese	0.3	0.3	0.9	0.07	0.07	0.5	0.5	0.3	0.004	0.01
Mercury	0.07	0.1	0.4	0.02	0.02	--	0.02	0.01	0.07	0.02
Molybdenum	0.03	0.02	0.03	0.0003	0.00001	0.3	0.2	0.05	0.03	0.3
Nickel	0.09	0.1	0.3	0.04	0.04	0.2	0.2	0.2	0.00002	0.00006
Selenium	0.4	0.8	**2**	0.7	0.7	0.0003	0.5	1	**3**	**5**
Silver	--	--	--	0.0004	0.0004	--	0.000003	0.0001	0.003	0.0008
Strontium	0.01	0.005	0.005	0.01	0.01	0.01	0.006	0.01	0.0007	0.0006
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	1	**2**	**6**	0.3	0.3	0.04	0.07	0.04	0.1	0.006
Zinc	0.1	0.2	0.5	0.09	0.1	0.06	0.06	0.08	0.4	0.2

Hazard quotients greater than one are in bold.

Table 4-TR_A-1
Data Summaries
Risk Characterization
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates											
											Larval Mayfly (Whole Body)					Adult Mayfly						
	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)					(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																						
Aluminum	12/12	7370	-	143000	70028	6 / 8	0.0676	-	0.263	0.167	3/3	8060	-	10900	10900	m	0/9	0	-	0	0	
Antimony	3/12	1.32	-	2.52	2.52 m	0 / 8	0	-	0	0	3/3	0.15	-	0.16	0.16	m	0/9	0	-	0	0	
Arsenic	12/12	5.2	-	63.4	28.62	8 / 8	0.0005	-	0.0013	1E-03	3/3	9.3	-	11	11	m	9/9	0.09	-	0.21	0.16	
Barium	12/12	50.7	-	190	133.4	8 / 8	0.0264	-	0.0396	0.033	3/3	66.1	-	86.2	86.2	m	9/9	0.42	-	0.97	0.86	
Beryllium	10/12	0.623	-	4.39	2.525	1 / 8	0.00048	-	0.0005	5E-04 m	3/3	0.44	-	0.66	0.66	m	0/9	0	-	0	0	
Boron	12/12	8.63	-	60.5	50.23	8 / 8	0.0126	-	0.0182	0.016	2/3	5.3	-	5.6	5.6	m	3/9	0.93	-	1.3	1.3 m	
Cadmium	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	0.76	-	1.6	1.6	m	9/9	0.22	-	0.76	0.56	
Chromium	12/12	14.8	-	125	69.36	1 / 8	0.00043	-	0.0004	4E-04 m	3/3	9.3	-	12.2	12.2	m	9/9	0.2	-	0.44	0.34	
Cobalt	12/12	4.52	-	18	13.27	0 / 8	0	-	0	0	3/3	6.7	-	7.8	7.8	m	9/9	0.79	-	0.98	0.95	
Copper	12/12	5.52	-	90.4	36.85	8 / 8	0.00056	-	0.0022	0.001	3/3	19.7	-	21.7	21.7	m	9/9	10.3	-	28.8	25	
Iron	12/12	14500	-	93800	51886	7 / 8	0.0805	-	0.236	0.164	3/3	9040	-	11700	11700	m	9/9	69.4	-	180	161	
Lead	12/12	12.1	-	102	47.71	1 / 8	0.00047	-	0.0005	5E-04 m	3/3	8	-	10.4	10.4	m	0/9	0	-	0	0	
Manganese	12/12	160	-	1700	1016	7 / 8	0.0386	-	0.0943	0.069	3/3	1190	-	1500	1500	m	9/9	2.1	-	5.6	4.33	
Mercury	10/12	0.07	-	0.39	0.204	0 / 8	0	-	0	0	3/3	0.14	-	0.17	0.17	m	9/9	0.03	-	0.05	0.05	
Molybdenum	0/12	0	-	0	0	6 / 8	0.00041	-	0.0006	6E-04	3/3	0.93	-	0.97	0.97	m	9/9	0.39	-	0.54	0.5	
Nickel	12/12	3.24	-	135	45.88	4 / 8	0.00035	-	0.0011	0.001 m	3/3	8.4	-	10.8	10.8	m	0/9	0	-	0	0	
Selenium	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	4.9	-	5.9	5.9	m	9/9	2.9	-	4.1	3.63	
Silver	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	0.04	-	0.077	0.077	m	9/9	0.01	-	0.04	0.03	
Strontium	12/12	6.27	-	43.6	27.56	8 / 8	0.0738	-	0.107	0.092	3/3	17.3	-	20.9	20.9	m	9/9	0.54	-	1	0.97	
Thallium	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	0.13	-	0.16	0.16	m	0/9	0	-	0	0	
Vanadium	12/12	21.1	-	193	89.27	2 / 8	0.00102	-	0.0015	0.002 m	3/3	14	-	18.3	18.3	m	9/9	0.11	-	0.23	0.19	
Zinc	12/12	27.5	-	460	307.8	0 / 8	0	-	0	0	3/3	218	-	292	292	m	9/9	91.8	-	224	169	

Table 4-TR_A-1
Data Summaries
Risk Characterization
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	14.5	-	362.2	362	m	6/6	441	-	3074	3074	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		4/6	0.064	-	0.11	0.11	m	0/40	0	-	0	0	
Arsenic	4/6	0.11	-	0.2677	0.27	m	6/6	1.6	-	5.12	5.12	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	25.5	-	210.8	211	m	6/6	18.1	-	43.3	43.3	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		3/6	0.162	-	0.27	0.27	m	0/40	0	-	0	0	
Boron	6/6	4.98	-	51.97	52	m	2/6	1.982	-	2.37	2.37	m	0/40	0	-	0	0	
Cadmium	0/6	0	-	0	0		6/6	0.0463	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	0/6	0	-	0	0		5/6	1.6	-	4.65	4.65	m	0/40	0	-	0	0	
Cobalt	6/6	0.07	-	0.6024	0.6	m	6/6	0.47	-	2.05	2.05	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	5.11	-	8.397	8.4	m	6/6	5.4	-	14.8	14.8	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	56.5	-	419.7	420	m	6/6	448	-	1395	1395	m	34/40	99.1	-	532.7	238	
Lead	4/6	0.15	-	0.4094	0.41	m	6/6	0.75	-	3.21	3.21	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	168	-	395.3	395	m	6/6	140	-	327	327	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		6/6	0.06	-	0.15	0.15	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.17	-	2.899	2.9	m	2/6	0.1613	-	0.18	0.18	m	7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.47	-	2.047	2.05	m	6/6	1.2	-	12.4	12.4	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2	-	3.44	3.44	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		5/6	0.014	-	0.04	0.04	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	11.4	-	58.27	58.3	m	6/6	37.3	-	46.5	46.5	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	2/6	0.31	-	0.6535	0.65	m	6/6	1.1	-	6.98	6.98	m	0/40	0	-	0	0	
Zinc	6/6	32.5	-	76.87	76.9	m	6/6	73.7	-	131	131	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-TR_A-2
Screening Risk Characterization for the Wood Duck
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.167		10,900	m	362.2	m	4.31E+02	109.7	4
Antimony	2.52	m	0		0.16	m	0		8.49E-03	18	0.0005
Arsenic	28.62		0.001		11	m	0.2677	m	3.60E-01	2.24	0.2
Barium	133.4		0.0331		86.2	m	210.8	m	1.42E+01	20.8	0.7
Beryllium	2.525		0.0005	m	0.66	m	0		2.21E-02	0.532	0.04
Boron	50.23		0.0164		5.6	m	51.97	m	3.10E+00	28	0.1
Cadmium	0		0		1.6	m	0		4.34E-02	1.47	0.03
Chromium	69.36		0.0004	m	12.2	m	0		4.45E-01	2.66	0.2
Cobalt	13.27		0		7.8	m	0.6024	m	2.67E-01	7.61	0.04
Copper	36.85		0.0013		21.7	m	8.397	m	1.11E+00	4.05	0.3
Iron	51,886		0.164		11,700	m	419.7	m	4.26E+02	109.3	4
Lead	47.71		0.0005	m	10.4	m	0.4094	m	3.83E-01	1.63	0.2
Manganese	1,016		0.0692		1,500	m	395.3	m	6.42E+01	179	0.4
Mercury	0.204		0		0.17	m	0		4.95E-03	0.45	0.01
Molybdenum	0		0.0006		0.97	m	2.899	m	1.86E-01	3.5	0.05
Nickel	45.88		0.0011	m	10.8	m	2.047	m	4.81E-01	6.71	0.07
Selenium	0		0		5.9	m	0		1.60E-01	0.29	0.6
Silver	0		0		0.077	m	0		2.09E-03	2.02	0.001
Strontium	27.56		0.0919		20.9	m	58.27	m	3.83E+00	312	0.01
Thallium	0		0		0.16	m	0		4.34E-03	0.35	0.01
Vanadium	89.27		0.0015	m	18.3	m	0.6535	m	6.80E-01	0.344	2
Zinc	307.8		0		292	m	76.87	m	1.27E+01	66.1	0.2

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-3
Screening Risk Characterization for the Mallard Duck
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.167		10,900	m	362.2	m	7.31E+02	109.7	7
Antimony	2.52	m	0		0.16	m	0		1.40E-02	18	0.0008
Arsenic	28.62		0.001		11	m	0.2677	m	6.40E-01	2.24	0.3
Barium	133.4		0.0331		86.2	m	210.8	m	8.42E+00	20.8	0.4
Beryllium	2.525		0.0005	m	0.66	m	0		4.00E-02	0.532	0.08
Boron	50.23		0.0164		5.6	m	51.97	m	1.30E+00	28	0.05
Cadmium	0		0		1.6	m	0		8.30E-02	1.47	0.06
Chromium	69.36		0.0004	m	12.2	m	0		7.91E-01	2.66	0.3
Cobalt	13.27		0		7.8	m	0.6024	m	4.45E-01	7.61	0.06
Copper	36.85		0.0013		21.7	m	8.397	m	1.35E+00	4.05	0.3
Iron	51,886		0.164		11,700	m	419.7	m	7.32E+02	109.3	7
Lead	47.71		0.0005	m	10.4	m	0.4094	m	6.55E-01	1.63	0.4
Manganese	1,016		0.0692		1,500	m	395.3	m	8.70E+01	179	0.5
Mercury	0.204		0		0.17	m	0		9.28E-03	0.45	0.02
Molybdenum	0		0.0006		0.97	m	2.899	m	1.00E-01	3.5	0.03
Nickel	45.88		0.0011	m	10.8	m	2.047	m	7.00E-01	6.71	0.1
Selenium	0		0		5.9	m	0		3.06E-01	0.29	1
Silver	0		0		0.077	m	0		3.99E-03	2.02	0.002
Strontium	27.56		0.0919		20.9	m	58.27	m	2.16E+00	312	0.007
Thallium	0		0		0.16	m	0		8.30E-03	0.35	0.02
Vanadium	89.27		0.0015	m	18.3	m	0.6535	m	1.16E+00	0.344	3
Zinc	307.8		0		292	m	76.87	m	1.72E+01	66.1	0.3

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-4
Screening Risk Characterization for the Killdeer
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	70,028		0.167		10,900	m	2.76E+03	109.7	25
Antimony	2.52	m	0		0.16	m	6.41E-02	18	0.004
Arsenic	28.62		0.001		11	m	2.12E+00	2.24	0.9
Barium	133.4		0.0331		86.2	m	1.52E+01	20.8	0.7
Beryllium	2.525		0.0005	m	0.66	m	1.40E-01	0.532	0.3
Boron	50.23		0.0164		5.6	m	1.65E+00	28	0.06
Cadmium	0		0		1.6	m	2.43E-01	1.47	0.2
Chromium	69.36		0.0004	m	12.2	m	2.95E+00	2.66	1
Cobalt	13.27		0		7.8	m	1.40E+00	7.61	0.2
Copper	36.85		0.0013		21.7	m	3.88E+00	4.05	1
Iron	51,886		0.164		11,700	m	2.60E+03	109.3	24
Lead	47.71		0.0005	m	10.4	m	2.33E+00	1.63	1
Manganese	1,016		0.0692		1,500	m	2.44E+02	179	1
Mercury	0.204		0		0.17	m	2.91E-02	0.45	0.06
Molybdenum	0		0.0006		0.97	m	1.47E-01	3.5	0.04
Nickel	45.88		0.0011	m	10.8	m	2.37E+00	6.71	0.4
Selenium	0		0		5.9	m	8.97E-01	0.29	3
Silver	0		0		0.077	m	1.17E-02	2.02	0.006
Strontium	27.56		0.0919		20.9	m	3.62E+00	312	0.01
Thallium	0		0		0.16	m	2.43E-02	0.35	0.07
Vanadium	89.27		0.0015	m	18.3	m	4.19E+00	0.344	12
Zinc	307.8		0		292	m	4.92E+01	66.1	0.7

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-5
Screening Risk Characterization for the Heron
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.167		10,900	m	3,074	m	2.20E+02	109.7	2
Antimony	2.52	m	0		0.16	m	0.107	m	7.47E-03	18	0.0004
Arsenic	28.62		0.00097		11	m	5.116	m	3.09E-01	2.24	0.1
Barium	133.4		0.0331		86.2	m	43.26	m	2.55E+00	20.8	0.1
Beryllium	2.525		0.00048	m	0.66	m	0.2698	m	1.70E-02	0.532	0.03
Boron	50.23		0.0164		5.6	m	2.372	m	1.65E-01	28	0.006
Cadmium	0		0		1.6	m	0.09	m	6.74E-03	1.47	0.005
Chromium	69.36		0.00043	m	12.2	m	4.651	m	3.08E-01	2.66	0.1
Cobalt	13.27		0		7.8	m	2.047	m	1.29E-01	7.61	0.02
Copper	36.85		0.00134		21.7	m	14.75	m	8.55E-01	4.05	0.2
Iron	51,886		0.164		11,700	m	1,395	m	1.19E+02	109.3	1
Lead	47.71		0.00047	m	10.4	m	3.209	m	2.15E-01	1.63	0.1
Manganese	1,016		0.0692		1,500	m	326.7	m	2.02E+01	179	0.1
Mercury	0.204		0		0.17	m	0.1475	m	8.41E-03	0.45	0.02
Molybdenum	0		0.00055		0.97	m	0.1814	m	1.11E-02	3.5	0.003
Nickel	45.88		0.00113	m	10.8	m	12.44	m	7.21E-01	6.71	0.1
Selenium	0		0		5.9	m	3.442	m	1.96E-01	0.29	0.7
Silver	0		0		0.077	m	0.0386	m	2.21E-03	2.02	0.001
Strontium	27.56		0.0919		20.9	m	46.54	m	2.60E+00	312	0.008
Thallium	0		0		0.16	m	0		1.79E-04	0.35	0.0005
Vanadium	89.27		0.00153	m	18.3	m	6.977	m	4.54E-01	0.344	1
Zinc	307.8		0		292	m	130.9	m	7.69E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-6
Screening Risk Characterization for the Osprey
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.167		3,074	m	1.90E+02	109.7	2
Antimony	0		0.107	m	6.60E-03	18	0.0004
Arsenic	0.000971		5.116	m	3.16E-01	2.24	0.1
Barium	0.0331		43.26	m	2.67E+00	20.8	0.1
Beryllium	0.00048	m	0.2698	m	1.67E-02	0.532	0.03
Boron	0.0164		2.372	m	1.47E-01	28	0.005
Cadmium	0		0.09	m	5.55E-03	1.47	0.004
Chromium	0.00043	m	4.651	m	2.87E-01	2.66	0.1
Cobalt	0		2.047	m	1.26E-01	7.61	0.02
Copper	0.00134		14.75	m	9.10E-01	4.05	0.2
Iron	0.164		1,395	m	8.61E+01	109.3	0.8
Lead	0.00047	m	3.209	m	1.98E-01	1.63	0.1
Manganese	0.0692		326.7	m	2.02E+01	179	0.1
Mercury	0		0.1475	m	9.10E-03	0.45	0.02
Molybdenum	0.0005513		0.1814	m	1.12E-02	3.5	0.003
Nickel	0.00113	m	12.44	m	7.68E-01	6.71	0.1
Selenium	0		3.442	m	2.12E-01	0.29	0.7
Silver	0		0.0386	m	2.38E-03	2.02	0.001
Strontium	0.0919		46.54	m	2.88E+00	312	0.009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00153	m	6.977	m	4.31E-01	0.344	1
Zinc	0		130.9	m	8.08E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-7
Screening Risk Characterization for the Muskrat
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	70,028		0.167		362.2	m	3.67E+02	1.93	190
Antimony	2.52	m	0		0		1.25E-02	0.059	0.2
Arsenic	28.62		0.001		0.2677	m	1.56E-01	1.04	0.2
Barium	133.4		0.0331		210.8	m	1.18E+01	51.8	0.2
Beryllium	2.525		0.0005	m	0		1.26E-02	0.532	0.02
Boron	50.23		0.0164		51.97	m	3.00E+00	28.8	0.1
Cadmium	0		0		0		0.00E+00	0.77	--
Chromium	69.36		0.0004	m	0		3.45E-01	2.4	0.1
Cobalt	13.27		0		0.6024	m	9.78E-02	7.33	0.01
Copper	36.85		0.0013		8.397	m	6.27E-01	5.6	0.1
Iron	51,886		0.164		419.7	m	2.80E+02	22.8	12
Lead	47.71		0.0005	m	0.4094	m	2.59E-01	4.7	0.06
Manganese	1,016		0.0692		395.3	m	2.59E+01	51.5	0.5
Mercury	0.204		0		0		1.01E-03	1	0.001
Molybdenum	0		0.0006		2.899	m	1.53E-01	0.26	0.6
Nickel	45.88		0.0011	m	2.047	m	3.36E-01	1.7	0.2
Selenium	0		0		0		0.00E+00	0.143	--
Silver	0		0		0		0.00E+00	6.02	--
Strontium	27.56		0.0919		58.27	m	3.23E+00	263	0.01
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	89.27		0.0015	m	0.6535	m	4.78E-01	4.16	0.1
Zinc	307.8		0		76.87	m	5.59E+00	75.4	0.07

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-8
Screening Risk Characterization for the Raccoon
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	70,028		0.167		10,900	m	362.2	m	3,074	m	3.98E+02	1.93	210
Antimony	2.52	m	0		0.16	m	0		0.107	m	1.08E-02	0.059	0.2
Arsenic	28.62		0.00097		11	m	0.2677	m	5.116	m	2.61E-01	1.04	0.3
Barium	133.4		0.0331		86.2	m	210.8	m	43.26	m	6.07E+00	51.8	0.1
Beryllium	2.525		0.00048	m	0.66	m	0		0.2698	m	1.80E-02	0.532	0.03
Boron	50.23		0.0164		5.6	m	51.97	m	2.372	m	1.33E+00	28.8	0.05
Cadmium	0		0		1.6	m	0		0.09	m	2.24E-02	0.77	0.03
Chromium	69.36		0.00043	m	12.2	m	0		4.651	m	4.08E-01	2.4	0.2
Cobalt	13.27		0		7.8	m	0.6024	m	2.047	m	1.68E-01	7.33	0.02
Copper	36.85		0.00134		21.7	m	8.397	m	14.75	m	6.16E-01	5.6	0.1
Iron	51,886		0.164		11,700	m	419.7	m	1,395	m	3.48E+02	22.8	15
Lead	47.71		0.00047	m	10.4	m	0.4094	m	3.209	m	3.17E-01	4.7	0.07
Manganese	1,016		0.0692		1,500	m	395.3	m	326.7	m	3.29E+01	51.5	0.6
Mercury	0.204		0		0.17	m	0		0.1475	m	3.21E-03	1	0.003
Molybdenum	0		0.00055		0.97	m	2.899	m	0.1814	m	7.39E-02	0.26	0.3
Nickel	45.88		0.00113	m	10.8	m	2.047	m	12.44	m	3.61E-01	1.7	0.2
Selenium	0		0		5.9	m	0		3.442	m	8.59E-02	0.143	0.6
Silver	0		0		0.077	m	0		0.0386	m	1.11E-03	6.02	0.0002
Strontium	27.56		0.0919		20.9	m	58.27	m	46.54	m	1.65E+00	263	0.006
Thallium	0		0		0.16	m	0		0		2.23E-03	0.015	0.1
Vanadium	89.27		0.00153	m	18.3	m	0.6535	m	6.977	m	5.76E-01	4.16	0.1
Zinc	307.8		0		292	m	76.87	m	130.9	m	6.84E+00	75.4	0.09

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-9
Screening Risk Characterization for the Mink
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Amphibian Frogs (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics															
Aluminum	70,028		0.167		10,900	m	362.2	m	3,074	m	56.6		2.65E+02	1.93	140
Antimony	2.52	m	0		0.16	m	0		0.107	m	0		8.07E-03	0.059	0.1
Arsenic	28.62		0.001		11	m	0.2677	m	5.116	m	0.8164	m	3.08E-01	1.04	0.3
Barium	133.4		0.0331		86.2	m	210.8	m	43.26	m	78.98		3.56E+00	51.8	0.07
Beryllium	2.525		0.0005	m	0.66	m	0		0.2698	m	0		1.77E-02	0.532	0.03
Boron	50.23		0.0164		5.6	m	51.97	m	2.372	m	0		4.37E-01	28.8	0.02
Cadmium	0		0		1.6	m	0		0.09	m	0.143		1.26E-02	0.77	0.02
Chromium	69.36		0.0004	m	12.2	m	0		4.651	m	0		3.36E-01	2.4	0.1
Cobalt	13.27		0		7.8	m	0.6024	m	2.047	m	0.228		1.46E-01	7.33	0.02
Copper	36.85		0.0013		21.7	m	8.397	m	14.75	m	18.35		8.43E-01	5.6	0.2
Iron	51,886		0.164		11,700	m	419.7	m	1,395	m	237.9		1.80E+02	22.8	8
Lead	47.71		0.0005	m	10.4	m	0.4094	m	3.209	m	0.7493	m	2.45E-01	4.7	0.05
Manganese	1,016		0.0692		1,500	m	395.3	m	326.7	m	88.97		2.49E+01	51.5	0.5
Mercury	0.204		0		0.17	m	0		0.1475	m	0.13		7.52E-03	1	0.008
Molybdenum	0		0.0006		0.97	m	2.899	m	0.1814	m	0.32		2.73E-02	0.26	0.1
Nickel	45.88		0.0011	m	10.8	m	2.047	m	12.44	m	0		6.42E-01	1.7	0.4
Selenium	0		0		5.9	m	0		3.442	m	2.066		1.80E-01	0.143	1
Silver	0		0		0.077	m	0		0.0386	m	0.038		2.09E-03	6.02	0.0003
Strontium	27.56		0.0919		20.9	m	58.27	m	46.54	m	77.81		2.50E+00	263	0.009
Thallium	0		0		0.16	m	0		0		0.34	m	1.32E-03	0.015	0.09
Vanadium	89.27		0.0015	m	18.3	m	0.6535	m	6.977	m	0		4.91E-01	4.16	0.1
Zinc	307.8		0		292	m	76.87	m	130.9	m	145		7.98E+00	75.4	0.1

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-10
Screening Risk Characterization for the Tree Swallow
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.167		0		3.55E-02	109.7	0.0003
Antimony	0		0		0.00E+00	18	--
Arsenic	0.000971		0.162		4.01E-02	2.24	0.02
Barium	0.0331		0.857		2.18E-01	20.8	0.01
Beryllium	0.00048	m	0		1.02E-04	0.532	0.0002
Boron	0.0164		1.3	m	3.24E-01	28	0.01
Cadmium	0		0.564		1.39E-01	1.47	0.09
Chromium	0.00043	m	0.344		8.49E-02	2.66	0.03
Cobalt	0		0.948		2.34E-01	7.61	0.03
Copper	0.00134		25.01		6.16E+00	4.05	2
Iron	0.164		161.3		3.98E+01	109.3	0.4
Lead	0.00047	m	0		1.00E-04	1.63	0.00006
Manganese	0.0692		4.326		1.08E+00	179	0.006
Mercury	0		0.0479		1.18E-02	0.45	0.03
Molybdenum	0.0005513		0.504		1.24E-01	3.5	0.04
Nickel	0.00113	m	0		2.40E-04	6.71	0.00004
Selenium	0		3.629		8.94E-01	0.29	3
Silver	0		0.0317		7.81E-03	2.02	0.004
Strontium	0.0919		0.972		2.59E-01	312	0.0008
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00153	m	0.188		4.66E-02	0.344	0.1
Zinc	0		169.2		4.17E+01	66.1	0.6

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-11
Screening Risk Characterization for the Gray Bat
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.167		0		2.63E-02	1.93	0.01
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00097102		0.162		2.96E-02	1.04	0.03
Barium	0.0331		0.857		1.61E-01	51.8	0.003
Beryllium	0.00048	m	0		7.57E-05	0.532	0.0001
Boron	0.0164		1.3	m	2.39E-01	28.8	0.008
Cadmium	0		0.564		1.02E-01	0.77	0.1
Chromium	0.00043	m	0.344		6.25E-02	2.4	0.03
Cobalt	0		0.948		1.72E-01	7.33	0.02
Copper	0.00134		25.01		4.54E+00	5.6	0.8
Iron	0.164		161.3		2.93E+01	22.8	1
Lead	0.00047	m	0		7.41E-05	4.7	0.00002
Manganese	0.0692		4.326		7.96E-01	51.5	0.02
Mercury	0		0.0479		8.69E-03	1	0.009
Molybdenum	0.00055125		0.504		9.16E-02	0.26	0.4
Nickel	0.00113	m	0		1.78E-04	1.7	0.0001
Selenium	0		3.629		6.59E-01	0.143	5
Silver	0		0.0317		5.75E-03	6.02	0.001
Strontium	0.0919		0.972		1.91E-01	263	0.0007
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00153	m	0.188		3.44E-02	4.16	0.008
Zinc	0		169.2		3.07E+01	75.4	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_A-12
Screening Risk Characterization Results Summary
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**4**	**7**	**25**	**2**	**2**	**190**	**210**	**140**	0.0003	0.01
Antimony	0.0005	0.0008	0.004	0.0004	0.0004	0.2	0.2	0.1	--	--
Arsenic	0.2	0.3	0.9	0.1	0.1	0.2	0.3	0.3	0.02	0.03
Barium	0.7	0.4	0.7	0.1	0.1	0.2	0.1	0.07	0.01	0.003
Beryllium	0.04	0.08	0.3	0.03	0.03	0.02	0.03	0.03	0.0002	0.0001
Boron	0.1	0.05	0.06	0.006	0.005	0.1	0.05	0.02	0.01	0.008
Cadmium	0.03	0.06	0.2	0.005	0.004	--	0.03	0.02	0.09	0.1
Chromium	0.2	0.3	1	0.1	0.1	0.1	0.2	0.1	0.03	0.03
Cobalt	0.04	0.06	0.2	0.02	0.02	0.01	0.02	0.02	0.03	0.02
Copper	0.3	0.3	1	0.2	0.2	0.1	0.1	0.2	**2**	0.8
Iron	**4**	**7**	**24**	1	0.8	**12**	**15**	**8**	0.4	1
Lead	0.2	0.4	1	0.1	0.1	0.06	0.07	0.05	0.00006	0.00002
Manganese	0.4	0.5	1	0.1	0.1	0.5	0.6	0.5	0.006	0.02
Mercury	0.01	0.02	0.06	0.02	0.02	0.001	0.003	0.008	0.03	0.009
Molybdenum	0.05	0.03	0.04	0.003	0.003	0.6	0.3	0.1	0.04	0.4
Nickel	0.07	0.1	0.4	0.1	0.1	0.2	0.2	0.4	0.00004	0.0001
Selenium	0.6	1	**3**	0.7	0.7	--	0.6	1	**3**	**5**
Silver	0.001	0.002	0.006	0.001	0.001	--	0.0002	0.0003	0.004	0.001
Strontium	0.01	0.007	0.01	0.008	0.009	0.01	0.006	0.009	0.0008	0.0007
Thallium	0.01	0.02	0.07	0.0005	--	--	0.1	0.09	--	--
Vanadium	**2**	**3**	**12**	1	1	0.1	0.1	0.1	0.1	0.008
Zinc	0.2	0.3	0.7	0.1	0.1	0.07	0.09	0.1	0.6	0.4

Hazard quotients greater than one are in bold.

Table 4-TR_B-1
Data Summaries
Risk Characterization
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates											
											Larval Mayfly (Whole Body)					Adult Mayfly						
	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)					(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																						
Aluminum	12/12	7370	-	143000	70028	6 / 8	0.0676	-	0.263	0.167	3/3	9250	-	10700	10700	m	0/18	0	-	0	0	
Antimony	3/12	1.32	-	2.52	2.52 m	0 / 8	0	-	0	0	3/3	0.16	-	0.18	0.18	m	0/18	0	-	0	0	
Arsenic	12/12	5.2	-	63.4	28.62	8 / 8	0.0005	-	0.0013	0.001	3/3	9.1	-	10.4	10.4	m	18/18	0.11	-	0.23	0.16	
Barium	12/12	50.7	-	190	133.4	8 / 8	0.0264	-	0.0396	0.0331	3/3	73.1	-	87.6	87.6	m	18/18	0.4	-	0.83	0.73	
Beryllium	10/12	0.623	-	4.39	2.525	1 / 8	0.00048	-	0.0005	0.0005 m	3/3	0.42	-	0.62	0.62	m	0/18	0	-	0	0	
Boron	12/12	8.63	-	60.5	50.23	8 / 8	0.0126	-	0.0182	0.0164	3/3	6.6	-	7.4	7.4	m	4/18	0.44	-	0.66	0.66	m
Cadmium	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	0.96	-	1.7	1.7	m	18/18	0.11	-	0.38	0.28	
Chromium	12/12	14.8	-	125	69.36	1 / 8	0.00043	-	0.0004	0.0004 m	3/3	10.6	-	12.1	12.1	m	18/18	0.14	-	0.28	0.22	
Cobalt	12/12	4.52	-	18	13.27	0 / 8	0	-	0	0	3/3	6.3	-	7.2	7.2	m	18/18	0.75	-	1.1	0.96	
Copper	12/12	5.52	-	90.4	36.85	8 / 8	0.00056	-	0.0022	0.0013	3/3	20.2	-	21.4	21.4	m	18/18	11.3	-	28.2	22.9	
Iron	12/12	14500	-	93800	51886	7 / 8	0.0805	-	0.236	0.164	3/3	10300	-	11400	11400	m	18/18	76.9	-	184	152	
Lead	12/12	12.1	-	102	47.71	1 / 8	0.00047	-	0.0005	0.0005 m	3/3	8.9	-	10.1	10.1	m	0/18	0	-	0	0	
Manganese	12/12	160	-	1700	1016	7 / 8	0.0386	-	0.0943	0.0692	3/3	979	-	1460	1460	m	18/18	1.9	-	5.3	3.44	
Mercury	10/12	0.07	-	0.39	0.204	0 / 8	0	-	0	0	3/3	0.11	-	0.13	0.13	m	18/18	0.03	-	0.06	0.05	
Molybdenum	0/12	0	-	0	0	6 / 8	0.00041	-	0.0006	0.0006	3/3	0.88	-	1.3	1.3	m	18/18	0.34	-	0.66	0.54	
Nickel	12/12	3.24	-	135	45.88	4 / 8	0.00035	-	0.0011	0.0011 m	3/3	9.3	-	10.6	10.6	m	0/18	0	-	0	0	
Selenium	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	5.6	-	6	6	m	18/18	3.3	-	5.3	4.11	
Silver	0/12	0	-	0	0	0 / 8	0	-	0	0	1/3	0.039	-	0.039	0.039	m	12/18	0.01	-	0.02	0.02	
Strontium	12/12	6.27	-	43.6	27.56	8 / 8	0.0738	-	0.107	0.0919	3/3	19.5	-	22.4	22.4	m	18/18	0.55	-	1.1	0.86	
Thallium	0/12	0	-	0	0	0 / 8	0	-	0	0	1/3	0.19	-	0.19	0.19	m	0/18	0	-	0	0	
Vanadium	12/12	21.1	-	193	89.27	2 / 8	0.00102	-	0.0015	0.0015 m	3/3	16.2	-	18.4	18.4	m	18/18	0.08	-	0.21	0.17	
Zinc	12/12	27.5	-	460	307.8	0 / 8	0	-	0	0	3/3	193	-	240	240	m	18/18	89.1	-	213	154	

Table 4-TR_B-1
Data Summaries
Risk Characterization
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	18.6	-	223.4	223	m	6/6	441	-	3074	3074	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		4/6	0.064	-	0.11	0.11	m	0/40	0	-	0	0	
Arsenic	1/6	0.13	-	0.1344	0.13	m	6/6	1.6	-	5.12	5.12	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	3.56	-	49.19	49.2	m	6/6	18.1	-	43.3	43.3	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		3/6	0.162	-	0.27	0.27	m	0/40	0	-	0	0	
Boron	6/6	4.22	-	16.94	16.9	m	2/6	1.982	-	2.37	2.37	m	0/40	0	-	0	0	
Cadmium	2/6	0.07	-	0.125	0.13	m	6/6	0.0463	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	3/6	0.52	-	1.317	1.32	m	5/6	1.6	-	4.65	4.65	m	0/40	0	-	0	0	
Cobalt	6/6	0.07	-	1.22	1.22	m	6/6	0.47	-	2.05	2.05	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	4.88	-	26.36	26.4	m	6/6	5.4	-	14.8	14.8	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	55.7	-	243.4	243	m	6/6	448	-	1395	1395	m	34/40	99.1	-	532.7	238	
Lead	4/6	0.11	-	0.7364	0.74	m	6/6	0.75	-	3.21	3.21	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	243	-	887.8	888	m	6/6	140	-	327	327	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		6/6	0.06	-	0.15	0.15	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.19	-	1.976	1.98	m	2/6	0.1613	-	0.18	0.18	m	7/40	0.29	-	0.4814	0.32	
Nickel	5/6	0.46	-	5.039	5.04	m	6/6	1.2	-	12.4	12.4	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2	-	3.44	3.44	m	40/40	0.87	-	3.858	2.07	
Silver	1/6	0.02	-	0.0153	0.02	m	5/6	0.014	-	0.04	0.04	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	4.35	-	37.56	37.6	m	6/6	37.3	-	46.5	46.5	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	4/6	0.26	-	0.3117	0.31	m	6/6	1.1	-	6.98	6.98	m	0/40	0	-	0	0	
Zinc	4/6	30.7	-	60.48	60.5	m	6/6	73.7	-	131	131	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-TR_B-3
Screening Risk Characterization for the Wood Duck
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.167		10,700	m	223.4	m	4.18E+02	109.7	4
Antimony	2.52	m	0		0.18	m	0		9.03E-03	18	0.0005
Arsenic	28.62		0.001		10.4	m	0.1344	m	3.37E-01	2.24	0.2
Barium	133.4		0.0331		87.6	m	49.19	m	5.31E+00	20.8	0.3
Beryllium	2.525		0.0005	m	0.62	m	0		2.10E-02	0.532	0.04
Boron	50.23		0.0164		7.4	m	16.94	m	1.22E+00	28	0.04
Cadmium	0		0		1.7	m	0.125	m	5.30E-02	1.47	0.04
Chromium	69.36		0.0004	m	12.1	m	1.317	m	5.15E-01	2.66	0.2
Cobalt	13.27		0		7.2	m	1.22	m	2.84E-01	7.61	0.04
Copper	36.85		0.0013		21.4	m	26.36	m	2.09E+00	4.05	0.5
Iron	51,886		0.164		11,400	m	243.4	m	4.08E+02	109.3	4
Lead	47.71		0.0005	m	10.1	m	0.7364	m	3.93E-01	1.63	0.2
Manganese	1,016		0.0692		1,460	m	887.8	m	9.02E+01	179	0.5
Mercury	0.204		0		0.13	m	0		3.86E-03	0.45	0.009
Molybdenum	0		0.0006		1.3	m	1.976	m	1.44E-01	3.5	0.04
Nickel	45.88		0.0011	m	10.6	m	5.039	m	6.41E-01	6.71	0.1
Selenium	0		0		6	m	0		1.63E-01	0.29	0.6
Silver	0		0		0.039	m	0.01532	m	1.90E-03	2.02	0.0009
Strontium	27.56		0.0919		22.4	m	37.56	m	2.73E+00	312	0.009
Thallium	0		0		0.19	m	0		5.16E-03	0.35	0.01
Vanadium	89.27		0.0015	m	18.4	m	0.3117	m	6.63E-01	0.344	2
Zinc	307.8		0		240	m	60.48	m	1.04E+01	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-3
Screening Risk Characterization for the Mallard Duck
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics												
Aluminum	70,028		0.167		10,700	m	223.4	m	7.19E+02	386.5	109.7	7
Antimony	2.52	m	0		0.18	m	0		1.51E-02	21	18	0.0008
Arsenic	28.62		0.001		10.4	m	0.1344	m	6.07E-01	22.4	2.24	0.3
Barium	133.4		0.0331		87.6	m	49.19	m	5.70E+00	41.7	20.8	0.3
Beryllium	2.525		0.0005	m	0.62	m	0		3.79E-02	5.32	0.532	0.07
Boron	50.23		0.0164		7.4	m	16.94	m	7.92E-01	93.6	28	0.03
Cadmium	0		0		1.7	m	0.125	m	9.03E-02	14.7	1.47	0.06
Chromium	69.36		0.0004	m	12.1	m	1.317	m	8.09E-01	26.6	2.66	0.3
Cobalt	13.27		0		7.2	m	1.22	m	4.25E-01	76.1	7.61	0.06
Copper	36.85		0.0013		21.4	m	26.36	m	1.65E+00	12.1	4.05	0.4
Iron	51,886		0.164		11,400	m	243.4	m	7.14E+02	790.5	109.3	7
Lead	47.71		0.0005	m	10.1	m	0.7364	m	6.45E-01	3.3	1.63	0.4
Manganese	1,016		0.0692		1,460	m	887.8	m	9.34E+01	1790	179	0.5
Mercury	0.204		0		0.13	m	0		7.21E-03	0.9	0.45	0.02
Molybdenum	0		0.0006		1.3	m	1.976	m	1.02E-01	35.3	3.5	0.03
Nickel	45.88		0.0011	m	10.6	m	5.039	m	7.42E-01	67.1	6.71	0.1
Selenium	0		0		6	m	0		3.11E-01	0.579	0.29	1
Silver	0		0		0.039	m	0.01532	m	2.29E-03	20.2	2.02	0.001
Strontium	27.56		0.0919		22.4	m	37.56	m	1.88E+00	624	312	0.006
Thallium	0		0		0.19	m	0		9.85E-03	3.5	0.35	0.03
Vanadium	89.27		0.0015	m	18.4	m	0.3117	m	1.16E+00	3.44	0.344	3
Zinc	307.8		0		240	m	60.48	m	1.42E+01	661	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-4
Screening Risk Characterization for the Killdeer
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	70,028		0.167		10,700	m	2.73E+03	109.7	25
Antimony	2.52	m	0		0.18	m	6.72E-02	18	0.004
Arsenic	28.62		0.001		10.4	m	2.03E+00	2.24	0.9
Barium	133.4		0.0331		87.6	m	1.54E+01	20.8	0.7
Beryllium	2.525		0.0005	m	0.62	m	1.34E-01	0.532	0.3
Boron	50.23		0.0164		7.4	m	1.92E+00	28	0.07
Cadmium	0		0		1.7	m	2.58E-01	1.47	0.2
Chromium	69.36		0.0004	m	12.1	m	2.94E+00	2.66	1
Cobalt	13.27		0		7.2	m	1.30E+00	7.61	0.2
Copper	36.85		0.0013		21.4	m	3.84E+00	4.05	0.9
Iron	51,886		0.164		11,400	m	2.55E+03	109.3	23
Lead	47.71		0.0005	m	10.1	m	2.29E+00	1.63	1
Manganese	1,016		0.0692		1,460	m	2.38E+02	179	1
Mercury	0.204		0		0.13	m	2.30E-02	0.45	0.05
Molybdenum	0		0.0006		1.3	m	1.98E-01	3.5	0.06
Nickel	45.88		0.0011	m	10.6	m	2.34E+00	6.71	0.3
Selenium	0		0		6	m	9.12E-01	0.29	3
Silver	0		0		0.039	m	5.93E-03	2.02	0.003
Strontium	27.56		0.0919		22.4	m	3.85E+00	312	0.01
Thallium	0		0		0.19	m	2.89E-02	0.35	0.08
Vanadium	89.27		0.0015	m	18.4	m	4.21E+00	0.344	12
Zinc	307.8		0		240	m	4.13E+01	66.1	0.6

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-5
Screening Risk Characterization for the Heron
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	70,028		0.167		10,700	m	3,074	m	2.20E+02	109.7	2
Antimony	2.52	m	0		0.18	m	0.107	m	7.49E-03	18	0.0004
Arsenic	28.62		0.00097		10.4	m	5.116	m	3.09E-01	2.24	0.1
Barium	133.4		0.0331		87.6	m	43.26	m	2.55E+00	20.8	0.1
Beryllium	2.525		0.00048	m	0.62	m	0.2698	m	1.70E-02	0.532	0.03
Boron	50.23		0.0164		7.4	m	2.372	m	1.68E-01	28	0.006
Cadmium	0		0		1.7	m	0.09	m	6.85E-03	1.47	0.005
Chromium	69.36		0.00043	m	12.1	m	4.651	m	3.08E-01	2.66	0.1
Cobalt	13.27		0		7.2	m	2.047	m	1.28E-01	7.61	0.02
Copper	36.85		0.00134		21.4	m	14.75	m	8.55E-01	4.05	0.2
Iron	51,886		0.164		11,400	m	1,395	m	1.19E+02	109.3	1
Lead	47.71		0.00047	m	10.1	m	3.209	m	2.14E-01	1.63	0.1
Manganese	1,016		0.0692		1,460	m	326.7	m	2.02E+01	179	0.1
Mercury	0.204		0		0.13	m	0.1475	m	8.36E-03	0.45	0.02
Molybdenum	0		0.00055		1.3	m	0.1814	m	1.14E-02	3.5	0.003
Nickel	45.88		0.00113	m	10.6	m	12.44	m	7.21E-01	6.71	0.1
Selenium	0		0		6	m	3.442	m	1.96E-01	0.29	0.7
Silver	0		0		0.039	m	0.0386	m	2.16E-03	2.02	0.001
Strontium	27.56		0.0919		22.4	m	46.54	m	2.60E+00	312	0.008
Thallium	0		0		0.19	m	0		2.13E-04	0.35	0.0006
Vanadium	89.27		0.00153	m	18.4	m	6.977	m	4.54E-01	0.344	1
Zinc	307.8		0		240	m	130.9	m	7.63E+00	66.1	0.1

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-6
Screening Risk Characterization for the Osprey
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.167		3,074	m	1.90E+02	109.7	2
Antimony	0		0.107	m	6.60E-03	18	0.0004
Arsenic	0.000971		5.116	m	3.16E-01	2.24	0.1
Barium	0.0331		43.26	m	2.67E+00	20.8	0.1
Beryllium	0.00048	m	0.2698	m	1.67E-02	0.532	0.03
Boron	0.0164		2.372	m	1.47E-01	28	0.005
Cadmium	0		0.09	m	5.55E-03	1.47	0.004
Chromium	0.00043	m	4.651	m	2.87E-01	2.66	0.1
Cobalt	0		2.047	m	1.26E-01	7.61	0.02
Copper	0.00134		14.75	m	9.10E-01	4.05	0.2
Iron	0.164		1,395	m	8.61E+01	109.3	0.8
Lead	0.00047	m	3.209	m	1.98E-01	1.63	0.1
Manganese	0.0692		326.7	m	2.02E+01	179	0.1
Mercury	0		0.1475	m	9.10E-03	0.45	0.02
Molybdenum	0.0005513		0.1814	m	1.12E-02	3.5	0.003
Nickel	0.00113	m	12.44	m	7.68E-01	6.71	0.1
Selenium	0		3.442	m	2.12E-01	0.29	0.7
Silver	0		0.0386	m	2.38E-03	2.02	0.001
Strontium	0.0919		46.54	m	2.88E+00	312	0.009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00153	m	6.977	m	4.31E-01	0.344	1
Zinc	0		130.9	m	8.08E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-7
Screening Risk Characterization for the Muskrat
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	70,028		0.167		223.4	m	3.60E+02	1.93	190
Antimony	2.52	m	0		0		1.25E-02	0.059	0.2
Arsenic	28.62		0.001		0.1344	m	1.49E-01	1.04	0.1
Barium	133.4		0.0331		49.19	m	3.27E+00	51.8	0.06
Beryllium	2.525		0.0005	m	0		1.26E-02	0.532	0.02
Boron	50.23		0.0164		16.94	m	1.15E+00	28.8	0.04
Cadmium	0		0		0.125	m	6.61E-03	0.77	0.009
Chromium	69.36		0.0004	m	1.317	m	4.14E-01	2.4	0.2
Cobalt	13.27		0		1.22	m	1.30E-01	7.33	0.02
Copper	36.85		0.0013		26.36	m	1.58E+00	5.6	0.3
Iron	51,886		0.164		243.4	m	2.71E+02	22.8	12
Lead	47.71		0.0005	m	0.7364	m	2.76E-01	4.7	0.06
Manganese	1,016		0.0692		887.8	m	5.20E+01	51.5	1
Mercury	0.204		0		0		1.01E-03	1	0.001
Molybdenum	0		0.0006		1.976	m	1.05E-01	0.26	0.4
Nickel	45.88		0.0011	m	5.039	m	4.94E-01	1.7	0.3
Selenium	0		0		0		0.00E+00	0.143	--
Silver	0		0		0.01532	m	8.10E-04	6.02	0.0001
Strontium	27.56		0.0919		37.56	m	2.13E+00	263	0.008
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	89.27		0.0015	m	0.3117	m	4.60E-01	4.16	0.1
Zinc	307.8		0		60.48	m	4.73E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-8
Screening Risk Characterization for the Raccoon
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	70,028		0.167		10,700	m	223.4	m	3,074	m	3.92E+02	1.93	200
Antimony	2.52	m	0		0.18	m	0		0.107	m	1.11E-02	0.059	0.2
Arsenic	28.62		0.00097		10.4	m	0.1344	m	5.116	m	2.49E-01	1.04	0.2
Barium	133.4		0.0331		87.6	m	49.19	m	43.26	m	2.74E+00	51.8	0.05
Beryllium	2.525		0.00048	m	0.62	m	0		0.2698	m	1.75E-02	0.532	0.03
Boron	50.23		0.0164		7.4	m	16.94	m	2.372	m	6.27E-01	28.8	0.02
Cadmium	0		0		1.7	m	0.125	m	0.09	m	2.64E-02	0.77	0.03
Chromium	69.36		0.00043	m	12.1	m	1.317	m	4.651	m	4.34E-01	2.4	0.2
Cobalt	13.27		0		7.2	m	1.22	m	2.047	m	1.72E-01	7.33	0.02
Copper	36.85		0.00134		21.4	m	26.36	m	14.75	m	9.84E-01	5.6	0.2
Iron	51,886		0.164		11,400	m	243.4	m	1,395	m	3.40E+02	22.8	15
Lead	47.71		0.00047	m	10.1	m	0.7364	m	3.209	m	3.20E-01	4.7	0.07
Manganese	1,016		0.0692		1,460	m	887.8	m	326.7	m	4.25E+01	51.5	0.8
Mercury	0.204		0		0.13	m	0		0.1475	m	2.66E-03	1	0.003
Molybdenum	0		0.00055		1.3	m	1.976	m	0.1814	m	5.93E-02	0.26	0.2
Nickel	45.88		0.00113	m	10.6	m	5.039	m	12.44	m	4.20E-01	1.7	0.2
Selenium	0		0		6	m	0		3.442	m	8.73E-02	0.143	0.6
Silver	0		0		0.039	m	0.01532	m	0.0386	m	9.03E-04	6.02	0.0001
Strontium	27.56		0.0919		22.4	m	37.56	m	46.54	m	1.24E+00	263	0.005
Thallium	0		0		0.19	m	0		0		2.65E-03	0.015	0.2
Vanadium	89.27		0.00153	m	18.4	m	0.3117	m	6.977	m	5.70E-01	4.16	0.1
Zinc	307.8		0		240	m	60.48	m	130.9	m	5.77E+00	75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-9
Screening Risk Characterization for the Mink
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Amphibian Frogs (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics															
Aluminum	70,028		0.167		10,700	m	223.4	m	3,074	m	56.6		2.63E+02	1.93	140
Antimony	2.52	m	0		0.18	m	0		0.107	m	0		8.18E-03	0.059	0.1
Arsenic	28.62		0.001		10.4	m	0.1344	m	5.116	m	0.8164	m	3.04E-01	1.04	0.3
Barium	133.4		0.0331		87.6	m	49.19	m	43.26	m	78.98		2.78E+00	51.8	0.05
Beryllium	2.525		0.0005	m	0.62	m	0		0.2698	m	0		1.75E-02	0.532	0.03
Boron	50.23		0.0164		7.4	m	16.94	m	2.372	m	0		2.77E-01	28.8	0.01
Cadmium	0		0		1.7	m	0.125	m	0.09	m	0.143		1.37E-02	0.77	0.02
Chromium	69.36		0.0004	m	12.1	m	1.317	m	4.651	m	0		3.42E-01	2.4	0.1
Cobalt	13.27		0		7.2	m	1.22	m	2.047	m	0.228		1.45E-01	7.33	0.02
Copper	36.85		0.0013		21.4	m	26.36	m	14.75	m	18.35		9.28E-01	5.6	0.2
Iron	51,886		0.164		11,400	m	243.4	m	1,395	m	237.9		1.77E+02	22.8	8
Lead	47.71		0.0005	m	10.1	m	0.7364	m	3.209	m	0.7493	m	2.45E-01	4.7	0.05
Manganese	1,016		0.0692		1,460	m	887.8	m	326.7	m	88.97		2.71E+01	51.5	0.5
Mercury	0.204		0		0.13	m	0		0.1475	m	0.13		7.31E-03	1	0.007
Molybdenum	0		0.0006		1.3	m	1.976	m	0.1814	m	0.32		2.47E-02	0.26	0.09
Nickel	45.88		0.0011	m	10.6	m	5.039	m	12.44	m	0		6.55E-01	1.7	0.4
Selenium	0		0		6	m	0		3.442	m	2.066		1.80E-01	0.143	1
Silver	0		0		0.039	m	0.01532	m	0.0386	m	0.038		1.96E-03	6.02	0.0003
Strontium	27.56		0.0919		22.4	m	37.56	m	46.54	m	77.81		2.41E+00	263	0.009
Thallium	0		0		0.19	m	0		0		0.34	m	1.48E-03	0.015	0.1
Vanadium	89.27		0.0015	m	18.4	m	0.3117	m	6.977	m	0		4.90E-01	4.16	0.1
Zinc	307.8		0		240	m	60.48	m	130.9	m	145		7.62E+00	75.4	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-10
Screening Risk Characterization for the Tree Swallow
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.167		0		3.55E-02	109.7	0.0003
Antimony	0		0		0.00E+00	18	--
Arsenic	0.000971		0.16		3.96E-02	2.24	0.02
Barium	0.0331		0.731		1.87E-01	20.8	0.009
Beryllium	0.00048	m	0		1.02E-04	0.532	0.0002
Boron	0.0164		0.66	m	1.66E-01	28	0.006
Cadmium	0		0.277		6.83E-02	1.47	0.05
Chromium	0.00043	m	0.216		5.33E-02	2.66	0.02
Cobalt	0		0.963		2.37E-01	7.61	0.03
Copper	0.00134		22.94		5.65E+00	4.05	1
Iron	0.164		151.8		3.74E+01	109.3	0.3
Lead	0.00047	m	0		1.00E-04	1.63	0.00006
Manganese	0.0692		3.436		8.61E-01	179	0.005
Mercury	0		0.0467		1.15E-02	0.45	0.03
Molybdenum	0.0005513		0.544		1.34E-01	3.5	0.04
Nickel	0.00113	m	0		2.40E-04	6.71	0.00004
Selenium	0		4.11		1.01E+00	0.29	3
Silver	0		0.0169		4.16E-03	2.02	0.002
Strontium	0.0919		0.862		2.32E-01	312	0.0007
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00153	m	0.168		4.17E-02	0.344	0.1
Zinc	0		154		3.79E+01	66.1	0.6

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-11
Screening Risk Characterization for the Gray Bat
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.167		0		2.63E-02	1.93	0.01
Antimony	0		0		0.00E+00	0.059	--
Arsenic	0.00097102		0.16		2.92E-02	1.04	0.03
Barium	0.0331		0.731		1.38E-01	51.8	0.003
Beryllium	0.00048	m	0		7.57E-05	0.532	0.0001
Boron	0.0164		0.66	m	1.22E-01	28.8	0.004
Cadmium	0		0.277		5.03E-02	0.77	0.07
Chromium	0.00043	m	0.216		3.93E-02	2.4	0.02
Cobalt	0		0.963		1.75E-01	7.33	0.02
Copper	0.00134		22.94		4.16E+00	5.6	0.7
Iron	0.164		151.8		2.76E+01	22.8	1
Lead	0.00047	m	0		7.41E-05	4.7	0.00002
Manganese	0.0692		3.436		6.35E-01	51.5	0.01
Mercury	0		0.0467		8.48E-03	1	0.008
Molybdenum	0.00055125		0.544		9.88E-02	0.26	0.4
Nickel	0.00113	m	0		1.78E-04	1.7	0.0001
Selenium	0		4.11		7.46E-01	0.143	5
Silver	0		0.0169		3.07E-03	6.02	0.0005
Strontium	0.0919		0.862		1.71E-01	263	0.0007
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00153	m	0.168		3.07E-02	4.16	0.007
Zinc	0		154		2.80E+01	75.4	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_B-12
Screening Risk Characterization Results Summary
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**4**	**7**	**25**	**2**	**2**	**190**	**200**	**140**	0.0003	0.01
Antimony	0.0005	0.0008	0.004	0.0004	0.0004	0.2	0.2	0.1	--	--
Arsenic	0.2	0.3	0.9	0.1	0.1	0.1	0.2	0.3	0.02	0.03
Barium	0.3	0.3	0.7	0.1	0.1	0.06	0.05	0.05	0.009	0.003
Beryllium	0.04	0.07	0.3	0.03	0.03	0.02	0.03	0.03	0.0002	0.0001
Boron	0.04	0.03	0.07	0.006	0.005	0.04	0.02	0.01	0.006	0.004
Cadmium	0.04	0.06	0.2	0.005	0.004	0.009	0.03	0.02	0.05	0.07
Chromium	0.2	0.3	1	0.1	0.1	0.2	0.2	0.1	0.02	0.02
Cobalt	0.04	0.06	0.2	0.02	0.02	0.02	0.02	0.02	0.03	0.02
Copper	0.5	0.4	0.9	0.2	0.2	0.3	0.2	0.2	1	0.7
Iron	**4**	**7**	**23**	1	0.8	**12**	**15**	**8**	0.3	1
Lead	0.2	0.4	1	0.1	0.1	0.06	0.07	0.05	0.00006	0.00002
Manganese	0.5	0.5	1	0.1	0.1	1	0.8	0.5	0.005	0.01
Mercury	0.009	0.02	0.05	0.02	0.02	0.001	0.003	0.007	0.03	0.008
Molybdenum	0.04	0.03	0.06	0.003	0.003	0.4	0.2	0.09	0.04	0.4
Nickel	0.1	0.1	0.3	0.1	0.1	0.3	0.2	0.4	0.00004	0.0001
Selenium	0.6	1	**3**	0.7	0.7	--	0.6	1	**3**	**5**
Silver	0.0009	0.001	0.003	0.001	0.001	0.0001	0.0001	0.0003	0.002	0.0005
Strontium	0.009	0.006	0.01	0.008	0.009	0.008	0.005	0.009	0.0007	0.0007
Thallium	0.01	0.03	0.08	0.0006	--	--	0.2	0.1	--	--
Vanadium	**2**	**3**	**12**	1	1	0.1	0.1	0.1	0.1	0.007
Zinc	0.2	0.2	0.6	0.1	0.1	0.06	0.08	0.1	0.6	0.4

Hazard quotients greater than one are in bold.

Table 4-TR_R-1
Data Summaries
Risk Characterization
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water					Invertebrates												
												Larval Mayfly (Whole Body)						Adult Mayfly						
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)				
Inorganics																								
Aluminum	5/5	2480	-	14800	14800	m	8 / 8	0.0781	-	0.206	0.152		3/3	6710	-	9420	9420	m	3/9	6.2	-	7.7	7.7	m
Antimony	0/5	0	-	0	0		0 / 8	0	-	0	0		3/3	0.08	-	0.1	0.1	m	1/9	0.03	-	0.03	0.03	m
Arsenic	4/5	1.83	-	5.4	5.4	m	8 / 8	0.00036	-	0.0012	0.0009		3/3	4.4	-	6	6	m	9/9	0.09	-	0.26	0.21	
Barium	5/5	22.6	-	90.4	90.4	m	8 / 8	0.0248	-	0.0371	0.0335		3/3	58.1	-	87	87	m	9/9	0.78	-	1.4	1.15	
Beryllium	1/5	0.769	-	0.769	0.769	m	0 / 8	0	-	0	0		3/3	0.29	-	0.4	0.4	m	0/9	0	-	0	0	
Boron	0/5	0	-	0	0		5 / 8	0.014	-	0.017	0.0166		3/3	2.2	-	3.4	3.4	m	8/9	0.69	-	1.5	1.15	
Cadmium	0/5	0	-	0	0		0 / 8	0	-	0	0		3/3	1.1	-	1.3	1.3	m	9/9	0.25	-	0.42	0.36	
Chromium	5/5	3.21	-	13.8	13.8	m	1 / 8	0.00038	-	0.0004	0.0004	m	3/3	7.5	-	10.6	10.6	m	9/9	0.22	-	0.28	0.25	
Cobalt	5/5	2.15	-	10.5	10.5	m	0 / 8	0	-	0	0		3/3	4.4	-	6	6	m	9/9	0.77	-	1.2	1.08	
Copper	5/5	4.03	-	6.83	6.83	m	8 / 8	0.0005	-	0.0013	0.001		3/3	12	-	15	15	m	9/9	13.8	-	27.1	25.1	
Iron	5/5	3210	-	18500	18500	m	8 / 8	0.116	-	0.199	0.169		3/3	8290	-	12000	12000	m	9/9	92.2	-	182	169	
Lead	5/5	3.15	-	10.4	10.4	m	0 / 8	0	-	0	0		3/3	8.3	-	12.1	12.1	m	1/9	0.11	-	0.11	0.11	m
Manganese	5/5	29.9	-	689	689	m	8 / 8	0.0494	-	0.0766	0.0653		3/3	861	-	1540	1540	m	9/9	2	-	6.7	4.7	
Mercury	0/5	0	-	0	0		0 / 8	0	-	0	0		3/3	0.05	-	0.066	0.066	m	9/9	0.02	-	0.04	0.03	
Molybdenum	0/5	0	-	0	0		5 / 8	0.00039	-	0.0007	0.0006		3/3	0.51	-	0.69	0.69	m	9/9	0.33	-	0.47	0.44	
Nickel	5/5	3.42	-	14.7	14.7	m	5 / 8	0.00035	-	0.0006	0.0005		3/3	5.7	-	8	8	m	1/9	0.15	-	0.15	0.15	m
Selenium	0/5	0	-	0	0		2 / 8	0.00033	-	0.0005	0.0005	m	3/3	4	-	4.8	4.8	m	9/9	1.5	-	2	1.92	
Silver	0/5	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		9/9	0.03	-	0.07	0.06	
Strontium	3/5	5.31	-	16.3	16.3	m	8 / 8	0.0671	-	0.109	0.0968		3/3	7.2	-	8.9	8.9	m	9/9	0.58	-	1.3	1.04	
Thallium	0/5	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		0/9	0	-	0	0	
Vanadium	5/5	4.05	-	26.3	26.3	m	2 / 8	0.001	-	0.0012	0.0012	m	3/3	10.7	-	15.1	15.1	m	9/9	0.1	-	0.14	0.12	
Zinc	5/5	15	-	54.1	54.1	m	0 / 8	0	-	0	0		3/3	211	-	214	214	m	9/9	94.4	-	216	166	

Table 4-TR_R-1
Data Summaries
Risk Characterization
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	26.4	-	506.8	507	m	6/6	101.7	-	645	645	m	9/48	38.1	-	219.1	51.4	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Arsenic	2/6	0.23	-	0.5285	0.53	m	6/6	1.8	-	2.1	2.1	m	7/48	0.25	-	0.3904	0.27	
Barium	6/6	10.5	-	44.59	44.6	m	6/6	10.68	-	21.5	21.5	m	48/48	24	-	148.1	66.5	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Boron	6/6	12.6	-	55.93	55.9	m	0/6	0	-	0	0		0/48	0	-	0	0	
Cadmium	2/6	0.03	-	0.1382	0.14	m	6/6	0.04054	-	0.06	0.06	m	6/48	0.08	-	0.2155	0.1	
Chromium	0/6	0	-	0	0		3/6	0.87	-	2	2	m	1/48	29.7	-	29.74	29.7	m
Cobalt	5/6	0.07	-	0.6341	0.63	m	6/6	0.312	-	0.6	0.6	m	39/48	0.13	-	0.6548	0.32	
Copper	6/6	5.78	-	11.86	11.9	m	6/6	4	-	10	10	m	48/48	4.64	-	46.37	17.6	
Iron	6/6	49.7	-	478	478	m	6/6	166.7	-	712	712	m	45/48	107	-	419.7	229	
Lead	4/6	0.11	-	0.7881	0.79	m	6/6	0.2564	-	1.1	1.1	m	7/48	0.58	-	3.177	3.18	m
Manganese	6/6	67.9	-	400.8	401	m	6/6	117.5	-	203	203	m	48/48	23.9	-	189.7	83.2	
Mercury	0/6	0	-	0	0		3/6	0.066	-	0.11	0.11	m	1/48	0.09	-	0.0931	0.09	m
Molybdenum	6/6	0.28	-	1.429	1.43	m	0/6	0	-	0	0		3/48	0.28	-	0.4217	0.42	m
Nickel	6/6	0.58	-	5.07	5.07	m	3/6	0.61	-	4.4	4.4	m	0/48	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2.432	-	3.5	3.5	m	48/48	0.86	-	3.103	1.53	
Silver	0/6	0	-	0	0		1/6	0.01441	-	0.01	0.01	m	9/48	0.02	-	0.0854	0.03	
Strontium	6/6	11.3	-	58.68	58.7	m	6/6	32.91	-	58.6	58.6	m	48/48	18	-	99.28	55.1	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Vanadium	3/6	0.39	-	1.017	1.02	m	6/6	0.3718	-	1.5	1.5	m	1/48	1.68	-	1.677	1.68	m
Zinc	6/6	30.7	-	80.49	80.5	m	6/6	82.5	-	109	109	m	48/48	87.8	-	311	146	

EPC Exposure point concentrations;
the lower of the maximum (m) and the Upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 4-TR_R-2
Screening Risk Characterization for the Wood Duck
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0.152		9,420	m	506.8	m	3.08E+02	109.7	3
Antimony	0		0		0.1	m	0		2.71E-03	18	0.0002
Arsenic	5.4	m	0.0009		6	m	0.5285	m	2.01E-01	2.24	0.09
Barium	90.4	m	0.0335		87	m	44.59	m	4.97E+00	20.8	0.2
Beryllium	0.769	m	0		0.4	m	0		1.21E-02	0.532	0.02
Boron	0		0.0166		3.4	m	55.93	m	3.17E+00	28	0.1
Cadmium	0		0		1.3	m	0.1382	m	4.29E-02	1.47	0.03
Chromium	13.8	m	0.0004	m	10.6	m	0		3.10E-01	2.66	0.1
Cobalt	10.5	m	0		6	m	0.6341	m	2.15E-01	7.61	0.03
Copper	6.83	m	0.001		15	m	11.86	m	1.07E+00	4.05	0.3
Iron	18,500	m	0.169		12,000	m	478	m	3.82E+02	109.3	3
Lead	10.4	m	0		12.1	m	0.7881	m	3.89E-01	1.63	0.2
Manganese	689	m	0.0653		1,540	m	400.8	m	6.50E+01	179	0.4
Mercury	0		0		0.066	m	0		1.79E-03	0.45	0.004
Molybdenum	0		0.0006		0.69	m	1.429	m	9.75E-02	3.5	0.03
Nickel	14.7	m	0.0005		8	m	5.07	m	5.21E-01	6.71	0.08
Selenium	0		0.0005	m	4.8	m	0		1.30E-01	0.29	0.4
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	16.3	m	0.0968		8.9	m	58.68	m	3.51E+00	312	0.01
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0.0012	m	15.1	m	1.017	m	5.09E-01	0.344	1
Zinc	54.1	m	0		214	m	80.49	m	1.03E+01	66.1	0.2

mg/kg	Milligrams per kilogram.
mg/L	Milligrams per liter.
mg/kg-BW-day	Milligrams per kilogram of body weight each day.
NOAEL	No observed adverse effect level.
WB	Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-3
Screening Risk Characterization for the Mallard Duck
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0.152		9,420	m	506.8	m	5.31E+02	109.7	5
Antimony	0		0		0.1	m	0		5.19E-03	18	0.0003
Arsenic	5.4	m	0.0009		6	m	0.5285	m	3.33E-01	2.24	0.1
Barium	90.4	m	0.0335		87	m	44.59	m	5.49E+00	20.8	0.3
Beryllium	0.769	m	0		0.4	m	0		2.25E-02	0.532	0.04
Boron	0		0.0166		3.4	m	55.93	m	1.14E+00	28	0.04
Cadmium	0		0		1.3	m	0.1382	m	6.98E-02	1.47	0.05
Chromium	13.8	m	0.0004	m	10.6	m	0		5.81E-01	2.66	0.2
Cobalt	10.5	m	0		6	m	0.6341	m	3.46E-01	7.61	0.05
Copper	6.83	m	0.001		15	m	11.86	m	9.99E-01	4.05	0.2
Iron	18,500	m	0.169		12,000	m	478	m	6.73E+02	109.3	6
Lead	10.4	m	0		12.1	m	0.7881	m	6.65E-01	1.63	0.4
Manganese	689	m	0.0653		1,540	m	400.8	m	8.84E+01	179	0.5
Mercury	0		0		0.066	m	0		3.42E-03	0.45	0.008
Molybdenum	0		0.0006		0.69	m	1.429	m	6.05E-02	3.5	0.02
Nickel	14.7	m	0.0005		8	m	5.07	m	5.36E-01	6.71	0.08
Selenium	0		0.0005	m	4.8	m	0		2.49E-01	0.29	0.9
Silver	0		0		0		0		0.00E+00	2.02	--
Strontium	16.3	m	0.0968		8.9	m	58.68	m	1.52E+00	312	0.005
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0.0012	m	15.1	m	1.017	m	8.61E-01	0.344	3
Zinc	54.1	m	0		214	m	80.49	m	1.26E+01	66.1	0.2

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-4
Screening Risk Characterization for the Killdeer
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	14,800	m	0.152		9,420	m	1.67E+03	109.7	15
Antimony	0		0		0.1	m	1.52E-02	18	0.0008
Arsenic	5.4	m	0.0009		6	m	9.97E-01	2.24	0.4
Barium	90.4	m	0.0335		87	m	1.47E+01	20.8	0.7
Beryllium	0.769	m	0		0.4	m	7.29E-02	0.532	0.1
Boron	0		0.0166		3.4	m	5.19E-01	28	0.02
Cadmium	0		0		1.3	m	1.98E-01	1.47	0.1
Chromium	13.8	m	0.0004	m	10.6	m	1.83E+00	2.66	0.7
Cobalt	10.5	m	0		6	m	1.08E+00	7.61	0.1
Copper	6.83	m	0.001		15	m	2.39E+00	4.05	0.6
Iron	18,500	m	0.169		12,000	m	2.12E+03	109.3	19
Lead	10.4	m	0		12.1	m	2.00E+00	1.63	1
Manganese	689	m	0.0653		1,540	m	2.45E+02	179	1
Mercury	0		0		0.066	m	1.00E-02	0.45	0.02
Molybdenum	0		0.0006		0.69	m	1.05E-01	3.5	0.03
Nickel	14.7	m	0.0005		8	m	1.45E+00	6.71	0.2
Selenium	0		0.0005	m	4.8	m	7.30E-01	0.29	3
Silver	0		0		0		0.00E+00	2.02	--
Strontium	16.3	m	0.0968		8.9	m	1.62E+00	312	0.005
Thallium	0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0.0012	m	15.1	m	2.71E+00	0.344	8
Zinc	54.1	m	0		214	m	3.34E+01	66.1	0.5

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-5
Screening Risk Characterization for the Heron
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics											
Aluminum	14,800	m	0.152		9,420	m	645	m	5.43E+01	109.7	0.5
Antimony	0		0		0.1	m	0		1.12E-04	18	0.000006
Arsenic	5.4	m	0.00088		6	m	2.1	m	1.25E-01	2.24	0.06
Barium	90.4	m	0.0335		87	m	21.5	m	1.33E+00	20.8	0.06
Beryllium	0.769	m	0		0.4	m	0		8.80E-04	0.532	0.002
Boron	0		0.0166		3.4	m	0		4.56E-03	28	0.0002
Cadmium	0		0		1.3	m	0.063	m	4.92E-03	1.47	0.003
Chromium	13.8	m	0.00038	m	10.6	m	2	m	1.30E-01	2.66	0.05
Cobalt	10.5	m	0		6	m	0.6	m	4.56E-02	7.61	0.006
Copper	6.83	m	0.00097		15	m	10	m	5.70E-01	4.05	0.1
Iron	18,500	m	0.169		12,000	m	712	m	6.29E+01	109.3	0.6
Lead	10.4	m	0		12.1	m	1.1	m	7.98E-02	1.63	0.05
Manganese	689	m	0.0653		1,540	m	203	m	1.33E+01	179	0.07
Mercury	0		0		0.066	m	0.11	m	6.12E-03	0.45	0.01
Molybdenum	0		0.00058		0.69	m	0		8.00E-04	3.5	0.0002
Nickel	14.7	m	0.00049		8	m	4.4	m	2.59E-01	6.71	0.04
Selenium	0		0.00045	m	4.8	m	3.5	m	1.98E-01	0.29	0.7
Silver	0		0		0		0.01441	m	7.92E-04	2.02	0.0004
Strontium	16.3	m	0.0968		8.9	m	58.56	m	3.24E+00	312	0.01
Thallium	0		0		0		0		0.00E+00	0.35	--
Vanadium	26.3	m	0.00122	m	15.1	m	1.5	m	1.14E-01	0.344	0.3
Zinc	54.1	m	0		214	m	109	m	6.26E+00	66.1	0.09

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-6
Screening Risk Characterization for the Osprey
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.152		645	m	3.98E+01	109.7	0.4
Antimony	0		0		0.00E+00	18	--
Arsenic	0.0008832		2.1	m	1.30E-01	2.24	0.06
Barium	0.0335		21.5	m	1.33E+00	20.8	0.06
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0166		0		8.28E-04	28	0.00003
Cadmium	0		0.063	m	3.89E-03	1.47	0.003
Chromium	0.00038	m	2	m	1.23E-01	2.66	0.05
Cobalt	0		0.6	m	3.70E-02	7.61	0.005
Copper	0.0009721		10	m	6.17E-01	4.05	0.2
Iron	0.169		712	m	4.39E+01	109.3	0.4
Lead	0		1.1	m	6.79E-02	1.63	0.04
Manganese	0.0653		203	m	1.25E+01	179	0.07
Mercury	0		0.11	m	6.79E-03	0.45	0.02
Molybdenum	0.00058		0		2.89E-05	3.5	0.000008
Nickel	0.0004938		4.4	m	2.72E-01	6.71	0.04
Selenium	0.00045	m	3.5	m	2.16E-01	0.29	0.7
Silver	0		0.01441	m	8.89E-04	2.02	0.0004
Strontium	0.0968		58.56	m	3.62E+00	312	0.01
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00122	m	1.5	m	9.26E-02	0.344	0.3
Zinc	0		109	m	6.73E+00	66.1	0.1

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-7
Screening Risk Characterization for the Muskrat
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics									
Aluminum	14,800	m	0.152		506.8	m	1.00E+02	1.93	52
Antimony	0		0		0		0.00E+00	0.059	--
Arsenic	5.4	m	0.0009		0.5285	m	5.49E-02	1.04	0.05
Barium	90.4	m	0.0335		44.59	m	2.81E+00	51.8	0.05
Beryllium	0.769	m	0		0		3.82E-03	0.532	0.007
Boron	0		0.0166		55.93	m	2.96E+00	28.8	0.1
Cadmium	0		0		0.1382	m	7.30E-03	0.77	0.009
Chromium	13.8	m	0.0004	m	0		6.86E-02	2.4	0.03
Cobalt	10.5	m	0		0.6341	m	8.57E-02	7.33	0.01
Copper	6.83	m	0.001		11.86	m	6.61E-01	5.6	0.1
Iron	18,500	m	0.169		478	m	1.17E+02	22.8	5
Lead	10.4	m	0		0.7881	m	9.33E-02	4.7	0.02
Manganese	689	m	0.0653		400.8	m	2.46E+01	51.5	0.5
Mercury	0		0		0		0.00E+00	1	--
Molybdenum	0		0.0006		1.429	m	7.56E-02	0.26	0.3
Nickel	14.7	m	0.0005		5.07	m	3.41E-01	1.7	0.2
Selenium	0		0.0005	m	0		4.38E-05	0.143	0.0003
Silver	0		0		0		0.00E+00	6.02	--
Strontium	16.3	m	0.0968		58.68	m	3.19E+00	263	0.01
Thallium	0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0.0012	m	1.017	m	1.85E-01	4.16	0.04
Zinc	54.1	m	0		80.49	m	4.52E+00	75.4	0.06

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-8
Screening Risk Characterization for the Raccoon
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics													
Aluminum	14,800	m	0.152		9,420	m	506.8	m	645	m	1.92E+02	1.93	100
Antimony	0		0		0.1	m	0		0		1.39E-03	0.059	0.02
Arsenic	5.4	m	0.00088		6	m	0.5285	m	2.1	m	1.15E-01	1.04	0.1
Barium	90.4	m	0.0335		87	m	44.59	m	21.5	m	2.47E+00	51.8	0.05
Beryllium	0.769	m	0		0.4	m	0		0		8.16E-03	0.532	0.02
Boron	0		0.0166		3.4	m	55.93	m	0		1.21E+00	28.8	0.04
Cadmium	0		0		1.3	m	0.1382	m	0.063	m	2.11E-02	0.77	0.03
Chromium	13.8	m	0.00038	m	10.6	m	0		2	m	1.96E-01	2.4	0.08
Cobalt	10.5	m	0		6	m	0.6341	m	0.6	m	1.33E-01	7.33	0.02
Copper	6.83	m	0.00097		15	m	11.86	m	10	m	4.89E-01	5.6	0.09
Iron	18,500	m	0.169		12,000	m	478	m	712	m	2.40E+02	22.8	11
Lead	10.4	m	0		12.1	m	0.7881	m	1.1	m	2.21E-01	4.7	0.05
Manganese	689	m	0.0653		1,540	m	400.8	m	203	m	3.23E+01	51.5	0.6
Mercury	0		0		0.066	m	0		0.11	m	1.04E-03	1	0.001
Molybdenum	0		0.00058		0.69	m	1.429	m	0		3.93E-02	0.26	0.2
Nickel	14.7	m	0.00049		8	m	5.07	m	4.4	m	2.71E-01	1.7	0.2
Selenium	0		0.00045	m	4.8	m	0		3.5	m	7.07E-02	0.143	0.5
Silver	0		0		0		0		0.01441	m	1.55E-05	6.02	0.000003
Strontium	16.3	m	0.0968		8.9	m	58.68	m	58.56	m	1.47E+00	263	0.006
Thallium	0		0		0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0.00122	m	15.1	m	1.017	m	1.5	m	3.22E-01	4.16	0.08
Zinc	54.1	m	0		214	m	80.49	m	109	m	4.95E+00	75.4	0.07

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-9
Screening Risk Characterization for the Mink
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate WB Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish WB Shad (mg/kg)		Amphibian Frogs (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics															
Aluminum	14,800	m	0.152		9,420	m	506.8	m	645	m	51.4		9.62E+01	1.93	50
Antimony	0		0		0.1	m	0		0		0		5.37E-04	0.059	0.009
Arsenic	5.4	m	0.0009		6	m	0.5285	m	2.1	m	0.268		1.30E-01	1.04	0.1
Barium	90.4	m	0.0335		87	m	44.59	m	21.5	m	66.51		1.78E+00	51.8	0.03
Beryllium	0.769	m	0		0.4	m	0		0		0		2.97E-03	0.532	0.006
Boron	0		0.0166		3.4	m	55.93	m	0		0		2.90E-01	28.8	0.01
Cadmium	0		0		1.3	m	0.1382	m	0.063	m	0.095		1.04E-02	0.77	0.01
Chromium	13.8	m	0.0004	m	10.6	m	0		2	m	29.74	m	1.96E-01	2.4	0.08
Cobalt	10.5	m	0		6	m	0.6341	m	0.6	m	0.324		7.23E-02	7.33	0.01
Copper	6.83	m	0.001		15	m	11.86	m	10	m	17.55		5.90E-01	5.6	0.1
Iron	18,500	m	0.169		12,000	m	478	m	712	m	229.3		1.17E+02	22.8	5
Lead	10.4	m	0		12.1	m	0.7881	m	1.1	m	3.177	m	1.31E-01	4.7	0.03
Manganese	689	m	0.0653		1,540	m	400.8	m	203	m	83.21		1.96E+01	51.5	0.4
Mercury	0		0		0.066	m	0		0.11	m	0.09309	m	5.12E-03	1	0.005
Molybdenum	0		0.0006		0.69	m	1.429	m	0		0.4217	m	1.12E-02	0.26	0.04
Nickel	14.7	m	0.0005		8	m	5.07	m	4.4	m	0		2.69E-01	1.7	0.2
Selenium	0		0.0005	m	4.8	m	0		3.5	m	1.534		1.75E-01	0.143	1
Silver	0		0		0		0		0.01441	m	0.031		6.49E-04	6.02	0.0001
Strontium	16.3	m	0.0968		8.9	m	58.68	m	58.56	m	55.11		2.90E+00	263	0.01
Thallium	0		0		0		0		0		0		0.00E+00	0.015	--
Vanadium	26.3	m	0.0012	m	15.1	m	1.017	m	1.5	m	1.677	m	1.80E-01	4.16	0.04
Zinc	54.1	m	0		214	m	80.49	m	109	m	146.2		6.39E+00	75.4	0.08

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.
WB Whole Body.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-10
Screening Risk Characterization for the Tree Swallow
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.152		7.7	m	1.93E+00	109.7	0.02
Antimony	0		0.025	m	6.16E-03	18	0.0003
Arsenic	0.0008832		0.209		5.17E-02	2.24	0.02
Barium	0.0335		1.154		2.91E-01	20.8	0.01
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0166		1.15		2.87E-01	28	0.01
Cadmium	0		0.363		8.94E-02	1.47	0.06
Chromium	0.00038	m	0.253		6.24E-02	2.66	0.02
Cobalt	0		1.08		2.66E-01	7.61	0.03
Copper	0.0009721		25.14		6.19E+00	4.05	2
Iron	0.169		168.7		4.16E+01	109.3	0.4
Lead	0		0.11	m	2.71E-02	1.63	0.02
Manganese	0.0653		4.697		1.17E+00	179	0.007
Mercury	0		0.0336		8.28E-03	0.45	0.02
Molybdenum	0.00058		0.435		1.07E-01	3.5	0.03
Nickel	0.0004938		0.15	m	3.71E-02	6.71	0.006
Selenium	0.00045	m	1.919		4.73E-01	0.29	2
Silver	0		0.0611		1.51E-02	2.02	0.007
Strontium	0.0968		1.038		2.76E-01	312	0.0009
Thallium	0		0		0.00E+00	0.35	--
Vanadium	0.00122	m	0.118		2.93E-02	0.344	0.09
Zinc	0		166.4		4.10E+01	66.1	0.6

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 6 for sources of avian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-11
Screening Risk Characterization for the Gray Bat
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value [c] NOAEL (mg/kg-BW-day)	Hazard Quotient (HQ) [d] NOAEL
Inorganics							
Aluminum	0.152		7.7	m	1.42E+00	1.93	0.7
Antimony	0		0.025	m	4.54E-03	0.059	0.08
Arsenic	0.00088324		0.209		3.81E-02	1.04	0.04
Barium	0.0335		1.154		2.15E-01	51.8	0.004
Beryllium	0		0		0.00E+00	0.532	--
Boron	0.0166		1.15		2.11E-01	28.8	0.007
Cadmium	0		0.363		6.59E-02	0.77	0.09
Chromium	0.00038	m	0.253		4.60E-02	2.4	0.02
Cobalt	0		1.08		1.96E-01	7.33	0.03
Copper	0.00097212		25.14		4.56E+00	5.6	0.8
Iron	0.169		168.7		3.06E+01	22.8	1
Lead	0		0.11	m	2.00E-02	4.7	0.004
Manganese	0.0653		4.697		8.63E-01	51.5	0.02
Mercury	0		0.0336		6.10E-03	1	0.006
Molybdenum	0.00058		0.435		7.90E-02	0.26	0.3
Nickel	0.00049375		0.15	m	2.73E-02	1.7	0.02
Selenium	0.00045	m	1.919		3.48E-01	0.143	2
Silver	0		0.0611		1.11E-02	6.02	0.002
Strontium	0.0968		1.038		2.04E-01	263	0.0008
Thallium	0		0		0.00E+00	0.015	--
Vanadium	0.00122	m	0.118		2.16E-02	4.16	0.005
Zinc	0		166.4		3.02E+01	75.4	0.4

mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No observed adverse effect level.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate screening dietary ingestion and Table 2 for receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-TR_R-12
Screening Risk Characterization Results Summary
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Hazard Quotient (HQ)									
	Aquatic- and Riparian- Feeding Birds					Aquatic- and Riparian- Feeding Mammals			Aerial Feeding Insectivores	
Constituent	**Wood Duck**	**Mallard Duck**	**Killdeer**	**Heron**	**Osprey**	**Muskrat**	**Raccoon**	**Mink**	**Tree Swallow**	**Gray Bat**
Aluminum	**3**	**5**	**15**	0.5	0.4	**52**	**100**	**50**	0.02	0.7
Antimony	0.0002	0.0003	0.0008	0.000006	--	--	0.02	0.009	0.0003	0.08
Arsenic	0.09	0.1	0.4	0.06	0.06	0.05	0.1	0.1	0.02	0.04
Barium	0.2	0.3	0.7	0.06	0.06	0.05	0.05	0.03	0.01	0.004
Beryllium	0.02	0.04	0.1	0.002	--	0.007	0.02	0.006	--	--
Boron	0.1	0.04	0.02	0.0002	0.00003	0.1	0.04	0.01	0.01	0.007
Cadmium	0.03	0.05	0.1	0.003	0.003	0.009	0.03	0.01	0.06	0.09
Chromium	0.1	0.2	0.7	0.05	0.05	0.03	0.08	0.08	0.02	0.02
Cobalt	0.03	0.05	0.1	0.006	0.005	0.01	0.02	0.01	0.03	0.03
Copper	0.3	0.2	0.6	0.1	0.2	0.1	0.09	0.1	**2**	0.8
Iron	**3**	**6**	**19**	0.6	0.4	**5**	**11**	**5**	0.4	1
Lead	0.2	0.4	1	0.05	0.04	0.02	0.05	0.03	0.02	0.004
Manganese	0.4	0.5	1	0.07	0.07	0.5	0.6	0.4	0.007	0.02
Mercury	0.004	0.008	0.02	0.01	0.02	--	0.001	0.005	0.02	0.006
Molybdenum	0.03	0.02	0.03	0.0002	0.000008	0.3	0.2	0.04	0.03	0.3
Nickel	0.08	0.08	0.2	0.04	0.04	0.2	0.2	0.2	0.006	0.02
Selenium	0.4	0.9	**3**	0.7	0.7	0.0003	0.5	1	**2**	**2**
Silver	--	--	--	0.0004	0.0004	--	0.000003	0.0001	0.007	0.002
Strontium	0.01	0.005	0.005	0.01	0.01	0.01	0.006	0.01	0.0009	0.0008
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	1	**3**	**8**	0.3	0.3	0.04	0.08	0.04	0.09	0.005
Zinc	0.2	0.2	0.5	0.09	0.1	0.06	0.07	0.08	0.6	0.4

Hazard quotients greater than one are in bold.

Table 4-Legacy Constituents-1
Exposure Point Concentrations
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Whole Body Gizzard Shad							
	Data Summary							
	FOD	n	Minimum (mg/kg)	Maximum (mg/kg)	Location of Maximum	UCL (mg/kg)	EPC (mg/kg)	
Whole System								
Dieldrin	1/15	15	0.02251	0.02251	CR_R(CRM8.0)	NA	0.0225	m
Heptachlor Epoxide	5/15	15	0.0137	0.02162	CR_R(CRM8.0)	0.016	0.016	
Total Chlordane	15/15	15	0.03009	0.05454	CR_R(CRM8.0)	0.0452	0.0452	
Total Detects Chlordane	15/15	15	0.01852	0.05454	CR_R(CRM8.0)	0.0446	0.0446	
Total DDX	15/15	15	0.06357	0.07389	ER_B(ERM2.5)	0.0692	0.0692	
Total Detects DDX	1/15	15	0.02477	0.02477	ER_C(ERM4.5)	NA	0.0248	m
Total PCBs	15/15	15	1.4833	5.6553	ER_B(ERM2.5)	2.47	2.47	
Total detects PCBs	13/15	15	0.2498	1.1982	ER_C(ERM4.5)	0.586	0.586	

DDX Dichlorodiphenyltrichloroethane (DDT) and derivatives.
EPC Exposure point concentrations. The lower of the maximum and the UCL.
FOD Frequency of Detection.
mg/kg Milligrams per kilogram.
n Number of samples.
PCB Polychlorinated Biphenyl.
UCL Upper confidence limit on the mean.

Total: Includes non-detected results at the sample detection limit.

Table 4-Legacy Constituents-2
Risk Characterization for the Mink
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration in Fish [a] (mg/kg)		Dietary Ingestion [b] (mg/kg-day)	Toxicity Reference Value (TRV) [c] NOAEL (mg/kg-day)	Hazard Quotient [d] NOAEL
Whole System					
Dieldrin	2.25E-02	m	1.21E-03	0.015	0.08
Heptachlor Epoxide	1.60E-02		8.59E-04	0.1	0.009
Total Chlordane	4.52E-02		2.43E-03	4.58	0.0005
Total Detects Chlordane	4.46E-02		2.39E-03	4.58	0.0005
Total DDX	6.92E-02		3.72E-03	0.147	0.03
Total Detects DDX	2.48E-02	m	1.33E-03	0.147	0.009
Total PCBs	2.47E+00		1.33E-01	0.36	0.4
Total detects PCBs	5.86E-01		3.15E-02	0.36	0.09

DDX Dichlorodiphenyltrichloroethane (DDT) and derivatives.
mg/kg Milligrams per kilogram.
mg/kg-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effect Level.
PCB Polychlorinated Biphenyl.

[a] Exposure point concentrations were set equal to the lesser of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate dietary ingestion. And Table 2 for average ingestion rates and body weights. Receptor diet was assumed to be 100% fish.

[c] See Table 7 for sources of mammalian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-Legacy Constituents-3
Risk Characterization for the Heron
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration in Fish [a] (mg/kg)		Dietary Ingestion [b] (mg/kg-day)	Toxicity Reference Value (TRV) [c] NOAEL (mg/kg-day)	Hazard Quotient [d] NOAEL
Whole System					
Dieldrin	2.25E-02	m	1.26E-03	0.0709	0.02
Heptachlor Epoxide	1.60E-02		8.97E-04	NA	--
Total Chlordane	4.52E-02		2.53E-03	2.14	0.001
Total Detects Chlordane	4.46E-02		2.50E-03	2.14	0.001
Total DDX	6.92E-02		3.88E-03	0.227	0.02
Total Detects DDX	2.48E-02	m	1.39E-03	0.227	0.006
Total PCBs	2.47E+00		1.38E-01	0.09	2
Total detects PCBs	5.86E-01		3.29E-02	0.09	0.4

DDX Dichlorodiphenyltrichloroethane (DDT) and derivatives.
mg/kg Milligrams per kilogram.
mg/kg-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effect Level.
PCB Polychlorinated Biphenyl.

[a] Exposure point concentrations were set equal to the lesser of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate dietary ingestion. And Table 2 for average ingestion rates and body weights. Receptor diet was assumed to be 100% fish.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 4-Legacy Constituents-4
Risk Characterization for the Osprey
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration in Fish [a] (mg/kg)		Dietary Ingestion [b] (mg/kg-day)	Toxicity Reference Value (TRV) [c] NOAEL (mg/kg-day)	Hazard Quotient [d] NOAEL
Whole System					
Dieldrin	2.25E-02	m	1.39E-03	0.0709	0.02
Heptachlor Epoxide	1.60E-02		9.87E-04	NA	--
Total Chlordane	4.52E-02		2.79E-03	2.14	0.001
Total Detects Chlordane	4.46E-02		2.75E-03	2.14	0.001
Total DDX	6.92E-02		4.27E-03	0.227	0.02
Total Detects DDX	2.48E-02	m	1.53E-03	0.227	0.007
Total PCBs	2.47E+00		1.52E-01	0.09	2
Total detects PCBs	5.86E-01		3.62E-02	0.09	0.4

DDX Dichlorodiphenyltrichloroethane (DDT) and derivatives.
mg/kg Milligrams per kilogram.
mg/kg-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effect Level.
PCB Polychlorinated Biphenyl.

[a] Exposure point concentrations were set equal to the lesser of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate dietary ingestion. And Table 2 for average ingestion rates and body weights. Receptor diet was assumed to be 100% fish.

[c] See Table 6 for sources of avian toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Attachment 5

Refined Deterministic Risk Characterization Models per Reach and Receptor

Table 5-ER_A-1
Data Summaries
Risk Characterization
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water						Invertebrates															
													Larval Mayfly						Adult Mayfly									
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC					
Constituent				(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)						
Inorganics																												
Aluminum	12/12	13800	-	76500	40823		14 / 16	0.0809	-	0.255	0.149		3/3	7540	-	8540	8540	m	6/18	3.9	-	17.6	6.57					
Antimony	4/12	1.27	-	1.8	1.8	m	1 / 16	0.00042	-	0.0004	0.0004	m	3/3	0.26	-	0.53	0.53	m	1/18	0.02	-	0.02	0.02	m				
Arsenic	12/12	5.02	-	32.3	18.72		16 / 16	0.00053	-	0.0025	0.0017		3/3	33.5	-	97	97	m	18/18	0.23	-	0.41	0.3					
Barium	12/12	84.5	-	245	169.8		16 / 16	0.0344	-	0.0487	0.0428		3/3	91.3	-	140	140	m	18/18	0.71	-	1.7	1.36					
Beryllium	11/12	0.59	-	2.19	1.52		0 / 16	0	-	0	0		3/3	0.77	-	0.96	0.96	m	0/18	0	-	0	0					
Boron	12/12	6.01	-	88	35.39		16 / 16	0.0143	-	0.0298	0.0224		3/3	5.4	-	8.7	8.7	m	18/18	0.42	-	3.3	1.38					
Cadmium	0/12	0	-	0	0		0 / 16	0	-	0	0		3/3	0.24	-	1.1	1.1	m	18/18	0.03	-	0.24	0.15					
Chromium	12/12	15.2	-	86	49.16		8 / 16	0.00037	-	0.0027	0.0008		3/3	10.8	-	12	12	m	9/18	0.13	-	0.29	0.22					
Cobalt	12/12	7.74	-	46.6	24.88		0 / 16	0	-	0	0		3/3	7.4	-	8.1	8.1	m	18/18	0.54	-	0.91	0.81					
Copper	12/12	6.08	-	31.7	22.06		16 / 16	0.00058	-	0.0021	0.0017		3/3	19.5	-	21.2	21.2	m	18/18	10.6	-	26.7	21.7					
Iron	12/12	13300	-	48200	39267		16 / 16	0.0776	-	0.22	0.121		3/3	8760	-	11600	11600	m	18/18	93.4	-	196	165					
Lead	12/12	12.5	-	126	67.89		1 / 16	0.00036	-	0.0004	0.0004	m	3/3	8.6	-	10.3	10.3	m	0/18	0	-	0	0					
Manganese	12/12	289	-	2910	1511		16 / 16	0.021	-	0.0393	0.0316		3/3	482	-	535	535	m	18/18	1.9	-	6.4	3.44					
Mercury	6/12	0.058	-	0.13	0.0865		2 / 16	0.00016	-	0.0002	0.0002	m	3/3	0.095	-	0.14	0.14	m	18/18	0.04	-	0.07	0.05					
Molybdenum	0/12	0	-	0	0		14 / 16	0.00054	-	0.0015	0.0011		3/3	1.6	-	2.9	2.9	m	18/18	0.33	-	0.85	0.68					
Nickel	12/12	7.42	-	40.6	25.41		16 / 16	0.00035	-	0.0007	0.0006		3/3	12.4	-	13.3	13.3	m	1/18	0.1	-	0.1	0.1	m				
Selenium	3/12	1.89	-	3.05	3.05	m	7 / 16	0.00035	-	0.0009	0.0005		3/3	6.3	-	11.9	11.9	m	18/18	5.6	-	8.2	7.35					
Silver	0/12	0	-	0	0		0 / 16	0	-	0	0		0/3	0	-	0	0		18/18	0.01	-	0.02	0.01					
Strontium	12/12	9.94	-	149	102.2		16 / 16	0.109	-	0.126	0.119		3/3	27.5	-	57.2	57.2	m	18/18	0.63	-	1.2	0.97					
Thallium	0/12	0	-	0	0		0 / 16	0	-	0	0		3/3	0.23	-	0.56	0.56	m	0/18	0	-	0	0					
Vanadium	12/12	24.2	-	80.1	55.44		10 / 16	0.0011	-	0.003	0.0021		3/3	19.1	-	25.5	25.5	m	18/18	0.07	-	0.2	0.17					
Zinc	12/12	27.3	-	132	74.73		2 / 16	0.00993	-	0.0137	0.0137	m	3/3	137	-	155	155	m	18/18	87.6	-	220	160					

Table 5-ER_A-1
Data Summaries
Risk Characterization
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	35.3	-	200.8	201	m	3/3	1670	-	1970	1970	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		0/3	0	-	0	0		0/40	0	-	0	0	
Arsenic	0/6	0	-	0	0		3/3	2	-	2.1	2.1	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	25.6	-	39.74	39.7	m	3/3	30	-	32	32	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		0/3	0	-	0	0		0/40	0	-	0	0	
Boron	6/6	9.69	-	60	60	m	1/3	1.9	-	1.9	1.9	m	0/40	0	-	0	0	
Cadmium	0/6	0	-	0	0		0/3	0	-	0	0		17/40	0.09	-	0.3406	0.14	
Chromium	1/6	0.46	-	0.4592	0.46	m	3/3	3.5	-	5.9	5.9	m	0/40	0	-	0	0	
Cobalt	6/6	0.09	-	0.5528	0.55	m	3/3	1.5	-	1.7	1.7	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	5.36	-	9.398	9.4	m	3/3	5.5	-	6	6	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	66.9	-	265.3	265	m	3/3	1610	-	2020	2020	m	34/40	99.1	-	532.7	238	
Lead	2/6	0.09	-	0.1224	0.12	m	3/3	1.7	-	2	2	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	48.5	-	333.8	334	m	3/3	144	-	149	149	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		3/3	0.061	-	0.1	0.1	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	5/6	0.58	-	1.282	1.28	m	0/3	0	-	0	0		7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.83	-	2.161	2.16	m	3/3	2.1	-	2.4	2.4	m	0/40	0	-	0	0	
Selenium	1/6	0.53	-	0.531	0.53	m	3/3	1.9	-	2.7	2.7	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		0/3	0	-	0	0		8/40	0.03	-	0.0927	0.04	
Strontium	6/6	27.1	-	69.23	69.2	m	3/3	47.6	-	52.6	52.6	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/3	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.28	-	0.2806	0.28	m	3/3	2.7	-	3.1	3.1	m	0/40	0	-	0	0	
Zinc	5/6	19.9	-	39.1	39.1	m	3/3	86.8	-	91.5	91.5	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-ER_A-2
Refined Risk Characterization for the Wood Duck
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	40,823	0.149	8,540	m	200.8	m	6.04E+01	386.5	109.7	0.2	0.6
Iron	39,267	0.121	11,600	m	265.3	m	2.65E+01	790.5	109.3	0.03	0.2
Vanadium	55.44	0.0021	25.5	m	0.2806	m	7.10E-01	13	8	0.05	0.09

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-3
Refined Risk Characterization for the Mallard Duck
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	NOAEL
Inorganics												
Aluminum	40,823		0.149	8,540	m	200.8	m	9.73E+01	386.5	109.7	0.3	0.9
Arsenic	18.72		0.0017	97	m	0		5.07E+00	13	5	0.4	1
Iron	39,267		0.121	11,600	m	265.3	m	4.38E+01	790.5	109.3	0.06	0.4
Selenium	3.05	m	0.0005	11.9	m	0.531	m	6.33E-01	0.8	0.4	0.8	2
Vanadium	55.44		0.0021	25.5	m	0.2806	m	1.33E+00	13	8	0.1	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-4
Refined Risk Characterization for the Killdeer
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	40,823		0.149		8,540	m	2.79E+02	386.5	109.7	0.7	3
Arsenic	18.72		0.0017		97	m	1.50E+01	13	5	1	3
Iron	39,267		0.121		11,600	m	1.48E+02	790.5	109.3	0.2	1
Lead	67.89		0.0004	m	10.3	m	1.62E+00	3.3	1.63	0.5	1
Selenium	3.05	m	0.0005		11.9	m	1.86E+00	0.8	0.4	2	5
Vanadium	55.44		0.0021		25.5	m	3.90E+00	13	8	0.3	0.5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-5
Refined Risk Characterization for the Heron
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	40,823	0.149	8,540	m	1,970	m	3.56E+01	386.5	109.7	0.09	0.3
Iron	39,267	0.121	11,600	m	2,020	m	4.03E+01	790.5	109.3	0.05	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-6
Refined Risk Characterization for the Osprey
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.149	1,970	m	3.75E+01	386.5	109.7	0.1	0.3
Iron	0.121	2,020	m	4.28E+01	790.5	109.3	0.05	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-7
Refined Risk Characterization for the Muskrat
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	40,823	0.149	200.8	m	1.30E+01	212.6	17	0.06	0.8
Iron	39,267	0.121	265.3	m	1.49E+01	31.6	22.8	0.5	0.7
Manganese	1,511	0.0316	333.8	m	2.33E+01	271	162	0.09	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-8
Refined Risk Characterization for the Raccoon
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	40,823	0.149	8,540	m	200.8	m	1,970	m	3.14E+01	212.6	17	0.1	2
Iron	39,267	0.121	11,600	m	265.3	m	2,020	m	2.01E+01	31.6	22.8	0.6	0.9

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-9
Refined Risk Characterization for the Mink
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics														
Aluminum	40,823	0.149	8,540	m	200.8	m	1,970	m	56.6	3.68E+01	212.6	17	0.2	2
Iron	39,267	0.121	11,600	m	265.3	m	2,020	m	237.9	3.63E+01	31.6	22.8	1	2

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-10
Refined Risk Characterization for the Tree Swallow
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Copper	0.00168	21.67	5.34E+00	12.1	4.05	0.4	1
Selenium	0.00048313	7.349	1.81E+00	0.8	0.4	2	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-11
Refined Risk Characterization for the Gray Bat
Emory River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Aluminum	0.149	6.567	2.73E-01	212.6	17	0.001	0.02
Copper	0.00168	21.67	3.93E+00	9.34	5.6	0.4	0.7
Selenium	0.00048313	7.349	1.33E+00	0.215	0.143	6	9

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_A-12
Refined Risk Characterization Results Summary
Emory River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.6	0.3	0.9	0.7	**3**	0.09	0.3	0.1	0.3
Arsenic	--	--	0.4	1	1	**3**	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.2	0.06	0.4	0.2	1	0.05	0.4	0.05	0.4
Lead	--	--	--	--	0.5	1	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.8	**2**	**2**	**5**	--	--	--	--
Vanadium	0.05	0.09	0.1	0.2	0.3	0.5	--	--	--	--

NA Not Applicable.

Table 5-ER_A-12
Refined Risk Characterization Results Summary
Emory River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.06	0.8	0.1	**2**	0.2	**2**	--	--	0.001	0.02
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.4	1	0.4	0.7
Iron	0.5	0.7	0.6	0.9	1	**2**	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.09	0.1	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	**2**	**5**	**6**	**9**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-ER_B-1
Data Summaries
Risk Characterization
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates											
											Larval Mayfly					Adult Mayfly						
	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)					(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																						
Aluminum	18/18	3320	-	39400	21792	13 / 16	0.124	-	0.319	0.231	3/3	9050	-	10300	10300	m	11/18	4.3	-	27.1	9.38	
Antimony	2/18	1.39	-	2.26	2.26	m	0 / 16	0	-	0	0	3/3	0.2	-	0.22	0.22	m	2/18	0.017	-	0.044	0.04	m
Arsenic	17/18	3.15	-	62.4	31.33	16 / 16	0.00134	-	0.0028	0.0022	3/3	13.1	-	17.6	17.6	m	18/18	0.35	-	0.62	0.5	
Barium	18/18	20.4	-	478	193.2	16 / 16	0.0374	-	0.054	0.0492	3/3	84.9	-	93	93	m	18/18	0.91	-	1.8	1.52	
Beryllium	15/18	0.656	-	3.52	1.417	0 / 16	0	-	0	0	3/3	0.74	-	0.88	0.88	m	0/18	0	-	0	0	
Boron	12/18	5.31	-	51.8	20.81	16 / 16	0.0158	-	0.027	0.0225	2/3	5	-	5.4	5.4	m	18/18	0.48	-	2.3	1.5	
Cadmium	0/18	0	-	0	0	0 / 16	0	-	0	0	3/3	0.45	-	0.68	0.68	m	18/18	0.015	-	0.15	0.09	
Chromium	18/18	5.27	-	42.4	27.62	4 / 16	0.00033	-	0.0005	0.0005	m	3/3	10.9	-	12.4	12.4	m	18/18	0.14	-	0.23	0.19	
Cobalt	18/18	2.59	-	38.1	18.42	0 / 16	0	-	0	0	3/3	8.9	-	9.8	9.8	m	18/18	0.37	-	0.79	0.66	
Copper	18/18	1.64	-	47.1	21.72	16 / 16	0.00065	-	0.0017	0.0013	3/3	17.8	-	19.4	19.4	m	18/18	12.3	-	27.7	20.9	
Iron	18/18	3420	-	40000	26649	15 / 16	0.121	-	0.251	0.193	3/3	10200	-	11400	11400	m	18/18	101	-	233	170	
Lead	18/18	3.06	-	79.5	31.51	8 / 16	0.00033	-	0.0004	0.0004	3/3	8.8	-	9.7	9.7	m	0/18	0	-	0	0	
Manganese	18/18	43.6	-	4120	1381	16 / 16	0.00825	-	0.101	0.0674	3/3	454	-	520	520	m	18/18	2	-	4.8	3.63	
Mercury	7/18	0.053	-	0.12	0.078	1 / 16	0.00019	-	0.0002	0.0002	m	3/3	0.076	-	0.078	0.078	m	18/18	0.025	-	0.037	0.03	
Molybdenum	0/18	0	-	0	0	14 / 16	0.00062	-	0.0013	0.001	3/3	1.2	-	1.4	1.4	m	18/18	0.34	-	1.4	0.88	
Nickel	18/18	4.2	-	54.7	25.82	16 / 16	0.00044	-	0.0009	0.0006	3/3	14.1	-	15.6	15.6	m	0/18	0	-	0	0	
Selenium	3/18	1.36	-	3.64	3.64	m	8 / 16	0.00033	-	0.0006	0.0004	3/3	6.6	-	7.2	7.2	m	18/18	6.5	-	8.4	7.83	
Silver	0/18	0	-	0	0	0 / 16	0	-	0	0	2/3	0.037	-	0.048	0.048	m	18/18	0.005	-	0.018	0.01	
Strontium	17/18	5.66	-	321	119.6	16 / 16	0.107	-	0.123	0.116	3/3	22.1	-	25	25	m	18/18	0.57	-	1.4	1.09	
Thallium	0/18	0	-	0	0	0 / 16	0	-	0	0	3/3	0.21	-	0.26	0.26	m	0/18	0	-	0	0	
Vanadium	18/18	5.08	-	78.6	39.47	15 / 16	0.00109	-	0.0022	0.0017	3/3	17.3	-	19.7	19.7	m	18/18	0.11	-	0.25	0.2	
Zinc	18/18	15.8	-	113	57.66	0 / 16	0	-	0	0	3/3	174	-	187	187	m	18/18	82.5	-	246	180	

Table 5-ER_B-1
Data Summaries
Risk Characterization
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	19	-	167.3	167	m	6/6	44.6	-	2590	2590	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		2/6	0.097	-	0.12	0.12	m	0/40	0	-	0	0	
Arsenic	6/6	0.1	-	1.077	1.08	m	6/6	2	-	4.3	4.3	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	22.9	-	54.09	54.1	m	6/6	13.43	-	43.4	43.4	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		2/6	0.16	-	0.25	0.25	m	0/40	0	-	0	0	
Boron	6/6	8.92	-	28.57	28.6	m	2/6	2.2	-	2.2	2.2	m	0/40	0	-	0	0	
Cadmium	3/6	0.05	-	0.2889	0.29	m	4/6	0.05556	-	0.11	0.11	m	17/40	0.09	-	0.3406	0.14	
Chromium	1/6	0.44	-	0.4377	0.44	m	3/6	3	-	4	4	m	0/40	0	-	0	0	
Cobalt	6/6	0.14	-	0.553	0.55	m	6/6	0.216	-	2.2	2.2	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	3.7	-	6.05	6.05	m	6/6	5.7	-	9.1	9.1	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	59.5	-	235.7	236	m	6/6	101.4	-	2480	2480	m	34/40	99.1	-	532.7	238	
Lead	4/6	0.11	-	0.2222	0.22	m	6/6	0.1481	-	2.8	2.8	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	268	-	883.7	884	m	6/6	122	-	218	218	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		3/6	0.08	-	0.09	0.09	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.61	-	1.429	1.43	m	3/6	0.16	-	0.26	0.26	m	7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.71	-	1.779	1.78	m	2/6	4.2	-	6.5	6.5	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2.2	-	3.95	3.95	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		3/6	0.019	-	0.02	0.02	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	11.8	-	35.94	35.9	m	6/6	37.4	-	47.6	47.6	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.31	-	0.3064	0.31	m	6/6	0.3194	-	6.3	6.3	m	0/40	0	-	0	0	
Zinc	5/6	28.3	-	55.16	55.2	m	6/6	74.7	-	139	139	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-ER_B-2
Refined Risk Characterization for the Wood Duck
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	21,792	0.231	10,300	m	167.3	m	6.82E+01	386.5	109.7	0.2	0.6
Iron	26,649	0.193	11,400	m	235.7	m	2.45E+01	790.5	109.3	0.03	0.2
Vanadium	39.47	0.0017	19.7	m	0.3064	m	5.53E-01	13	8	0.04	0.07

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-3
Refined Risk Characterization for the Mallard Duck
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	NOAEL
Inorganics												
Aluminum	21,792		0.231	10,300	m	167.3	m	1.15E+02	386.5	109.7	0.3	1
Arsenic	31.33		0.0022	17.6	m	1.077	m	1.00E+00	13	5	0.08	0.2
Iron	26,649		0.193	11,400	m	235.7	m	4.13E+01	790.5	109.3	0.05	0.4
Selenium	3.64	m	0.0004	7.2	m	0		3.82E-01	0.8	0.4	0.5	1
Vanadium	39.47		0.0017	19.7	m	0.3064	m	1.03E+00	13	8	0.08	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-4
Refined Risk Characterization for the Killdeer
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]					Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics										
Aluminum	21,792		0.231	10,300	m	3.32E+02	386.5	109.7	0.9	3
Arsenic	31.33		0.0022	17.6	m	3.17E+00	13	5	0.2	0.6
Iron	26,649		0.193	11,400	m	1.34E+02	790.5	109.3	0.2	1
Lead	31.51		0.0004	9.7	m	1.50E+00	3.3	1.63	0.5	0.9
Selenium	3.64	m	0.0004	7.2	m	1.15E+00	0.8	0.4	1	3
Vanadium	39.47		0.0017	19.7	m	3.01E+00	13	8	0.2	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-5
Refined Risk Characterization for the Heron
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	21,792	0.231	10,300	m	2,590	m	4.64E+01	386.5	109.7	0.1	0.4
Iron	26,649	0.193	11,400	m	2,480	m	4.85E+01	790.5	109.3	0.06	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-6
Refined Risk Characterization for the Osprey
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.231	2,590	m	4.93E+01	386.5	109.7	0.1	0.4
Iron	0.193	2,480	m	5.26E+01	790.5	109.3	0.07	0.5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-7
Refined Risk Characterization for the Muskrat
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	21,792	0.231	167.3	m	1.01E+01	212.6	17	0.05	0.6
Iron	26,649	0.193	235.7	m	1.07E+01	31.6	22.8	0.3	0.5
Manganese	1,381	0.0674	883.7	m	5.19E+01	271	162	0.2	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-8
Refined Risk Characterization for the Raccoon
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	21,792	0.231	10,300	m	167.3	m	2,590	m	3.53E+01	212.6	17	0.2	2
Iron	26,649	0.193	11,400	m	235.7	m	2,480	m	1.73E+01	31.6	22.8	0.5	0.8

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-9
Refined Risk Characterization for the Mink
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics														
Aluminum	21,792	0.231	10,300	m	167.3	m	2,590	m	56.6	4.64E+01	212.6	17	0.2	3
Iron	26,649	0.193	11,400	m	235.7	m	2,480	m	237.9	4.20E+01	31.6	22.8	1	2

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-10
Refined Risk Characterization for the Tree Swallow
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Copper	0.00125	20.94	5.16E+00	12.1	4.05	0.4	1
Selenium	0.00040471	7.83	1.93E+00	0.8	0.4	2	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-11
Refined Risk Characterization for the Gray Bat
Emory River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Aluminum	0.231	9.378	3.93E-01	212.6	17	0.002	0.02
Copper	0.00125	20.94	3.80E+00	9.34	5.6	0.4	0.7
Selenium	0.00040471	7.83	1.42E+00	0.215	0.143	7	10

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_B-12
Refined Risk Characterization Results Summary
Emory River: Reach B
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.6	0.3	1	0.9	**3**	0.1	0.4	0.1	0.4
Arsenic	--	--	0.08	0.2	0.2	0.6	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.2	0.05	0.4	0.2	1	0.06	0.4	0.07	0.5
Lead	--	--	--	--	0.5	0.9	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.5	1	1	**3**	--	--	--	--
Vanadium	0.04	0.07	0.08	0.1	0.2	0.4	--	--	--	--

NA Not Applicable.

Table 5-ER_B-12
Refined Risk Characterization Results Summary
Emory River: Reach B
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.05	0.6	0.2	**2**	0.2	**3**	--	--	0.002	0.02
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.4	1	0.4	0.7
Iron	0.3	0.5	0.5	0.8	1	**2**	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.2	0.3	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	**2**	**5**	**7**	**10**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-ER_C-1
Data Summaries
Risk Characterization
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water						Invertebrates															
													Larval Mayfly						Adult Mayfly									
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC					
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)								
Inorganics																												
Aluminum	10/10	1900	-	27100	16255		6 / 8	0.0816	-	0.339	0.218		3/3	5330	-	6340	6340	m	1/6	27.1	-	27.1	27.1	m				
Antimony	0/10	0	-	0	0		0 / 8	0	-	0	0		3/3	0.11	-	0.12	0.12	m	0/6	0	-	0	0					
Arsenic	7/10	1.79	-	5.17	3.285		8 / 8	0.00109	-	0.0026	0.0023		3/3	6.8	-	8.1	8.1	m	6/6	0.35	-	0.53	0.53	m				
Barium	10/10	17	-	447	239.2		8 / 8	0.0395	-	0.0544	0.0537		3/3	54.2	-	63	63	m	6/6	0.91	-	1.8	1.8	m				
Beryllium	3/10	0.541	-	1.09	1.09	m	0 / 8	0	-	0	0		3/3	0.4	-	0.5	0.5	m	0/6	0	-	0	0					
Boron	2/10	9.05	-	10.3	10.3	m	8 / 8	0.0166	-	0.0228	0.0216		3/3	2.8	-	3.3	3.3	m	6/6	0.48	-	1.2	1.2	m				
Cadmium	0/10	0	-	0	0		0 / 8	0	-	0	0		2/3	0.19	-	0.25	0.25	m	6/6	0.02	-	0.06	0.06	m				
Chromium	10/10	3.18	-	24.3	16.28		1 / 8	0.00047	-	0.0005	0.0005	m	3/3	6.2	-	7.2	7.2	m	6/6	0.14	-	0.18	0.18	m				
Cobalt	10/10	2.62	-	20.4	11.05		1 / 8	0.00046	-	0.0005	0.0005	m	3/3	5.1	-	6.1	6.1	m	6/6	0.37	-	0.41	0.41	m				
Copper	10/10	2	-	13.2	8.035		8 / 8	0.00055	-	0.001	0.0009		3/3	11.5	-	13.1	13.1	m	6/6	13.5	-	27.7	27.7	m				
Iron	10/10	3300	-	19100	12926		8 / 8	0.0971	-	0.316	0.227		3/3	6850	-	9220	9220	m	6/6	114	-	205	205	m				
Lead	10/10	2.45	-	14	8.905		1 / 8	0.00058	-	0.0006	0.0006	m	3/3	5.9	-	6.3	6.3	m	0/6	0	-	0	0					
Manganese	10/10	34.4	-	2940	1345		8 / 8	0.06	-	0.225	0.177		3/3	246	-	407	407	m	6/6	2	-	4.8	4.8	m				
Mercury	0/10	0	-	0	0		0 / 8	0	-	0	0		3/3	0.066	-	0.071	0.071	m	6/6	0.03	-	0.04	0.04	m				
Molybdenum	0/10	0	-	0	0		7 / 8	0.00082	-	0.0011	0.001		3/3	0.71	-	0.76	0.76	m	6/6	0.34	-	0.6	0.6	m				
Nickel	10/10	2.85	-	22.4	12.65		8 / 8	0.0005	-	0.0008	0.0007		3/3	8.3	-	9.6	9.6	m	0/6	0	-	0	0					
Selenium	0/10	0	-	0	0		0 / 8	0	-	0	0		3/3	3.8	-	5	5	m	6/6	6.5	-	7.5	7.5	m				
Silver	0/10	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		6/6	0.01	-	0.02	0.02	m				
Strontium	4/10	6.35	-	19.9	19.9	m	8 / 8	0.0964	-	0.111	0.111	m	3/3	11.8	-	12.7	12.7	m	6/6	0.57	-	1.4	1.4	m				
Thallium	0/10	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		0/6	0	-	0	0					
Vanadium	10/10	3.1	-	36.6	19.47		4 / 8	0.00111	-	0.0015	0.0015	m	3/3	9.5	-	10.7	10.7	m	6/6	0.12	-	0.17	0.17	m				
Zinc	10/10	12	-	84.8	50.19		0 / 8	0	-	0	0		3/3	153	-	217	217	m	6/6	82.5	-	246	246	m				

Table 5-ER_C-1
Data Summaries
Risk Characterization
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	31.8	-	440.1	440	m	5/6	25.66	-	573	573	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/40	0	-	0	0	
Arsenic	2/6	0.24	-	0.2687	0.27	m	6/6	1.1	-	1.81	1.81	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	19.2	-	76.17	76.2	m	6/6	10.55	-	16.7	16.7	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/40	0	-	0	0	
Boron	6/6	10	-	50.58	50.6	m	0/6	0	-	0	0		0/40	0	-	0	0	
Cadmium	3/6	0.15	-	0.3691	0.37	m	3/6	0.046	-	0.06	0.06	m	17/40	0.09	-	0.3406	0.14	
Chromium	0/6	0	-	0	0		3/6	1.5	-	2	2	m	0/40	0	-	0	0	
Cobalt	6/6	0.07	-	1.208	1.21	m	6/6	0.2064	-	0.65	0.65	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	4.07	-	7.558	7.56	m	6/6	4.2	-	7.52	7.52	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	57.1	-	645.3	645	m	6/6	79.36	-	714	714	m	34/40	99.1	-	532.7	238	
Lead	6/6	0.1	-	0.5756	0.58	m	5/6	0.1991	-	0.71	0.71	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	247	-	1591	1591	m	6/6	99.08	-	153	153	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		3/6	0.056	-	0.06	0.06	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.28	-	1.687	1.69	m	0/6	0	-	0	0		7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.87	-	2.175	2.18	m	3/6	0.84	-	1	1	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	1.8	-	3.21	3.21	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		1/6	0.012	-	0.01	0.01	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	12.2	-	50.58	50.6	m	6/6	28.9	-	33.9	33.9	m	40/40	34.9	-	132.2	77.8	
Thallium	1/6	0.06	-	0.0571	0.06	m	0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	5/6	0.13	-	0.7558	0.76	m	5/6	0.2566	-	1	1	m	0/40	0	-	0	0	
Zinc	5/6	36.3	-	57.05	57.1	m	6/6	73.9	-	97.3	97.3	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-ER_C-2
Refined Risk Characterization for the Wood Duck
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	16,255	0.218	6,340	m	440.1	m	6.06E+01	386.5	109.7	0.2	0.6
Iron	12,926	0.227	9,220	m	645.3	m	2.40E+01	790.5	109.3	0.03	0.2
Vanadium	19.47	0.0015 m	10.7	m	0.7558	m	3.33E-01	13	8	0.03	0.04

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-3
Refined Risk Characterization for the Mallard Duck
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)	Vegetation (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	16,255	0.218	6,340 m	440.1 m	7.69E+01	386.5	109.7	0.2	0.7
Arsenic	3.285	0.0023	8.1 m	0.2687 m	4.32E-01	13	5	0.03	0.09
Iron	12,926	0.227	9,220 m	645.3 m	3.37E+01	790.5	109.3	0.04	0.3
Selenium	0	0	5 m	0	2.59E-01	0.8	0.4	0.3	0.6
Vanadium	19.47	0.0015 m	10.7 m	0.7558 m	5.69E-01	13	8	0.04	0.07

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-4
Refined Risk Characterization for the Killdeer
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)				LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	16,255	0.218		6,340	m		2.05E+02	386.5	109.7	0.5	2
Arsenic	3.285	0.0023		8.1	m		1.28E+00	13	5	0.1	0.3
Iron	12,926	0.227		9,220	m		9.96E+01	790.5	109.3	0.1	0.9
Lead	8.905	0.0006	m	6.3	m		9.64E-01	3.3	1.63	0.3	0.6
Selenium	0	0		5	m		7.60E-01	0.8	0.4	0.9	2
Vanadium	19.47	0.0015	m	10.7	m		1.63E+00	13	8	0.1	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-5
Refined Risk Characterization for the Heron
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	16,255	0.218	6,340	m	573	m	1.13E+01	386.5	109.7	0.03	0.1
Iron	12,926	0.227	9,220	m	714	m	1.46E+01	790.5	109.3	0.02	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-6
Refined Risk Characterization for the Osprey
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.218	573	m	1.09E+01	386.5	109.7	0.03	0.1
Iron	0.227	714	m	1.51E+01	790.5	109.3	0.02	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-7
Refined Risk Characterization for the Muskrat
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	16,255	0.218	440.1	m	2.42E+01	212.6	17	0.1	1
Iron	12,926	0.227	645.3	m	1.08E+01	31.6	22.8	0.3	0.5
Manganese	1,345	0.177	1,591	m	8.91E+01	271	162	0.3	0.6

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-8
Refined Risk Characterization for the Raccoon
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics													
Aluminum	16,255	0.218	6,340	m	440.1	m	573	m	2.85E+01	212.6	17	0.1	2
Iron	12,926	0.227	9,220	m	645.3	m	714	m	1.36E+01	31.6	22.8	0.4	0.6

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-9
Refined Risk Characterization for the Mink
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics														
Aluminum	16,255	0.218	6,340	m	440.1	m	573	m	56.6	1.70E+01	212.6	17	0.08	1
Iron	12,926	0.227	9,220	m	645.3	m	714	m	237.9	1.52E+01	31.6	22.8	0.5	0.7

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-10
Refined Risk Characterization for the Tree Swallow
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Copper	0.00089991	27.7	m	6.83E+00	12.1	4.05	0.6	2
Selenium	0	7.5	m	1.85E+00	0.8	0.4	2	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-11
Refined Risk Characterization for the Gray Bat
Emory River: Reach C
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.218	27.1	m	1.06E+00	212.6	17	0.005	0.06
Copper	0.00089991	27.7	m	5.03E+00	9.34	5.6	0.5	0.9
Selenium	0	7.5	m	1.36E+00	0.215	0.143	6	10

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_C-12
Refined Risk Characterization Results Summary
Emory River: Reach C
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.6	0.2	0.7	0.5	**2**	0.03	0.1	0.03	0.1
Arsenic	--	--	0.03	0.09	0.1	0.3	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.2	0.04	0.3	0.1	0.9	0.02	0.1	0.02	0.1
Lead	--	--	--	--	0.3	0.6	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.3	0.6	0.9	**2**	--	--	--	--
Vanadium	0.03	0.04	0.04	0.07	0.1	0.2	--	--	--	--

NA Not Applicable.

Table 5-ER_C-12
Refined Risk Characterization Results Summary
Emory River: Reach C
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.1	1	0.1	**2**	0.08	1	--	--	0.005	0.06
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.6	**2**	0.5	0.9
Iron	0.3	0.5	0.4	0.6	0.5	0.7	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.3	0.6	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	**2**	**5**	**6**	**10**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-ER_R-1
Data Summaries
Risk Characterization
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water					Invertebrates											
												Larval Mayfly						Adult Mayfly					
	FOD	min		max	EPC		FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																							
Aluminum	5/5	2480	-	14800	14800	m	0 / 8	0	-	0	0	6/6	4090	-	6380	6380	m	1/6	5.2	-	5.2	5.2	m
Antimony	0/5	0	-	0	0		0 / 8	0	-	0	0	6/6	0.057	-	0.085	0.085	m	0/6	0	-	0	0	
Arsenic	4/5	1.83	-	5.4	5.4	m	8 / 8	0.00038	-	0.0013	0.0009	6/6	2.8	-	4.5	4.5	m	6/6	0.11	-	0.14	0.14	m
Barium	5/5	22.6	-	90.4	90.4	m	8 / 8	0.0454	-	0.0531	0.0505	6/6	43.2	-	58.6	58.6	m	6/6	0.54	-	0.68	0.68	m
Beryllium	1/5	0.769	-	0.769	0.769	m	0 / 8	0	-	0	0	6/6	0.19	-	0.29	0.29	m	0/6	0	-	0	0	
Boron	0/5	0	-	0	0		8 / 8	0.0172	-	0.0198	0.0189	6/6	2.5	-	4	4	m	6/6	0.44	-	0.77	0.77	m
Cadmium	0/5	0	-	0	0		0 / 8	0	-	0	0	6/6	0.35	-	2.4	2.4	m	6/6	0.3	-	0.4	0.4	m
Chromium	5/5	3.21	-	13.8	13.8	m	1 / 8	0.00041	-	0.0004	0.0004	m	6/6	4.5	-	6.8	6.8	m	1/6	12.7	-	12.7	12.7	m
Cobalt	5/5	2.15	-	10.5	10.5	m	0 / 8	0	-	0	0	6/6	4.1	-	7.2	7.2	m	6/6	0.76	-	0.82	0.82	m
Copper	5/5	4.03	-	6.83	6.83	m	7 / 8	0.00033	-	0.0007	0.0005	6/6	9.5	-	12.8	12.8	m	6/6	26.3	-	27.9	27.9	m
Iron	5/5	3210	-	18500	18500	m	8 / 8	0.0554	-	0.133	0.106	6/6	5930	-	8430	8430	m	6/6	177	-	185	185	m
Lead	5/5	3.15	-	10.4	10.4	m	0 / 8	0	-	0	0	6/6	4.5	-	6.8	6.8	m	0/6	0	-	0	0	
Manganese	5/5	29.9	-	689	689	m	8 / 8	0.0262	-	0.196	0.128	6/6	378	-	1380	1380	m	6/6	2	-	2.9	2.9	m
Mercury	0/5	0	-	0	0		1 / 8	0.00017	-	0.0002	0.0002	m	6/6	0.052	-	0.066	0.066	m	6/6	0.1	-	0.13	0.13	m
Molybdenum	0/5	0	-	0	0		8 / 8	0.00045	-	0.0009	0.0008	6/6	0.5	-	0.72	0.72	m	6/6	0.34	-	0.37	0.37	m
Nickel	5/5	3.42	-	14.7	14.7	m	7 / 8	0.0004	-	0.0007	0.0006	6/6	5.3	-	7.4	7.4	m	0/6	0	-	0	0	
Selenium	0/5	0	-	0	0		1 / 8	0.00038	-	0.0004	0.0004	m	6/6	2.6	-	4.2	4.2	m	6/6	3.7	-	4.1	4.1	m
Silver	0/5	0	-	0	0		0 / 8	0	-	0	0	6/6	0.03	-	0.16	0.16	m	6/6	0.02	-	0.03	0.03	m
Strontium	3/5	5.31	-	16.3	16.3	m	8 / 8	0.0824	-	0.107	0.102	6/6	4.5	-	6.7	6.7	m	6/6	0.58	-	0.74	0.74	m
Thallium	0/5	0	-	0	0		0 / 8	0	-	0	0	0/6	0	-	0	0		0/6	0	-	0	0	
Vanadium	5/5	4.05	-	26.3	26.3	m	0 / 8	0	-	0	0	6/6	6.7	-	9.4	9.4	m	6/6	0.12	-	0.14	0.14	m
Zinc	5/5	15	-	54.1	54.1	m	0 / 8	0	-	0	0	6/6	167	-	316	316	m	6/6	88	-	98.7	98.7	m

Table 5-ER_R-1
Data Summaries
Risk Characterization
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	37.3	-	955	955	m	6/6	706	-	1970	1970	m	9/48	38.1	-	219.1	51.4	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Arsenic	3/6	0.14	-	0.5	0.5	m	6/6	1.2	-	1.4	1.4	m	7/48	0.25	-	0.3904	0.27	
Barium	6/6	17.3	-	120.9	121	m	6/6	19.1	-	42.4	42.4	m	48/48	24	-	148.1	66.5	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Boron	6/6	6.52	-	57.81	57.8	m	0/6	0	-	0	0		0/48	0	-	0	0	
Cadmium	5/6	0.13	-	0.3859	0.39	m	3/6	0.066	-	0.29	0.29	m	6/48	0.08	-	0.2155	0.1	
Chromium	4/6	0.5	-	1.4	1.4	m	6/6	2.6	-	6.6	6.6	m	1/48	29.7	-	29.74	29.7	m
Cobalt	6/6	0.2	-	1.4	1.4	m	4/6	1.3	-	2.1	2.1	m	39/48	0.13	-	0.6548	0.32	
Copper	6/6	2.76	-	11.96	12	m	6/6	5	-	37.5	37.5	m	48/48	4.64	-	46.37	17.6	
Iron	6/6	71.8	-	1080	1080	m	6/6	1190	-	2960	2960	m	45/48	107	-	419.7	229	
Lead	5/6	0.23	-	1.016	1.02	m	5/6	1.6	-	3.7	3.7	m	7/48	0.58	-	3.177	3.18	m
Manganese	6/6	207	-	535	535	m	6/6	180	-	443	443	m	48/48	23.9	-	189.7	83.2	
Mercury	0/6	0	-	0	0		6/6	0.056	-	0.08	0.08	m	1/48	0.09	-	0.0931	0.09	m
Molybdenum	6/6	0.19	-	0.9375	0.94	m	0/6	0	-	0	0		3/48	0.28	-	0.4217	0.42	m
Nickel	6/6	1	-	3.828	3.83	m	6/6	2	-	32	32	m	0/48	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	1.9	-	2.6	2.6	m	48/48	0.86	-	3.103	1.53	
Silver	1/6	0.08	-	0.0761	0.08	m	3/6	0.012	-	0.02	0.02	m	9/48	0.02	-	0.0854	0.03	
Strontium	6/6	7.77	-	57.81	57.8	m	6/6	23.4	-	46.1	46.1	m	48/48	18	-	99.28	55.1	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Vanadium	4/6	0.29	-	1.6	1.6	m	5/6	1.8	-	3.8	3.8	m	1/48	1.68	-	1.677	1.68	m
Zinc	6/6	32.8	-	76.63	76.6	m	6/6	69.5	-	91.5	91.5	m	48/48	87.8	-	311	146	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-ER_R-2
Refined Risk Characterization for the Wood Duck
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]							Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics												
Aluminum	14,800	m	0	6,380	m	955	m	8.91E+01	386.5	109.7	0.2	0.8
Iron	18,500	m	0.106	8,430	m	1,080	m	2.80E+01	790.5	109.3	0.04	0.3
Vanadium	26.3	m	0	9.4	m	1.6	m	3.44E-01	13	8	0.03	0.04

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-3
Refined Risk Characterization for the Mallard Duck
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	NOAEL
Inorganics													
Aluminum	14,800	m	0		6,380	m	955	m	8.62E+01	386.5	109.7	0.2	0.8
Arsenic	5.4	m	0.0009		4.5	m	0.5	m	2.54E-01	13	5	0.02	0.05
Iron	18,500	m	0.106		8,430	m	1,080	m	3.35E+01	790.5	109.3	0.04	0.3
Selenium	0		0.0004	m	4.2	m	0		2.18E-01	0.8	0.4	0.3	0.5
Vanadium	26.3	m	0		9.4	m	1.6	m	5.17E-01	13	8	0.04	0.06

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-4
Refined Risk Characterization for the Killdeer
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics											
Aluminum	14,800	m	0		6,380	m	2.06E+02	386.5	109.7	0.5	2
Arsenic	5.4	m	0.0009		4.5	m	7.69E-01	13	5	0.06	0.2
Iron	18,500	m	0.106		8,430	m	9.76E+01	790.5	109.3	0.1	0.9
Lead	10.4	m	0		6.8	m	1.04E+00	3.3	1.63	0.3	0.6
Selenium	0		0.0004	m	4.2	m	6.38E-01	0.8	0.4	0.8	2
Vanadium	26.3	m	0		9.4	m	1.44E+00	13	8	0.1	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-5
Refined Risk Characterization for the Heron
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)				LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	14,800	m	0	6,380	m	1,970	m		3.50E+01	386.5	109.7	0.09	0.3
Iron	18,500	m	0.106	8,430	m	2,960	m		5.71E+01	790.5	109.3	0.07	0.5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-6
Refined Risk Characterization for the Osprey
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0	1,970	m	3.75E+01	386.5	109.7	0.1	0.3
Iron	0.106	2,960	m	6.27E+01	790.5	109.3	0.08	0.6

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-7
Refined Risk Characterization for the Muskrat
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics										
Aluminum	14,800	m	0	955	m	5.13E+01	212.6	17	0.2	3
Iron	18,500	m	0.106	1,080	m	1.71E+01	31.6	22.8	0.5	0.8
Manganese	689	m	0.128	535	m	3.09E+01	271	162	0.1	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-8
Refined Risk Characterization for the Raccoon
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	NOAEL
Inorganics														
Aluminum	14,800	m	0	6,380	m	955	m	1,970	m	3.96E+01	212.6	17	0.2	2
Iron	18,500	m	0.106	8,430	m	1,080	m	2,960	m	1.67E+01	31.6	22.8	0.5	0.7

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-9
Refined Risk Characterization for the Mink
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics															
Aluminum	14,800	m	0	6,380	m	955	m	1,970	m	51.4	3.76E+01	212.6	17	0.2	2
Iron	18,500	m	0.106	8,430	m	1,080	m	2,960	m	229.3	4.82E+01	31.6	22.8	2	2

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-10
Refined Risk Characterization for the Tree Swallow
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics									
Copper	0.00050124		27.9	m	6.87E+00	12.1	4.05	0.6	2
Selenium	0.00038	m	4.1	m	1.01E+00	0.8	0.4	1	3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-11
Refined Risk Characterization for the Gray Bat
Emory River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics									
Aluminum	0		5.2	m	1.98E-01	212.6	17	0.0009	0.01
Copper	0.00050124		27.9	m	5.06E+00	9.34	5.6	0.5	0.9
Selenium	0.00038	m	4.1	m	7.44E-01	0.215	0.143	3	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-ER_R-12
Refined Risk Characterization Results Summary
Emory River: Reach R
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.8	0.2	0.8	0.5	**2**	0.09	0.3	0.1	0.3
Arsenic	--	--	0.02	0.05	0.06	0.2	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.04	0.3	0.04	0.3	0.1	0.9	0.07	0.5	0.08	0.6
Lead	--	--	--	--	0.3	0.6	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.3	0.5	0.8	**2**	--	--	--	--
Vanadium	0.03	0.04	0.04	0.06	0.1	0.2	--	--	--	--

NA Not Applicable.

Table 5-ER_R-12
Refined Risk Characterization Results Summary
Emory River: Reach R
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	**3**	0.2	**2**	0.2	**2**	--	--	0.0009	0.01
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.6	**2**	0.5	0.9
Iron	0.5	0.8	0.5	0.7	**2**	**2**	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.1	0.2	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	1	**3**	**3**	**5**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-CR_A-1
Data Summaries
Risk Characterization
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates										
											Larval Mayfly					Adult Mayfly					
	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC	FOD	min		max	EPC	
Constituent		(mg/kg)					(mg/L)					(mg/kg)					(mg/kg)				
Inorganics																					
Aluminum	12/12	7370	-	143000	70028	7 / 8	0.0656	-	0.214	0.155	3/3	6930	-	10900	10900 m	0/6	0	-	0	0	
Antimony	3/12	1.32	-	2.52	2.52 m	0 / 8	0	-	0	0	3/3	0.19	-	0.27	0.27 m	0/6	0	-	0	0	
Arsenic	12/12	5.2	-	63.4	28.62	8 / 8	0.00084	-	0.0015	0.0013	3/3	12.6	-	14.6	14.6 m	6/6	0.16	-	0.26	0.26	m
Barium	12/12	50.7	-	190	133.4	8 / 8	0.0356	-	0.0442	0.0415	3/3	75.9	-	104	104 m	6/6	0.39	-	0.72	0.72	m
Beryllium	10/12	0.623	-	4.39	2.525	0 / 8	0	-	0	0	3/3	0.55	-	0.84	0.84 m	0/6	0	-	0	0	
Boron	12/12	8.63	-	60.5	50.23	8 / 8	0.0149	-	0.0267	0.0221	3/3	6.6	-	9	9 m	5/6	0.48	-	0.78	0.78	m
Cadmium	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	1.1	-	2.1	2.1 m	6/6	0.58	-	0.7	0.7	m
Chromium	12/12	14.8	-	125	69.36	2 / 8	0.00036	-	0.0005	0.0005 m	3/3	8.7	-	13.4	13.4 m	6/6	0.23	-	0.32	0.32	m
Cobalt	12/12	4.52	-	18	13.27	1 / 8	0.00033	-	0.0003	0.0003 m	3/3	5.7	-	8.3	8.3 m	6/6	0.82	-	1	1	m
Copper	12/12	5.52	-	90.4	36.85	8 / 8	0.00092	-	0.002	0.0016	3/3	18.6	-	23.4	23.4 m	6/6	17	-	27.5	27.5	m
Iron	12/12	14500	-	93800	51886	8 / 8	0.0678	-	0.15	0.117	3/3	7180	-	11900	11900 m	6/6	104	-	177	177	m
Lead	12/12	12.1	-	102	47.71	1 / 8	0.00037	-	0.0004	0.0004 m	3/3	6.7	-	10.5	10.5 m	0/6	0	-	0	0	
Manganese	12/12	160	-	1700	1016	8 / 8	0.025	-	0.0326	0.0311	3/3	733	-	959	959 m	6/6	1.8	-	3.7	3.7	m
Mercury	10/12	0.07	-	0.39	0.204	1 / 8	0.00023	-	0.0002	0.0002 m	3/3	0.27	-	0.31	0.31 m	6/6	0.04	-	0.06	0.06	m
Molybdenum	0/12	0	-	0	0	8 / 8	0.00053	-	0.001	0.0009	3/3	1.5	-	1.6	1.6 m	6/6	0.32	-	0.5	0.5	m
Nickel	12/12	3.24	-	135	45.88	7 / 8	0.00035	-	0.0008	0.0006	3/3	9.6	-	14.1	14.1 m	0/6	0	-	0	0	
Selenium	0/12	0	-	0	0	3 / 8	0.00036	-	0.0008	0.0008 m	3/3	6.5	-	6.6	6.6 m	6/6	5.2	-	6.7	6.7	m
Silver	0/12	0	-	0	0	0 / 8	0	-	0	0	3/3	0.05	-	0.08	0.08 m	6/6	0.01	-	0.01	0.01	m
Strontium	12/12	6.27	-	43.6	27.56	8 / 8	0.108	-	0.123	0.119	3/3	22.9	-	31	31 m	6/6	0.44	-	0.83	0.83	m
Thallium	0/12	0	-	0	0	0 / 8	0	-	0	0	0/3	0	-	0	0	0/6	0	-	0	0	
Vanadium	12/12	21.1	-	193	89.27	8 / 8	0.00102	-	0.002	0.0016	3/3	13.6	-	20.7	20.7 m	6/6	0.16	-	0.25	0.25	m
Zinc	12/12	27.5	-	460	307.8	0 / 8	0	-	0	0	3/3	175	-	194	194 m	6/6	80.1	-	205	205	m

Table 5-CR_A-1
Data Summaries
Risk Characterization
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	26.2	-	450.8	451	m	6/6	441	-	3074	3074	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		4/6	0.064	-	0.11	0.11	m	0/40	0	-	0	0	
Arsenic	4/6	0.2	-	0.7661	0.77	m	6/6	1.6	-	5.12	5.12	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	7.67	-	44.92	44.9	m	6/6	18.1	-	43.3	43.3	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		3/6	0.162	-	0.27	0.27	m	0/40	0	-	0	0	
Boron	6/6	8.83	-	67.01	67	m	2/6	1.982	-	2.37	2.37	m	0/40	0	-	0	0	
Cadmium	2/6	0.03	-	0.0518	0.05	m	6/6	0.0463	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	1/6	0.73	-	0.7254	0.73	m	5/6	1.6	-	4.65	4.65	m	0/40	0	-	0	0	
Cobalt	5/6	0.05	-	0.4404	0.44	m	6/6	0.47	-	2.05	2.05	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	5.3	-	11.11	11.1	m	6/6	5.4	-	14.8	14.8	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	54	-	435.2	435	m	6/6	448	-	1395	1395	m	34/40	99.1	-	532.7	238	
Lead	6/6	0.1	-	1.244	1.24	m	6/6	0.75	-	3.21	3.21	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	19.4	-	386.6	387	m	6/6	140	-	327	327	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		6/6	0.06	-	0.15	0.15	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.95	-	1.711	1.71	m	2/6	0.1613	-	0.18	0.18	m	7/40	0.29	-	0.4814	0.32	
Nickel	5/6	0.42	-	1.551	1.55	m	6/6	1.2	-	12.4	12.4	m	0/40	0	-	0	0	
Selenium	3/6	0.4	-	0.7487	0.75	m	6/6	2	-	3.44	3.44	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		5/6	0.014	-	0.04	0.04	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	12.3	-	55.61	55.6	m	6/6	37.3	-	46.5	46.5	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.83	-	0.829	0.83	m	6/6	1.1	-	6.98	6.98	m	0/40	0	-	0	0	
Zinc	6/6	29.3	-	53.8	53.8	m	6/6	73.7	-	131	131	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-CR_A-2
Refined Risk Characterization for the Wood Duck
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.155	10,900	m	450.8	m	8.81E+01	386.5	109.7	0.2	0.8
Iron	51,886	0.117	11,900	m	435.2	m	3.01E+01	790.5	109.3	0.04	0.3
Vanadium	89.27	0.0016	20.7	m	0.829	m	6.11E-01	13	8	0.05	0.08

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-3
Refined Risk Characterization for the Mallard Duck
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)	Vegetation (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	70,028	0.155	10,900 m	450.8 m	1.28E+02	386.5	109.7	0.3	1
Arsenic	28.62	0.0013	14.6 m	0.7661 m	8.36E-01	13	5	0.06	0.2
Iron	51,886	0.117	11,900 m	435.2 m	4.71E+01	790.5	109.3	0.06	0.4
Selenium	0	0.0008 m	6.6 m	0.7487 m	3.55E-01	0.8	0.4	0.4	0.9
Vanadium	89.27	0.0016	20.7 m	0.829 m	1.09E+00	13	8	0.08	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-4
Refined Risk Characterization for the Killdeer
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]					Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics										
Aluminum	70,028	0.155		10,900	m	3.60E+02	386.5	109.7	0.9	3
Arsenic	28.62	0.0013		14.6	m	2.67E+00	13	5	0.2	0.5
Iron	51,886	0.117		11,900	m	1.63E+02	790.5	109.3	0.2	1
Lead	47.71	0.0004	m	10.5	m	1.63E+00	3.3	1.63	0.5	1
Selenium	0	0.0008	m	6.6	m	1.00E+00	0.8	0.4	1	3
Vanadium	89.27	0.0016		20.7	m	3.18E+00	13	8	0.2	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-5
Refined Risk Characterization for the Heron
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.155	10,900	m	3,074	m	5.51E+01	386.5	109.7	0.1	0.5
Iron	51,886	0.117	11,900	m	1,395	m	2.90E+01	790.5	109.3	0.04	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-6
Refined Risk Characterization for the Osprey
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.155	3,074	m	5.85E+01	386.5	109.7	0.2	0.5
Iron	0.117	1,395	m	2.96E+01	790.5	109.3	0.04	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-7
Refined Risk Characterization for the Muskrat
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	70,028	0.155	450.8	m	2.79E+01	212.6	17	0.1	2
Iron	51,886	0.117	435.2	m	2.06E+01	31.6	22.8	0.7	0.9
Manganese	1,016	0.0311	386.6	m	2.42E+01	271	162	0.09	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-8
Refined Risk Characterization for the Raccoon
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	70,028	0.155	10,900	m	450.8	m	3,074	m	4.49E+01	212.6	17	0.2	3
Iron	51,886	0.117	11,900	m	435.2	m	1,395	m	2.34E+01	31.6	22.8	0.7	1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-9
Refined Risk Characterization for the Mink
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]									Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)		LOAEL	NOAEL	LOAEL	NOAEL
Inorganics														
Aluminum	70,028	0.155	10,900	m	450.8	m	3,074	m	56.6	5.53E+01	212.6	17	0.3	3
Iron	51,886	0.117	11,900	m	435.2	m	1,395	m	237.9	2.84E+01	31.6	22.8	0.9	1

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-10
Refined Risk Characterization for the Tree Swallow
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics									
Copper	0.00161		27.5	m	6.78E+00	12.1	4.05	0.6	2
Selenium	0.00076	m	6.7	m	1.65E+00	0.8	0.4	2	4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-11
Refined Risk Characterization for the Gray Bat
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics									
Aluminum	0.155		0		2.44E-02	212.6	17	0.0001	0.001
Copper	0.00161		27.5	m	4.99E+00	9.34	5.6	0.5	0.9
Selenium	0.00076	m	6.7	m	1.22E+00	0.215	0.143	6	9

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_A-12
Refined Risk Characterization Results Summary
Clinch River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.8	0.3	1	0.9	**3**	0.1	0.5	0.2	0.5
Arsenic	--	--	0.06	0.2	0.2	0.5	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.04	0.3	0.06	0.4	0.2	1	0.04	0.3	0.04	0.3
Lead	--	--	--	--	0.5	1	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.4	0.9	1	**3**	--	--	--	--
Vanadium	0.05	0.08	0.08	0.1	0.2	0.4	--	--	--	--

NA Not Applicable.

Table 5-CR_A-12
Refined Risk Characterization Results Summary
Clinch River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.1	**2**	0.2	**3**	0.3	**3**	--	--	0.0001	0.001
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.6	**2**	0.5	0.9
Iron	0.7	0.9	0.7	1	0.9	1	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.09	0.1	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	**2**	**4**	**6**	**9**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-CR_B-1
Data Summaries
Risk Characterization
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates										
											Larval Mayfly					Adult Mayfly					
	FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		
Constituent			(mg/kg)					(mg/L)					(mg/kg)					(mg/kg)			
Inorganics																					
Aluminum	13/13	9870	- 59400	34331		7 / 9	0.0794	- 0.139	0.125		3/3	8440	- 9120	9120	m	0/9	0	- 0	0		
Antimony	3/13	1.3	- 1.73	1.73	m	0 / 9	0	- 0	0		3/3	0.23	- 0.25	0.25	m	0/9	0	- 0	0		
Arsenic	13/13	7.31	- 82.6	42.61		8 / 9	0.00054	- 0.002	0.0013		3/3	13.6	- 16.4	16.4	m	9/9	0.19	- 0.28	0.25		
Barium	13/13	50.2	- 216	138.9		8 / 9	0.0352	- 0.0415	0.0395		3/3	92.5	- 96.9	96.9	m	9/9	0.56	- 0.92	0.81		
Beryllium	8/13	0.498	- 1.7	1.029		0 / 9	0	- 0	0		3/3	0.72	- 0.77	0.77	m	0/9	0	- 0	0		
Boron	12/13	8.02	- 45.7	35.3		7 / 9	0.0142	- 0.024	0.0196		3/3	6.2	- 7.2	7.2	m	8/9	0.46	- 1.4	0.99		
Cadmium	0/13	0	- 0	0		0 / 9	0	- 0	0		3/3	0.76	- 1.2	1.2	m	9/9	0.2	- 0.37	0.33		
Chromium	13/13	13.4	- 71.3	47.97		1 / 9	0.00039	- 0.0004	0.0004	m	3/3	10.8	- 11.7	11.7	m	7/9	0.21	- 0.29	0.26		
Cobalt	13/13	4.55	- 23.8	17.89		0 / 9	0	- 0	0		3/3	7.3	- 7.7	7.7	m	9/9	0.67	- 0.89	0.81		
Copper	13/13	7.2	- 46.8	22.84		8 / 9	0.00077	- 0.0026	0.0018		3/3	20.4	- 21	21	m	9/9	11.8	- 28.5	23.8		
Iron	13/13	14800	- 49200	34139		8 / 9	0.0696	- 0.133	0.119		3/3	9160	- 9560	9560	m	9/9	94.6	- 189	159		
Lead	13/13	12.3	- 86.7	39.23		0 / 9	0	- 0	0		3/3	8.6	- 8.9	8.9	m	0/9	0	- 0	0		
Manganese	13/13	145	- 3540	1655		9 / 10	0.0259	- 0.0391	0.0342		3/3	759	- 807	807	m	9/9	2	- 3.4	3.13		
Mercury	11/13	0.065	- 1	0.679		0 / 9	0	- 0	0		3/3	0.26	- 0.3	0.3	m	9/9	0.06	- 0.08	0.07		
Molybdenum	0/13	0	- 0	0		8 / 9	0.00056	- 0.001	0.0009		3/3	1.5	- 1.6	1.6	m	9/9	0.41	- 0.69	0.59		
Nickel	13/13	5.81	- 36.9	20.06		7 / 9	0.00042	- 0.0006	0.0005		3/3	11.9	- 12.4	12.4	m	1/9	0.33	- 0.33	0.33	m	
Selenium	1/13	1.77	- 1.77	1.77	m	4 / 9	0.00034	- 0.0004	0.0004	m	3/3	6.6	- 7.4	7.4	m	9/9	5.8	- 6.6	6.4		
Silver	0/13	0	- 0	0		0 / 9	0	- 0	0		3/3	0.06	- 0.07	0.065	m	9/9	0.01	- 0.016	0.01		
Strontium	13/13	7.27	- 42.1	23.22		8 / 9	0.109	- 0.116	0.115		3/3	26.1	- 31.1	31.1	m	9/9	0.61	- 0.94	0.78		
Thallium	3/13	1.35	- 3.11	3.11	m	0 / 9	0	- 0	0		0/3	0	- 0	0		0/9	0	- 0	0		
Vanadium	13/13	22.9	- 63.5	48.85		5 / 9	0.00107	- 0.0022	0.0016		3/3	17.1	- 18.9	18.9	m	9/9	0.17	- 0.25	0.23		
Zinc	13/13	30.3	- 194	87.05		0 / 9	0	- 0	0		3/3	172	- 182	182	m	9/9	91.4	- 212	198		

Table 5-CR_B-1
Data Summaries
Risk Characterization
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	25.9	-	154.1	154	m	6/6	602.7	-	1560	1560	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		2/6	0.065	-	0.08	0.08	m	0/40	0	-	0	0	
Arsenic	1/6	0.25	-	0.2523	0.25	m	6/6	1.9	-	3.1	3.1	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	12	-	45.97	46	m	6/6	16.89	-	25.7	25.7	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		2/6	0.1	-	0.13	0.13	m	0/40	0	-	0	0	
Boron	6/6	11.3	-	50.34	50.3	m	0/6	0	-	0	0		0/40	0	-	0	0	
Cadmium	5/6	0.03	-	0.0688	0.07	m	6/6	0.05023	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	2/6	0.61	-	0.7798	0.78	m	6/6	1.142	-	4.2	4.2	m	0/40	0	-	0	0	
Cobalt	6/6	0.09	-	0.4037	0.4	m	6/6	0.6818	-	1.6	1.6	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	6.42	-	12.55	12.6	m	6/6	5.1	-	9.55	9.55	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	55.2	-	168.3	168	m	6/6	616.4	-	1870	1870	m	34/40	99.1	-	532.7	238	
Lead	5/6	0.09	-	0.3394	0.34	m	6/6	0.6849	-	3.2	3.2	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	98.2	-	600.7	601	m	6/6	133.8	-	233	233	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		4/6	0.05479	-	0.11	0.11	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.26	-	4.319	4.32	m	2/6	0.15	-	0.19	0.19	m	7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.6	-	2.836	2.84	m	6/6	1.05	-	5.7	5.7	m	0/40	0	-	0	0	
Selenium	1/6	0.39	-	0.3899	0.39	m	6/6	1.6	-	3.35	3.35	m	40/40	0.87	-	3.858	2.07	
Silver	1/6	0.02	-	0.0174	0.02	m	4/6	0.014	-	0.02	0.02	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	16	-	37.41	37.4	m	6/6	29.3	-	42.8	42.8	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	1/6	0.33	-	0.3257	0.33	m	6/6	1.826	-	3.8	3.8	m	0/40	0	-	0	0	
Zinc	6/6	18.4	-	41.5	41.5	m	6/6	50.2	-	111	111	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-CR_B-2
Refined Risk Characterization for the Wood Duck
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	34,331	0.125	9,120	m	154.1	m	6.10E+01	386.5	109.7	0.2	0.6
Iron	34,139	0.119	9,560	m	168.3	m	2.14E+01	790.5	109.3	0.03	0.2
Vanadium	48.85	0.0016	18.9	m	0.3257	m	5.33E-01	13	8	0.04	0.07

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-3
Refined Risk Characterization for the Mallard Duck
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	NOAEL
Inorganics													
Aluminum	34,331		0.125		9,120	m	154.1	m	1.03E+02	386.5	109.7	0.3	0.9
Arsenic	42.61		0.0013		16.4	m	0.2523	m	9.52E-01	13	5	0.07	0.2
Iron	34,139		0.119		9,560	m	168.3	m	3.62E+01	790.5	109.3	0.05	0.3
Selenium	1.77	m	0.0004	m	7.4	m	0.3899	m	3.95E-01	0.8	0.4	0.5	1
Vanadium	48.85		0.0016		18.9	m	0.3257	m	9.89E-01	13	8	0.08	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-4
Refined Risk Characterization for the Killdeer
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics											
Aluminum	34,331		0.125		9,120	m	2.97E+02	386.5	109.7	0.8	3
Arsenic	42.61		0.0013		16.4	m	3.17E+00	13	5	0.2	0.6
Iron	34,139		0.119		9,560	m	1.24E+02	790.5	109.3	0.2	1
Lead	39.23		0		8.9	m	1.38E+00	3.3	1.63	0.4	0.8
Selenium	1.77	m	0.0004	m	7.4	m	1.15E+00	0.8	0.4	1	3
Vanadium	48.85		0.0016		18.9	m	2.89E+00	13	8	0.2	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-5
Refined Risk Characterization for the Heron
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	34,331	0.125	9,120	m	1,560	m	2.88E+01	386.5	109.7	0.07	0.3
Iron	34,139	0.119	9,560	m	1,870	m	3.71E+01	790.5	109.3	0.05	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-6
Refined Risk Characterization for the Osprey
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.125	1,560	m	2.97E+01	386.5	109.7	0.08	0.3
Iron	0.119	1,870	m	3.96E+01	790.5	109.3	0.05	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-7
Refined Risk Characterization for the Muskrat
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	34,331	0.125	154.1	m	1.02E+01	212.6	17	0.05	0.6
Iron	34,139	0.119	168.3	m	1.23E+01	31.6	22.8	0.4	0.5
Manganese	1,655	0.0342	600.7	m	3.79E+01	271	162	0.1	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-8
Refined Risk Characterization for the Raccoon
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	34,331	0.125	9,120	m	154.1	m	1,560	m	3.17E+01	212.6	17	0.1	2
Iron	34,139	0.119	9,560	m	168.3	m	1,870	m	1.68E+01	31.6	22.8	0.5	0.7

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-9
Refined Risk Characterization for the Mink
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics														
Aluminum	34,331	0.125	9,120	m	154.1	m	1,560	m	56.6	3.18E+01	212.6	17	0.1	2
Iron	34,139	0.119	9,560	m	168.3	m	1,870	m	237.9	3.30E+01	31.6	22.8	1	1

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").
[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.
[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.
[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-10
Refined Risk Characterization for the Tree Swallow
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics								
Copper	0.00182		23.81	5.87E+00	12.1	4.05	0.5	1
Selenium	0.00038	m	6.402	1.58E+00	0.8	0.4	2	4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-11
Refined Risk Characterization for the Gray Bat
Clinch River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics								
Aluminum	0.125		0	1.97E-02	212.6	17	0.00009	0.001
Copper	0.00182		23.81	4.32E+00	9.34	5.6	0.5	0.8
Selenium	0.00038	m	6.402	1.16E+00	0.215	0.143	5	8

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_B-12
Refined Risk Characterization Results Summary
Clinch River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.6	0.3	0.9	0.8	**3**	0.07	0.3	0.08	0.3
Arsenic	--	--	0.07	0.2	0.2	0.6	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.2	0.05	0.3	0.2	1	0.05	0.3	0.05	0.4
Lead	--	--	--	--	0.4	0.8	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.5	1	1	**3**	--	--	--	--
Vanadium	0.04	0.07	0.08	0.1	0.2	0.4	--	--	--	--

NA Not Applicable.

Table 5-CR_B-12
Refined Risk Characterization Results Summary
Clinch River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.05	0.6	0.1	**2**	0.1	**2**	--	--	0.00009	0.001
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.5	1	0.5	0.8
Iron	0.4	0.5	0.5	0.7	1	1	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.1	0.2	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	**2**	**4**	**5**	**8**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-CR_R-1
Data Summaries
Risk Characterization
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water						Invertebrates																	
													Larval Mayfly						Adult Mayfly											
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC							
Constituent		(mg/kg)						(mg/L)						(mg/kg)						(mg/kg)										
Inorganics																														
Aluminum	5/5	2480	-	14800	14800	m	8 / 9	0.0618	-	0.107	0.0918		3/3	6610	-	7620	7620	m	1/6	5.2	-	5.2	5.2	m						
Antimony	0/5	0	-	0	0		0 / 9	0	-	0	0		3/3	0.09	-	0.1	0.098	m	0/6	0	-	0	0							
Arsenic	4/5	1.83	-	5.4	5.4	m	9 / 9	0.00036	-	0.0006	0.0005		3/3	4.7	-	5.2	5.2	m	6/6	0.11	-	0.14	0.14	m						
Barium	5/5	22.6	-	90.4	90.4	m	9 / 9	0.0339	-	0.0375	0.0362		3/3	56.4	-	59.8	59.8	m	6/6	0.54	-	0.68	0.68	m						
Beryllium	1/5	0.769	-	0.769	0.769	m	0 / 9	0	-	0	0		3/3	0.33	-	0.36	0.36	m	0/6	0	-	0	0							
Boron	0/5	0	-	0	0		9 / 9	0.0131	-	0.0192	0.017		3/3	5.7	-	7.9	7.9	m	6/6	0.44	-	0.77	0.77	m						
Cadmium	0/5	0	-	0	0		0 / 9	0	-	0	0		3/3	0.74	-	0.95	0.95	m	6/6	0.3	-	0.4	0.4	m						
Chromium	5/5	3.21	-	13.8	13.8	m	2 / 9	0.00035	-	0.0005	0.0005	m	3/3	9	-	9.9	9.9	m	1/6	12.7	-	12.7	12.7	m						
Cobalt	5/5	2.15	-	10.5	10.5	m	0 / 9	0	-	0	0		3/3	5.7	-	6.2	6.2	m	6/6	0.76	-	0.82	0.82	m						
Copper	5/5	4.03	-	6.83	6.83	m	9 / 9	0.00044	-	0.0016	0.001		3/3	18.3	-	19.3	19.3	m	6/6	26.3	-	27.9	27.9	m						
Iron	5/5	3210	-	18500	18500	m	9 / 9	0.077	-	0.126	0.126	m	3/3	8640	-	9230	9230	m	6/6	177	-	185	185	m						
Lead	5/5	3.15	-	10.4	10.4	m	1 / 9	0.00034	-	0.0003	0.0003	m	3/3	9.2	-	9.8	9.8	m	0/6	0	-	0	0							
Manganese	5/5	29.9	-	689	689	m	9 / 9	0.0245	-	0.0351	0.0351	m	3/3	905	-	1040	1040	m	6/6	2	-	2.9	2.9	m						
Mercury	0/5	0	-	0	0		0 / 9	0	-	0	0		3/3	0.81	-	1.2	1.2	m	6/6	0.1	-	0.13	0.13	m						
Molybdenum	0/5	0	-	0	0		9 / 9	0.00035	-	0.0009	0.0008		3/3	0.67	-	0.79	0.79	m	6/6	0.34	-	0.37	0.37	m						
Nickel	5/5	3.42	-	14.7	14.7	m	6 / 9	0.00033	-	0.0007	0.0007	m	3/3	9.6	-	10.4	10.4	m	0/6	0	-	0	0							
Selenium	0/5	0	-	0	0		1 / 9	0.00043	-	0.0004	0.0004	m	3/3	4.2	-	4.6	4.6	m	6/6	3.7	-	4.1	4.1	m						
Silver	0/5	0	-	0	0		0 / 9	0	-	0	0		0/3	0	-	0	0		6/6	0.02	-	0.028	0.03	m						
Strontium	3/5	5.31	-	16.3	16.3	m	9 / 9	0.108	-	0.116	0.114		3/3	8.9	-	9.4	9.4	m	6/6	0.58	-	0.74	0.74	m						
Thallium	0/5	0	-	0	0		0 / 9	0	-	0	0		0/3	0	-	0	0		0/6	0	-	0	0							
Vanadium	5/5	4.05	-	26.3	26.3	m	0 / 9	0	-	0	0		3/3	10.9	-	11.9	11.9	m	6/6	0.12	-	0.14	0.14	m						
Zinc	5/5	15	-	54.1	54.1	m	0 / 9	0	-	0	0		3/3	168	-	197	197	m	6/6	88	-	98.7	98.7	m						

Table 5-CR_R-1
Data Summaries
Risk Characterization
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	26.4	-	506.8	507	m	6/6	101.7	-	645	645	m	9/48	38.1	-	219.1	51.4	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Arsenic	2/6	0.23	-	0.5285	0.53	m	6/6	1.8	-	2.1	2.1	m	7/48	0.25	-	0.3904	0.27	
Barium	6/6	10.5	-	44.59	44.6	m	6/6	10.68	-	21.5	21.5	m	48/48	24	-	148.1	66.5	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Boron	6/6	12.6	-	55.93	55.9	m	0/6	0	-	0	0		0/48	0	-	0	0	
Cadmium	2/6	0.03	-	0.1382	0.14	m	6/6	0.04054	-	0.06	0.06	m	6/48	0.08	-	0.2155	0.1	
Chromium	0/6	0	-	0	0		3/6	0.87	-	2	2	m	1/48	29.7	-	29.74	29.7	m
Cobalt	5/6	0.07	-	0.6341	0.63	m	6/6	0.312	-	0.6	0.6	m	39/48	0.13	-	0.6548	0.32	
Copper	6/6	5.78	-	11.86	11.9	m	6/6	4	-	10	10	m	48/48	4.64	-	46.37	17.6	
Iron	6/6	49.7	-	478	478	m	6/6	166.7	-	712	712	m	45/48	107	-	419.7	229	
Lead	4/6	0.11	-	0.7881	0.79	m	6/6	0.2564	-	1.1	1.1	m	7/48	0.58	-	3.177	3.18	m
Manganese	6/6	67.9	-	400.8	401	m	6/6	117.5	-	203	203	m	48/48	23.9	-	189.7	83.2	
Mercury	0/6	0	-	0	0		3/6	0.066	-	0.11	0.11	m	1/48	0.09	-	0.0931	0.09	m
Molybdenum	6/6	0.28	-	1.429	1.43	m	0/6	0	-	0	0		3/48	0.28	-	0.4217	0.42	m
Nickel	6/6	0.58	-	5.07	5.07	m	3/6	0.61	-	4.4	4.4	m	0/48	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2.432	-	3.5	3.5	m	48/48	0.86	-	3.103	1.53	
Silver	0/6	0	-	0	0		1/6	0.01441	-	0.01	0.01	m	9/48	0.02	-	0.0854	0.03	
Strontium	6/6	11.3	-	58.68	58.7	m	6/6	32.91	-	58.6	58.6	m	48/48	18	-	99.28	55.1	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Vanadium	3/6	0.39	-	1.017	1.02	m	6/6	0.3718	-	1.5	1.5	m	1/48	1.68	-	1.677	1.68	m
Zinc	6/6	30.7	-	80.49	80.5	m	6/6	82.5	-	109	109	m	48/48	87.8	-	311	146	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-CR_R-2
Refined Risk Characterization for the Wood Duck
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]				Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)	Vegetation (mg/kg)		LOAEL	NOAEL	LOAEL	NOAEL
Inorganics									

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-3
Refined Risk Characterization for the Mallard Duck
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics													
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	9.19E+01	386.5	109.7	0.2	0.8
Arsenic	5.4	m	0.0005		5.2	m	0.5285	m	2.91E-01	13	5	0.02	0.06
Iron	18,500	m	0.126	m	9,230	m	478	m	3.40E+01	790.5	109.3	0.04	0.3
Selenium	0		0.0004	m	4.6	m	0		2.39E-01	0.8	0.4	0.3	0.6
Vanadium	26.3	m	0		11.9	m	1.017	m	6.36E-01	13	8	0.05	0.08

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-4
Refined Risk Characterization for the Killdeer
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	14,800	m	0.0918		7,620	m	2.45E+02	386.5	109.7	0.6	2
Arsenic	5.4	m	0.0005		5.2	m	8.76E-01	13	5	0.07	0.2
Iron	18,500	m	0.126	m	9,230	m	1.05E+02	790.5	109.3	0.1	1
Lead	10.4	m	0.0003	m	9.8	m	1.50E+00	3.3	1.63	0.5	0.9
Selenium	0		0.0004	m	4.6	m	6.99E-01	0.8	0.4	0.9	2
Vanadium	26.3	m	0		11.9	m	1.82E+00	13	8	0.1	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-5
Refined Risk Characterization for the Heron
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics													
Aluminum	14,800	m	0.0918		7,620	m	645	m	1.28E+01	386.5	109.7	0.03	0.1
Iron	18,500	m	0.126	m	9,230	m	712	m	1.47E+01	790.5	109.3	0.02	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-6
Refined Risk Characterization for the Osprey
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	0.0918		645	m	1.23E+01	386.5	109.7	0.03	0.1
Iron	0.126	m	712	m	1.51E+01	790.5	109.3	0.02	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-7
Refined Risk Characterization for the Muskrat
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics											
Aluminum	14,800	m	0.0918		506.8	m	2.77E+01	212.6	17	0.1	2
Iron	18,500	m	0.126	m	478	m	1.08E+01	31.6	22.8	0.3	0.5
Manganese	689	m	0.0351	m	400.8	m	2.38E+01	271	162	0.09	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-8
Refined Risk Characterization for the Raccoon
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]										Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics															
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	645	m	3.35E+01	212.6	17	0.2	2
Iron	18,500	m	0.126	m	9,230	m	478	m	712	m	1.41E+01	31.6	22.8	0.4	0.6

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-9
Refined Risk Characterization for the Mink
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics																
Aluminum	14,800	m	0.0918		7,620	m	506.8	m	645	m	51.4	1.97E+01	212.6	17	0.09	1
Iron	18,500	m	0.126	m	9,230	m	478	m	712	m	229.3	1.54E+01	31.6	22.8	0.5	0.7

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effects Level.
mg/kg Milligrams per kilogram.
mg/kg-BW-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effects Level.
mg/L Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-10
Refined Risk Characterization for the Tree Swallow
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Copper	0.00099961		27.9	m	6.87E+00	12.1	4.05	0.6	2
Selenium	0.00043	m	4.1	m	1.01E+00	0.8	0.4	1	3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-11
Refined Risk Characterization for the Gray Bat
Clinch River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics									
Aluminum	0.0918		5.2	m	2.12E-01	212.6	17	0.001	0.01
Copper	0.00099961		27.9	m	5.06E+00	9.34	5.6	0.5	0.9
Selenium	0.00043	m	4.1	m	7.44E-01	0.215	0.143	3	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-CR_R-12
Refined Risk Characterization Results Summary
Clinch River: Reach R
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.7	0.2	0.8	0.6	**2**	0.03	0.1	0.03	0.1
Arsenic	--	--	0.02	0.06	0.07	0.2	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.2	0.04	0.3	0.1	1	0.02	0.1	0.02	0.1
Lead	--	--	--	--	0.5	0.9	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.3	0.6	0.9	**2**	--	--	--	--
Vanadium	0.03	0.05	0.05	0.08	0.1	0.2	--	--	--	--

NA Not Applicable.

Table 5-CR_R-12
Refined Risk Characterization Results Summary
Clinch River: Reach R
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.1	**2**	0.2	**2**	0.09	1	--	--	0.001	0.01
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.6	**2**	0.5	0.9
Iron	0.3	0.5	0.4	0.6	0.5	0.7	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.09	0.1	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	1	**3**	**3**	**5**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-TR_A-1
Data Summaries
Risk Characterization
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates										
											Larval Mayfly					Adult Mayfly					
	FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		
Constituent			(mg/kg)					(mg/L)					(mg/kg)					(mg/kg)			
Inorganics																					
Aluminum	12/12	7370	- 143000	70028		6 / 8	0.0676	- 0.263	0.167		3/3	8060	- 10900	10900	m	0/9	0	- 0	0		
Antimony	3/12	1.32	- 2.52	2.52	m	0 / 8	0	- 0	0		3/3	0.15	- 0.16	0.16	m	0/9	0	- 0	0		
Arsenic	12/12	5.2	- 63.4	28.62		8 / 8	0.0005	- 0.0013	0.001		3/3	9.3	- 11	11	m	9/9	0.09	- 0.21	0.16		
Barium	12/12	50.7	- 190	133.4		8 / 8	0.0264	- 0.0396	0.0331		3/3	66.1	- 86.2	86.2	m	9/9	0.42	- 0.97	0.86		
Beryllium	10/12	0.623	- 4.39	2.525		1 / 8	0.00048	- 0.0005	0.0005	m	3/3	0.44	- 0.66	0.66	m	0/9	0	- 0	0		
Boron	12/12	8.63	- 60.5	50.23		8 / 8	0.0126	- 0.0182	0.0164		2/3	5.3	- 5.6	5.6	m	3/9	0.93	- 1.3	1.3	m	
Cadmium	0/12	0	- 0	0		0 / 8	0	- 0	0		3/3	0.76	- 1.6	1.6	m	9/9	0.22	- 0.76	0.56		
Chromium	12/12	14.8	- 125	69.36		1 / 8	0.00043	- 0.0004	0.0004	m	3/3	9.3	- 12.2	12.2	m	9/9	0.2	- 0.44	0.34		
Cobalt	12/12	4.52	- 18	13.27		0 / 8	0	- 0	0		3/3	6.7	- 7.8	7.8	m	9/9	0.79	- 0.98	0.95		
Copper	12/12	5.52	- 90.4	36.85		8 / 8	0.00056	- 0.0022	0.0013		3/3	19.7	- 21.7	21.7	m	9/9	10.3	- 28.8	25		
Iron	12/12	14500	- 93800	51886		7 / 8	0.0805	- 0.236	0.164		3/3	9040	- 11700	11700	m	9/9	69.4	- 180	161		
Lead	12/12	12.1	- 102	47.71		1 / 8	0.00047	- 0.0005	0.0005	m	3/3	8	- 10.4	10.4	m	0/9	0	- 0	0		
Manganese	12/12	160	- 1700	1016		7 / 8	0.0386	- 0.0943	0.0692		3/3	1190	- 1500	1500	m	9/9	2.1	- 5.6	4.33		
Mercury	10/12	0.07	- 0.39	0.204		0 / 8	0	- 0	0		3/3	0.14	- 0.17	0.17	m	9/9	0.03	- 0.05	0.05		
Molybdenum	0/12	0	- 0	0		6 / 8	0.00041	- 0.0006	0.0006		3/3	0.93	- 0.97	0.97	m	9/9	0.39	- 0.54	0.5		
Nickel	12/12	3.24	- 135	45.88		4 / 8	0.00035	- 0.0011	0.0011	m	3/3	8.4	- 10.8	10.8	m	0/9	0	- 0	0		
Selenium	0/12	0	- 0	0		0 / 8	0	- 0	0		3/3	4.9	- 5.9	5.9	m	9/9	2.9	- 4.1	3.63		
Silver	0/12	0	- 0	0		0 / 8	0	- 0	0		3/3	0.043	- 0.077	0.077	m	9/9	0.01	- 0.04	0.03		
Strontium	12/12	6.27	- 43.6	27.56		8 / 8	0.0738	- 0.107	0.0919		3/3	17.3	- 20.9	20.9	m	9/9	0.54	- 1	0.97		
Thallium	0/12	0	- 0	0		0 / 8	0	- 0	0		3/3	0.13	- 0.16	0.16	m	0/9	0	- 0	0		
Vanadium	12/12	21.1	- 193	89.27		2 / 8	0.00102	- 0.0015	0.0015	m	3/3	14	- 18.3	18.3	m	9/9	0.11	- 0.23	0.19		
Zinc	12/12	27.5	- 460	307.8		0 / 8	0	- 0	0		3/3	218	- 292	292	m	9/9	91.8	- 224	169		

Table 5-TR_A-1
Data Summaries
Risk Characterization
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	14.5	-	362.2	362	m	6/6	441	-	3074	3074	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		4/6	0.064	-	0.11	0.11	m	0/40	0	-	0	0	
Arsenic	4/6	0.11	-	0.2677	0.27	m	6/6	1.6	-	5.12	5.12	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	25.5	-	210.8	211	m	6/6	18.1	-	43.3	43.3	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		3/6	0.162	-	0.27	0.27	m	0/40	0	-	0	0	
Boron	6/6	4.98	-	51.97	52	m	2/6	1.982	-	2.37	2.37	m	0/40	0	-	0	0	
Cadmium	0/6	0	-	0	0		6/6	0.0463	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	0/6	0	-	0	0		5/6	1.6	-	4.65	4.65	m	0/40	0	-	0	0	
Cobalt	6/6	0.07	-	0.6024	0.6	m	6/6	0.47	-	2.05	2.05	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	5.11	-	8.397	8.4	m	6/6	5.4	-	14.8	14.8	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	56.5	-	419.7	420	m	6/6	448	-	1395	1395	m	34/40	99.1	-	532.7	238	
Lead	4/6	0.15	-	0.4094	0.41	m	6/6	0.75	-	3.21	3.21	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	168	-	395.3	395	m	6/6	140	-	327	327	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		6/6	0.06	-	0.15	0.15	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.17	-	2.899	2.9	m	2/6	0.1613	-	0.18	0.18	m	7/40	0.29	-	0.4814	0.32	
Nickel	6/6	0.47	-	2.047	2.05	m	6/6	1.2	-	12.4	12.4	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2	-	3.44	3.44	m	40/40	0.87	-	3.858	2.07	
Silver	0/6	0	-	0	0		5/6	0.014	-	0.04	0.04	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	11.4	-	58.27	58.3	m	6/6	37.3	-	46.5	46.5	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	2/6	0.31	-	0.6535	0.65	m	6/6	1.1	-	6.98	6.98	m	0/40	0	-	0	0	
Zinc	6/6	32.5	-	76.87	76.9	m	6/6	73.7	-	131	131	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-TR_A-2
Refined Risk Characterization for the Wood Duck
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.167	10,900	m	362.2	m	8.32E+01	386.5	109.7	0.2	0.8
Iron	51,886	0.164	11,700	m	419.7	m	2.96E+01	790.5	109.3	0.04	0.3
Vanadium	89.27	0.0015 m	18.3	m	0.6535	m	5.36E-01	13	8	0.04	0.07

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-3
Refined Risk Characterization for the Mallard Duck
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.167	10,900	m	362.2	m	1.26E+02	386.5	109.7	0.3	1
Arsenic	28.62	0.001	11	m	0.2677	m	6.40E-01	13	5	0.05	0.1
Iron	51,886	0.164	11,700	m	419.7	m	4.64E+01	790.5	109.3	0.06	0.4
Selenium	0	0	5.9	m	0		3.06E-01	0.8	0.4	0.4	0.8
Vanadium	89.27	0.0015 m	18.3	m	0.6535	m	9.66E-01	13	8	0.07	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-4
Refined Risk Characterization for the Killdeer
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]					Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics										
Aluminum	70,028	0.167		10,900	m	3.60E+02	386.5	109.7	0.9	3
Arsenic	28.62	0.001		11	m	2.12E+00	13	5	0.2	0.4
Iron	51,886	0.164		11,700	m	1.61E+02	790.5	109.3	0.2	1
Lead	47.71	0.0005	m	10.4	m	1.62E+00	3.3	1.63	0.5	1
Selenium	0	0		5.9	m	8.97E-01	0.8	0.4	1	2
Vanadium	89.27	0.0015	m	18.3	m	2.82E+00	13	8	0.2	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-5
Refined Risk Characterization for the Heron
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.167	10,900	m	3,074	m	5.51E+01	386.5	109.7	0.1	0.5
Iron	51,886	0.164	11,700	m	1,395	m	2.89E+01	790.5	109.3	0.04	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-6
Refined Risk Characterization for the Osprey
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.167	3,074	m	5.85E+01	386.5	109.7	0.2	0.5
Iron	0.164	1,395	m	2.96E+01	790.5	109.3	0.04	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-7
Refined Risk Characterization for the Muskrat
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	70,028	0.167	362.2	m	2.32E+01	212.6	17	0.1	1
Iron	51,886	0.164	419.7	m	2.04E+01	31.6	22.8	0.6	0.9
Manganese	1,016	0.0692	395.3	m	2.47E+01	271	162	0.09	0.2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-8
Refined Risk Characterization for the Raccoon
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	70,028	0.167	10,900	m	362.2	m	3,074	m	4.31E+01	212.6	17	0.2	3
Iron	51,886	0.164	11,700	m	419.7	m	1,395	m	2.32E+01	31.6	22.8	0.7	1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-9
Refined Risk Characterization for the Mink
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]									Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)		LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics														
Aluminum	70,028	0.167	10,900	m	362.2	m	3,074	m	56.6	5.49E+01	212.6	17	0.3	3
Iron	51,886	0.164	11,700	m	419.7	m	1,395	m	237.9	2.83E+01	31.6	22.8	0.9	1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-10
Refined Risk Characterization for the Tree Swallow
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Copper	0.00134	25.01	6.16E+00	12.1	4.05	0.5	2
Selenium	0	3.629	8.94E-01	0.8	0.4	1	2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-11
Refined Risk Characterization for the Gray Bat
Tennessee River: Reach A
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Aluminum	0.167	0	2.63E-02	212.6	17	0.0001	0.002
Copper	0.00134	25.01	4.54E+00	9.34	5.6	0.5	0.8
Selenium	0	3.629	6.59E-01	0.215	0.143	3	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_A-12
Refined Risk Characterization Results Summary
Tennessee River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.8	0.3	1	0.9	**3**	0.1	0.5	0.2	0.5
Arsenic	--	--	0.05	0.1	0.2	0.4	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.04	0.3	0.06	0.4	0.2	1	0.04	0.3	0.04	0.3
Lead	--	--	--	--	0.5	1	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.4	0.8	1	**2**	--	--	--	--
Vanadium	0.04	0.07	0.07	0.1	0.2	0.4	--	--	--	--

NA Not Applicable.

Table 5-TR_A-12
Refined Risk Characterization Results Summary
Tennessee River: Reach A
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.1	1	0.2	**3**	0.3	**3**	--	--	0.0001	0.002
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.5	**2**	0.5	0.8
Iron	0.6	0.9	0.7	1	0.9	1	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.09	0.2	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	1	**2**	**3**	**5**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-TR_B-1
Data Summaries
Risk Characterization
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment					Surface Water					Invertebrates										
											Larval Mayfly					Adult Mayfly					
	FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		FOD	min	max	EPC		
Constituent		(mg/kg)					(mg/L)					(mg/kg)					(mg/kg)				
Inorganics																					
Aluminum	12/12	7370	- 143000	70028		6 / 8	0.0676	- 0.263	0.167		3/3	9250	- 10700	10700	m	0/18	0	- 0	0		
Antimony	3/12	1.32	- 2.52	2.52	m	0 / 8	0	- 0	0		3/3	0.16	- 0.18	0.18	m	0/18	0	- 0	0		
Arsenic	12/12	5.2	- 63.4	28.62		8 / 8	0.0005	- 0.0013	0.001		3/3	9.1	- 10.4	10.4	m	18/18	0.11	- 0.23	0.16		
Barium	12/12	50.7	- 190	133.4		8 / 8	0.0264	- 0.0396	0.0331		3/3	73.1	- 87.6	87.6	m	18/18	0.4	- 0.83	0.73		
Beryllium	10/12	0.623	- 4.39	2.525		1 / 8	0.00048	- 0.0005	0.0005	m	3/3	0.42	- 0.62	0.62	m	0/18	0	- 0	0		
Boron	12/12	8.63	- 60.5	50.23		8 / 8	0.0126	- 0.0182	0.0164		3/3	6.6	- 7.4	7.4	m	4/18	0.44	- 0.66	0.66	m	
Cadmium	0/12	0	- 0	0		0 / 8	0	- 0	0		3/3	0.96	- 1.7	1.7	m	18/18	0.11	- 0.38	0.28		
Chromium	12/12	14.8	- 125	69.36		1 / 8	0.00043	- 0.0004	0.0004	m	3/3	10.6	- 12.1	12.1	m	18/18	0.14	- 0.28	0.22		
Cobalt	12/12	4.52	- 18	13.27		0 / 8	0	- 0	0		3/3	6.3	- 7.2	7.2	m	18/18	0.75	- 1.1	0.96		
Copper	12/12	5.52	- 90.4	36.85		8 / 8	0.00056	- 0.0022	0.0013		3/3	20.2	- 21.4	21.4	m	18/18	11.3	- 28.2	22.9		
Iron	12/12	14500	- 93800	51886		7 / 8	0.0805	- 0.236	0.164		3/3	10300	- 11400	11400	m	18/18	76.9	- 184	152		
Lead	12/12	12.1	- 102	47.71		1 / 8	0.00047	- 0.0005	0.0005	m	3/3	8.9	- 10.1	10.1	m	0/18	0	- 0	0		
Manganese	12/12	160	- 1700	1016		7 / 8	0.0386	- 0.0943	0.0692		3/3	979	- 1460	1460	m	18/18	1.9	- 5.3	3.44		
Mercury	10/12	0.07	- 0.39	0.204		0 / 8	0	- 0	0		3/3	0.11	- 0.13	0.13	m	18/18	0.03	- 0.06	0.05		
Molybdenum	0/12	0	- 0	0		6 / 8	0.00041	- 0.0006	0.0006		3/3	0.88	- 1.3	1.3	m	18/18	0.34	- 0.66	0.54		
Nickel	12/12	3.24	- 135	45.88		4 / 8	0.00035	- 0.0011	0.0011	m	3/3	9.3	- 10.6	10.6	m	0/18	0	- 0	0		
Selenium	0/12	0	- 0	0		0 / 8	0	- 0	0		3/3	5.6	- 6	6	m	18/18	3.3	- 5.3	4.11		
Silver	0/12	0	- 0	0		0 / 8	0	- 0	0		1/3	0.039	- 0.039	0.039	m	12/18	0.01	- 0.02	0.02		
Strontium	12/12	6.27	- 43.6	27.56		8 / 8	0.0738	- 0.107	0.0919		3/3	19.5	- 22.4	22.4	m	18/18	0.55	- 1.1	0.86		
Thallium	0/12	0	- 0	0		0 / 8	0	- 0	0		1/3	0.19	- 0.19	0.19	m	0/18	0	- 0	0		
Vanadium	12/12	21.1	- 193	89.27		2 / 8	0.00102	- 0.0015	0.0015	m	3/3	16.2	- 18.4	18.4	m	18/18	0.08	- 0.21	0.17		
Zinc	12/12	27.5	- 460	307.8		0 / 8	0	- 0	0		3/3	193	- 240	240	m	18/18	89.1	- 213	154		

Table 5-TR_B-1
Data Summaries
Risk Characterization
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	18.6	-	223.4	223	m	6/6	441	-	3074	3074	m	5/40	43.1	-	187.1	56.6	
Antimony	0/6	0	-	0	0		4/6	0.064	-	0.11	0.11	m	0/40	0	-	0	0	
Arsenic	1/6	0.13	-	0.1344	0.13	m	6/6	1.6	-	5.12	5.12	m	4/40	0.4	-	0.8164	0.82	m
Barium	6/6	3.56	-	49.19	49.2	m	6/6	18.1	-	43.3	43.3	m	40/40	37	-	122.3	79	
Beryllium	0/6	0	-	0	0		3/6	0.162	-	0.27	0.27	m	0/40	0	-	0	0	
Boron	6/6	4.22	-	16.94	16.9	m	2/6	1.982	-	2.37	2.37	m	0/40	0	-	0	0	
Cadmium	2/6	0.07	-	0.125	0.13	m	6/6	0.0463	-	0.09	0.09	m	17/40	0.09	-	0.3406	0.14	
Chromium	3/6	0.52	-	1.317	1.32	m	5/6	1.6	-	4.65	4.65	m	0/40	0	-	0	0	
Cobalt	6/6	0.07	-	1.22	1.22	m	6/6	0.47	-	2.05	2.05	m	33/40	0.12	-	0.6098	0.23	
Copper	6/6	4.88	-	26.36	26.4	m	6/6	5.4	-	14.8	14.8	m	39/40	4.5	-	43.31	18.4	
Iron	6/6	55.7	-	243.4	243	m	6/6	448	-	1395	1395	m	34/40	99.1	-	532.7	238	
Lead	4/6	0.11	-	0.7364	0.74	m	6/6	0.75	-	3.21	3.21	m	4/40	0.52	-	0.7493	0.75	m
Manganese	6/6	243	-	887.8	888	m	6/6	140	-	327	327	m	40/40	36.1	-	218.5	89	
Mercury	0/6	0	-	0	0		6/6	0.06	-	0.15	0.15	m	7/40	0.12	-	0.1991	0.13	
Molybdenum	6/6	0.19	-	1.976	1.98	m	2/6	0.1613	-	0.18	0.18	m	7/40	0.29	-	0.4814	0.32	
Nickel	5/6	0.46	-	5.039	5.04	m	6/6	1.2	-	12.4	12.4	m	0/40	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2	-	3.44	3.44	m	40/40	0.87	-	3.858	2.07	
Silver	1/6	0.02	-	0.0153	0.02	m	5/6	0.014	-	0.04	0.04	m	8/40	0.03	-	0.0927	0.04	
Strontium	6/6	4.35	-	37.56	37.6	m	6/6	37.3	-	46.5	46.5	m	40/40	34.9	-	132.2	77.8	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		1/40	0.34	-	0.34	0.34	m
Vanadium	4/6	0.26	-	0.3117	0.31	m	6/6	1.1	-	6.98	6.98	m	0/40	0	-	0	0	
Zinc	4/6	30.7	-	60.48	60.5	m	6/6	73.7	-	131	131	m	40/40	96.4	-	283.2	145	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-TR_B-2
Refined Risk Characterization for the Wood Duck
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.167	10,700	m	223.4	m	7.45E+01	386.5	109.7	0.2	0.7
Iron	51,886	0.164	11,400	m	243.4	m	2.72E+01	790.5	109.3	0.03	0.2
Vanadium	89.27	0.0015 m	18.4	m	0.3117	m	5.20E-01	13	8	0.04	0.07

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-3
Refined Risk Characterization for the Mallard Duck
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.167	10,700	m	223.4	m	1.22E+02	386.5	109.7	0.3	1
Arsenic	28.62	0.001	10.4	m	0.1344	m	6.07E-01	13	5	0.05	0.1
Iron	51,886	0.164	11,400	m	243.4	m	4.48E+01	790.5	109.3	0.06	0.4
Selenium	0	0	6	m	0		3.11E-01	0.8	0.4	0.4	0.8
Vanadium	89.27	0.0015 m	18.4	m	0.3117	m	9.65E-01	13	8	0.07	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-4
Refined Risk Characterization for the Killdeer
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]					Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics										
Aluminum	70,028	0.167		10,700	m	3.53E+02	386.5	109.7	0.9	3
Arsenic	28.62	0.001		10.4	m	2.03E+00	13	5	0.2	0.4
Iron	51,886	0.164		11,400	m	1.58E+02	790.5	109.3	0.2	1
Lead	47.71	0.0005	m	10.1	m	1.57E+00	3.3	1.63	0.5	1
Selenium	0	0		6	m	9.12E-01	0.8	0.4	1	2
Vanadium	89.27	0.0015	m	18.4	m	2.83E+00	13	8	0.2	0.4

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-5
Refined Risk Characterization for the Heron
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]						Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics											
Aluminum	70,028	0.167	10,700	m	3,074	m	5.50E+01	386.5	109.7	0.1	0.5
Iron	51,886	0.164	11,400	m	1,395	m	2.89E+01	790.5	109.3	0.04	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-6
Refined Risk Characterization for the Osprey
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.167	3,074	m	5.85E+01	386.5	109.7	0.2	0.5
Iron	0.164	1,395	m	2.96E+01	790.5	109.3	0.04	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-7
Refined Risk Characterization for the Muskrat
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)	Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics									
Aluminum	70,028	0.167	223.4	m	1.59E+01	212.6	17	0.07	0.9
Iron	51,886	0.164	243.4	m	1.86E+01	31.6	22.8	0.6	0.8
Manganese	1,016	0.0692	887.8	m	5.07E+01	271	162	0.2	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-8
Refined Risk Characterization for the Raccoon
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics													
Aluminum	70,028	0.167	10,700	m	223.4	m	3,074	m	3.96E+01	212.6	17	0.2	2
Iron	51,886	0.164	11,400	m	243.4	m	1,395	m	2.22E+01	31.6	22.8	0.7	1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-9
Refined Risk Characterization for the Mink
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]									Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)	Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)		LOAEL	NOAEL	LOAEL	NOAEL
Inorganics														
Aluminum	70,028	0.167	10,700	m	223.4	m	3,074	m	56.6	5.40E+01	212.6	17	0.3	3
Iron	51,886	0.164	11,400	m	243.4	m	1,395	m	237.9	2.80E+01	31.6	22.8	0.9	1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-10
Refined Risk Characterization for the Tree Swallow
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Copper	0.00134	22.94	5.65E+00	12.1	4.05	0.5	1
Selenium	0	4.11	1.01E+00	0.8	0.4	1	3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-11
Refined Risk Characterization for the Gray Bat
Tennessee River: Reach B
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics							
Aluminum	0.167	0	2.63E-02	212.6	17	0.0001	0.002
Copper	0.00134	22.94	4.16E+00	9.34	5.6	0.4	0.7
Selenium	0	4.11	7.46E-01	0.215	0.143	3	5

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_B-12
Refined Risk Characterization Results Summary
Tennessee River: Reach B
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.7	0.3	1	0.9	**3**	0.1	0.5	0.2	0.5
Arsenic	--	--	0.05	0.1	0.2	0.4	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.2	0.06	0.4	0.2	1	0.04	0.3	0.04	0.3
Lead	--	--	--	--	0.5	1	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.4	0.8	1	**2**	--	--	--	--
Vanadium	0.04	0.07	0.07	0.1	0.2	0.4	--	--	--	--

NA Not Applicable.

Table 5-TR_B-12
Refined Risk Characterization Results Summary
Tennessee River: Reach B
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.07	0.9	0.2	**2**	0.3	**3**	--	--	0.0001	0.002
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.5	1	0.4	0.7
Iron	0.6	0.8	0.7	1	0.9	1	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.2	0.3	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	1	**3**	**3**	**5**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-TR_R-1
Data Summaries
Risk Characterization
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Seasonally Exposed Sediment						Surface Water					Invertebrates											
												Larval Mayfly						Adult Mayfly					
	FOD	min		max	EPC		FOD	min		max	EPC	FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/L)					(mg/kg)						(mg/kg)				
Inorganics																							
Aluminum	5/5	2480	-	14800	14800	m	8 / 8	0.0781	-	0.206	0.152	3/3	6710	-	9420	9420	m	3/9	6.2	-	7.7	7.7	m
Antimony	0/5	0	-	0	0		0 / 8	0	-	0	0	3/3	0.08	-	0.1	0.1	m	1/9	0.03	-	0.03	0.03	m
Arsenic	4/5	1.83	-	5.4	5.4	m	8 / 8	0.00036	-	0.0012	0.0009	3/3	4.4	-	6	6	m	9/9	0.09	-	0.26	0.21	
Barium	5/5	22.6	-	90.4	90.4	m	8 / 8	0.0248	-	0.0371	0.0335	3/3	58.1	-	87	87	m	9/9	0.78	-	1.4	1.15	
Beryllium	1/5	0.769	-	0.769	0.769	m	0 / 8	0	-	0	0	3/3	0.29	-	0.4	0.4	m	0/9	0	-	0	0	
Boron	0/5	0	-	0	0		5 / 8	0.014	-	0.017	0.0166	3/3	2.2	-	3.4	3.4	m	8/9	0.69	-	1.5	1.15	
Cadmium	0/5	0	-	0	0		0 / 8	0	-	0	0	3/3	1.1	-	1.3	1.3	m	9/9	0.25	-	0.42	0.36	
Chromium	5/5	3.21	-	13.8	13.8	m	1 / 8	0.00038	-	0.0004	0.0004	m	3/3	7.5	-	10.6	10.6	m	9/9	0.22	-	0.28	0.25	
Cobalt	5/5	2.15	-	10.5	10.5	m	0 / 8	0	-	0	0	3/3	4.4	-	6	6	m	9/9	0.77	-	1.2	1.08	
Copper	5/5	4.03	-	6.83	6.83	m	8 / 8	0.0005	-	0.0013	0.001	3/3	12	-	15	15	m	9/9	13.8	-	27.1	25.1	
Iron	5/5	3210	-	18500	18500	m	8 / 8	0.116	-	0.199	0.169	3/3	8290	-	12000	12000	m	9/9	92.2	-	182	169	
Lead	5/5	3.15	-	10.4	10.4	m	0 / 8	0	-	0	0	3/3	8.3	-	12.1	12.1	m	1/9	0.11	-	0.11	0.11	m
Manganese	5/5	29.9	-	689	689	m	8 / 8	0.0494	-	0.0766	0.0653	3/3	861	-	1540	1540	m	9/9	2	-	6.7	4.7	
Mercury	0/5	0	-	0	0		0 / 8	0	-	0	0	3/3	0.05	-	0.066	0.066	m	9/9	0.02	-	0.04	0.03	
Molybdenum	0/5	0	-	0	0		5 / 8	0.00039	-	0.0007	0.0006	3/3	0.51	-	0.69	0.69	m	9/9	0.33	-	0.47	0.44	
Nickel	5/5	3.42	-	14.7	14.7	m	5 / 8	0.00035	-	0.0006	0.0005	3/3	5.7	-	8	8	m	1/9	0.15	-	0.15	0.15	m
Selenium	0/5	0	-	0	0		2 / 8	0.00033	-	0.0005	0.0005	m	3/3	4	-	4.8	4.8	m	9/9	1.5	-	2	1.92	
Silver	0/5	0	-	0	0		0 / 8	0	-	0	0		0/3	0	-	0	0		9/9	0.03	-	0.07	0.06	
Strontium	3/5	5.31	-	16.3	16.3	m	8 / 8	0.0671	-	0.109	0.0968	3/3	7.2	-	8.9	8.9	m	9/9	0.58	-	1.3	1.04	
Thallium	0/5	0	-	0	0		0 / 8	0	-	0	0	0/3	0	-	0	0		0/9	0	-	0	0	
Vanadium	5/5	4.05	-	26.3	26.3	m	2 / 8	0.001	-	0.0012	0.0012	m	3/3	10.7	-	15.1	15.1	m	9/9	0.1	-	0.14	0.12	
Zinc	5/5	15	-	54.1	54.1	m	0 / 8	0	-	0	0		3/3	211	-	214	214	m	9/9	94.4	-	216	166	

Table 5-TR_R-1
Data Summaries
Risk Characterization
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

	Vegetation						Fish						Amphibians					
	Shoreline & Emergent						Shad (whole body)						Chorus and Peeper					
	FOD	min		max	EPC		FOD	min		max	EPC		FOD	min		max	EPC	
Constituent		(mg/kg)						(mg/kg)						(mg/kg)				
Inorganics																		
Aluminum	6/6	26.4	-	506.8	507	m	6/6	101.7	-	645	645	m	9/48	38.1	-	219.1	51.4	
Antimony	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Arsenic	2/6	0.23	-	0.5285	0.53	m	6/6	1.8	-	2.1	2.1	m	7/48	0.25	-	0.3904	0.27	
Barium	6/6	10.5	-	44.59	44.6	m	6/6	10.68	-	21.5	21.5	m	48/48	24	-	148.1	66.5	
Beryllium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Boron	6/6	12.6	-	55.93	55.9	m	0/6	0	-	0	0		0/48	0	-	0	0	
Cadmium	2/6	0.03	-	0.1382	0.14	m	6/6	0.04054	-	0.06	0.06	m	6/48	0.08	-	0.2155	0.1	
Chromium	0/6	0	-	0	0		3/6	0.87	-	2	2	m	1/48	29.7	-	29.74	29.7	m
Cobalt	5/6	0.07	-	0.6341	0.63	m	6/6	0.312	-	0.6	0.6	m	39/48	0.13	-	0.6548	0.32	
Copper	6/6	5.78	-	11.86	11.9	m	6/6	4	-	10	10	m	48/48	4.64	-	46.37	17.6	
Iron	6/6	49.7	-	478	478	m	6/6	166.7	-	712	712	m	45/48	107	-	419.7	229	
Lead	4/6	0.11	-	0.7881	0.79	m	6/6	0.2564	-	1.1	1.1	m	7/48	0.58	-	3.177	3.18	m
Manganese	6/6	67.9	-	400.8	401	m	6/6	117.5	-	203	203	m	48/48	23.9	-	189.7	83.2	
Mercury	0/6	0	-	0	0		3/6	0.066	-	0.11	0.11	m	1/48	0.09	-	0.0931	0.09	m
Molybdenum	6/6	0.28	-	1.429	1.43	m	0/6	0	-	0	0		3/48	0.28	-	0.4217	0.42	m
Nickel	6/6	0.58	-	5.07	5.07	m	3/6	0.61	-	4.4	4.4	m	0/48	0	-	0	0	
Selenium	0/6	0	-	0	0		6/6	2.432	-	3.5	3.5	m	48/48	0.86	-	3.103	1.53	
Silver	0/6	0	-	0	0		1/6	0.01441	-	0.01	0.01	m	9/48	0.02	-	0.0854	0.03	
Strontium	6/6	11.3	-	58.68	58.7	m	6/6	32.91	-	58.6	58.6	m	48/48	18	-	99.28	55.1	
Thallium	0/6	0	-	0	0		0/6	0	-	0	0		0/48	0	-	0	0	
Vanadium	3/6	0.39	-	1.017	1.02	m	6/6	0.3718	-	1.5	1.5	m	1/48	1.68	-	1.677	1.68	m
Zinc	6/6	30.7	-	80.49	80.5	m	6/6	82.5	-	109	109	m	48/48	87.8	-	311	146	

EPC Exposure point concentrations;
the lower of the maximum (m) and the upper confidence limit (UCL) on the mean, where calculable.
FOD Frequency of Detection.
min Minimum.
max Maximum.
mg/kg Milligrams per kilogram.
mg/L Milligrams per liter.

Table 5-TR_R-2
Refined Risk Characterization for the Wood Duck
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics													
Aluminum	14,800	m	0.152		9,420	m	506.8	m	8.17E+01	386.5	109.7	0.2	0.7
Iron	18,500	m	0.169		12,000	m	478	m	2.74E+01	790.5	109.3	0.03	0.3
Vanadium	26.3	m	0.0012	m	15.1	m	1.017	m	4.67E-01	13	8	0.04	0.06

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-3
Refined Risk Characterization for the Mallard Duck
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]								Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c]		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)			LOAEL (mg/kg-BW-day)	NOAEL (mg/kg-BW-day)	LOAEL	NOAEL
Inorganics													
Aluminum	14,800	m	0.152		9,420	m	506.8	m	1.11E+02	386.5	109.7	0.3	1
Arsenic	5.4	m	0.0009		6	m	0.5285	m	3.33E-01	13	5	0.03	0.07
Iron	18,500	m	0.169		12,000	m	478	m	4.29E+01	790.5	109.3	0.05	0.4
Selenium	0		0.0005	m	4.8	m	0		2.49E-01	0.8	0.4	0.3	0.6
Vanadium	26.3	m	0.0012	m	15.1	m	1.017	m	8.02E-01	13	8	0.06	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-4
Refined Risk Characterization for the Killdeer
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)		Invertebrate Larval Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics											
Aluminum	14,800	m	0.152		9,420	m	3.03E+02	386.5	109.7	0.8	3
Arsenic	5.4	m	0.0009		6	m	9.97E-01	13	5	0.08	0.2
Iron	18,500	m	0.169		12,000	m	1.31E+02	790.5	109.3	0.2	1
Lead	10.4	m	0		12.1	m	1.85E+00	3.3	1.63	0.6	1
Selenium	0		0.0005	m	4.8	m	7.30E-01	0.8	0.4	0.9	2
Vanadium	26.3	m	0.0012	m	15.1	m	2.31E+00	13	8	0.2	0.3

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-5
Refined Risk Characterization for the Heron
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]							Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Fish Shad (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics												
Aluminum	14,800	m	0.152	9,420	m	645	m	1.32E+01	386.5	109.7	0.03	0.1
Iron	18,500	m	0.169	12,000	m	712	m	1.49E+01	790.5	109.3	0.02	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-6
Refined Risk Characterization for the Osprey
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)	Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics								
Aluminum	0.152	645	m	1.23E+01	386.5	109.7	0.03	0.1
Iron	0.169	712	m	1.51E+01	790.5	109.3	0.02	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-7
Refined Risk Characterization for the Muskrat
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Vegetation (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics										
Aluminum	14,800	m	0.152	506.8	m	2.77E+01	212.6	17	0.1	2
Iron	18,500	m	0.169	478	m	1.08E+01	31.6	22.8	0.3	0.5
Manganese	689	m	0.0653	400.8	m	2.38E+01	271	162	0.09	0.1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-8
Refined Risk Characterization for the Raccoon
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	NOAEL	HQ Range [d] LOAEL	NOAEL
Inorganics														
Aluminum	14,800	m	0.152	9,420	m	506.8	m	645	m	3.88E+01	212.6	17	0.2	2
Iron	18,500	m	0.169	12,000	m	478	m	712	m	1.65E+01	31.6	22.8	0.5	0.7

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-9
Refined Risk Characterization for the Mink
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a]											Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] (mg/kg-BW-day)		HQ Range [d]	
	Exposed Sediment (mg/kg)		Surface Water (mg/L)	Invertebrate Larval Mayfly (mg/kg)		Vegetation (mg/kg)		Fish Shad (mg/kg)		Amphibian Frogs (mg/kg)			LOAEL	NOAEL	LOAEL	NOAEL
Inorganics																
Aluminum	14,800	m	0.152	9,420	m	506.8	m	645	m	51.4		2.17E+01	212.6	17	0.1	1
Iron	18,500	m	0.169	12,000	m	478	m	712	m	229.3		1.63E+01	31.6	22.8	0.5	0.7

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-10
Refined Risk Characterization for the Tree Swallow
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)	Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics								
Copper	0.00097212		25.14	6.19E+00	12.1	4.05	0.5	2
Selenium	0.00045	m	1.919	4.73E-01	0.8	0.4	0.6	1

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 6 for sources of avian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-11
Refined Risk Characterization for the Gray Bat
Tennessee River: Reach R
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration [a] Surface Water (mg/L)		Exposure Point Concentration [a] Invertebrate Adult Mayfly (mg/kg)		Dietary Ingestion [b] (mg/kg-BW-day)	Toxicity Reference Value Range [c] LOAEL (mg/kg-BW-day)	Toxicity Reference Value Range [c] NOAEL (mg/kg-BW-day)	HQ Range [d] LOAEL	HQ Range [d] NOAEL
Inorganics									
Aluminum	0.152		7.7	m	3.17E-01	212.6	17	0.001	0.02
Copper	0.00097212		25.14		4.56E+00	9.34	5.6	0.5	0.8
Selenium	0.00045	m	1.919		3.48E-01	0.215	0.143	2	2

HQ	Hazard Quotient.	mg/kg-BW-day	Milligrams per kilogram of body weight each day.
LOAEL	Lowest Observed Adverse Effects Level.	NOAEL	No Observed Adverse Effects Level.
mg/kg	Milligrams per kilogram.	mg/L	Milligrams per liter.

[a] Exposure point concentrations were set equal to the lower of upper confidence limits (UCLs) on the mean concentration and the maximum concentrations (indicated by "m").

[b] See Table 5 for equations used to estimate refined dietary ingestion, Table 3 for bioaccessibility factors, and Table 2 for average receptor exposure assumptions.

[c] See Table 7 for sources of mammalian toxicity reference values and Table 8 for refined values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-TR_R-12
Refined Risk Characterization Results Summary
Tennessee River: Reach R
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Birds									
	Wood Duck		Mallard Duck		Killdeer		Heron		Osprey	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.2	0.7	0.3	1	0.8	**3**	0.03	0.1	0.03	0.1
Arsenic	--	--	0.03	0.07	0.08	0.2	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Iron	0.03	0.3	0.05	0.4	0.2	1	0.02	0.1	0.02	0.1
Lead	--	--	--	--	0.6	1	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	0.3	0.6	0.9	**2**	--	--	--	--
Vanadium	0.04	0.06	0.06	0.1	0.2	0.3	--	--	--	--

NA Not Applicable.

Table 5-TR_R-12
Refined Risk Characterization Results Summary
Tennessee River: Reach R
Tennesse Valley Authority
Kingston Fossil Plant

	Aquatic- and Riparian- Feeding Mammals						Aerial Feeding Insectivores			
	Muskrat		Raccoon		Mink		Tree Swallow		Gray Bat	
	Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient		Hazard Quotient	
Constituent	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Aluminum	0.1	**2**	0.2	**2**	0.1	1	--	--	0.001	0.02
Arsenic	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	0.5	**2**	0.5	0.8
Iron	0.3	0.5	0.5	0.7	0.5	0.7	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	0.09	0.1	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	0.6	1	**2**	**2**
Vanadium	--	--	--	--	--	--	--	--	--	--

LOAEL Lowest Observed Adverse Effects Level.
NOAEL No Observed Adverse Effects Level.

Table 5-Legacy Constituents-1
Exposure Point Concentrations
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Whole Body Gizzard Shad							
	Data Summary							
	FOD	n	Minimum (mg/kg)	Maximum (mg/kg)	Location of Maximum	UCL (mg/kg)	EPC (mg/kg)	
Whole System								
Dieldrin	1/15	15	0.02251	0.02251	CR_R(CRM8.0)	NA	0.0225	m
Heptachlor Epoxide	5/15	15	0.0137	0.02162	CR_R(CRM8.0)	0.016	0.016	
Total Chlordane	15/15	15	0.03009	0.05454	CR_R(CRM8.0)	0.0452	0.0452	
Total Detects Chlordane	15/15	15	0.01852	0.05454	CR_R(CRM8.0)	0.0446	0.0446	
Total DDX	15/15	15	0.06357	0.07389	ER_B(ERM2.5)	0.0692	0.0692	
Total Detects DDX	1/15	15	0.02477	0.02477	ER_C(ERM4.5)	NA	0.0248	m
Total PCBs	15/15	15	1.4833	5.6553	ER_B(ERM2.5)	2.47	2.47	
Total detects PCBs	13/15	15	0.2498	1.1982	ER_C(ERM4.5)	0.586	0.586	

DDX Dichlorodiphenyltrichloroethane (DDT) and derivatives.
EPC Exposure point concentrations. The lower of the maximum and the UCL.
FOD Frequency of Detection.
mg/kg Milligrams per kilogram.
n Number of samples.
PCB Polychlorinated Biphenyl.
UCL Upper confidence limit on the mean.

Total: Includes non-detected results at the sample detection limit.

Table 5-Legacy Constituents-2
Risk Characterization for the Heron
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration in Fish [a] (mg/kg)	Dietary Ingestion [b] (mg/kg-day)	Toxicity Reference Value (TRV) [c] (mg/kg-day)		Hazard Quotient [d] (unitless)	
			LOAEL	NOAEL	LOAEL	NOAEL
Whole System						
Total PCBs	2.47E+00	1.38E-01	7	0.41	0.02	0.3
Total detects PCBs	5.86E-01	3.29E-02	7	0.41	0.005	0.08

HQ	Hazard Quotient.
LOAEL	Lowest Observed Adverse Effect Level.
mg/kg	Milligrams per kilogram.
mg/kg-day	Milligrams per kilogram of body weight each day.
NOAEL	No Observed Adverse Effect Level.
PCB	Polychlorinated Biphenyl.

[a] Exposure point concentrations were set equal to the upper confidence limits (UCLs) on the mean concentration.

[b] See Table 5 for equations used to estimate dietary ingestion. And Table 2 for average ingestion rates and body weights. Receptor diet was assumed to be 100% fish.

[c] See Table 9 and attachment 2 for sources of refined toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

Table 5-Legacy Constituents-3
Risk Characterization for the Osprey
Kingston Fossil Plant
Tennesse Valley Authority

Constituent	Exposure Point Concentration in Fish [a] (mg/kg)	Dietary Ingestion [b] (mg/kg-day)	Toxicity Reference Value (TRV) [c] (mg/kg-day)		Hazard Quotient [d] (unitless)	
			LOAEL	NOAEL	LOAEL	NOAEL
Whole System						
Total PCBs	2.47E+00	1.52E-01	7	0.41	0.02	0.4
Total detects PCBs	5.86E-01	3.62E-02	7	0.41	0.005	0.09

HQ Hazard Quotient.
LOAEL Lowest Observed Adverse Effect Level.
mg/kg Milligrams per kilogram.
mg/kg-day Milligrams per kilogram of body weight each day.
NOAEL No Observed Adverse Effect Level.
PCB Polychlorinated Biphenyl.

[a] Exposure point concentrations were set equal to the upper confidence limits (UCLs) on the mean concentration.

[b] See Table 5 for equations used to estimate dietary ingestion. And Table 2 for average ingestion rates and body weights. Receptor diet was assumed to be 100% fish.

[c] See Table 9 and attachment 2 for sources of refined toxicity reference values.

[d] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value). HQs are rounded to one significant figure.

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Attachment 6

Probabilistic Refined Risk
Characterization Models Simulations

Table 6-1
Probabilistic Risk Evaluation for the Mallard
Kingston Fossil Plant
Tennessee Valley Authority

Constituent	Seasonally Exposed Sediment min	max	mean	stdev	Invertebrates Larval Mayfly min	max	mean	stdev	Vegetation Shoreline & Emergent min	max	mean	stdev	Fish Shad (whole body) min	max	mean	stdev	Amphibians Chorus and Peeper min	max	mean	stdev	Sediment Bioaccessibility Range [a] min	max	mean	stdev	Body Weight Range [b] mean	stdev	Food Ingestion Rate (IR) [c] (kg/day)	Dietary Ingestion Dose [d] (mg/kg-day)	LOAEL-based TRV Range [e] mean	stdev	distribution	Hazard Quotient (HQ) [f] (unitless)	Probability of HQ Exceeding 0	0.1	0.5	1	2	3	5	7	10
	lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg-day)				Normal (kg)				(mg/kg-day)											
ER_A																																									
Selenium	1.23	3.05	1.629	0.57	6.3	11.9	10	3.205	0.173	0.833	0.406	0.248	1.9	2.7	2.2	0.436	0.869	3.858	1.884	0.672	1	1	1	1	1.158	0.112	0.0801	5.29E-01	0.7	1.2	triangle	0.6	1	0.5	0	0	0	0	0	0
ER_R																																									
Selenium	1.19	1.6	1.392	0.179	2.6	4.2	3.383	0.655	0.165	0.539	0.322	0.125	1.9	2.6	2.183	0.264	26.1	69.78	38.64	10.23	1	1	1	1	1.158	0.112	0.0801	1.00E-01	0.7	1.2	triangle	0.1	0.04	0	0	0	0	0	0	0

kg kilogram
max maximum
mg milligram
TRV Toxicity Reference Value
[a] Table 3 in Dietary Uptake Document.
[b] Table 10 in Dietary Uptake Document.
[c] The IR was calculated per Nagy (2001).
[d] Table 9 in Dietary Uptake Document.
[e] Assuming the diet proportions and fraction ingestion rate that is sediemnt (FIRsed) as shown in box.
[f] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[g] 0 indicates probability is below 0.001.

min minimum
LOAEL Lowest Observed Adverse Effects Level
stdev standard deviation

Diet Proportions		13
V	Vegetation	0.25
I	Invertebrates	0.75
F	Fish	0
A	Amphibians	0
FIRsed		0.033

Table 6-2
Probabilistic Risk Evaluation for the Mallard
Kingston Fossil Plant
Tennessee Valley Authority

Constituent	Seasonally Exposed Sediment min	max	mean	stdev	Invertebrates Larval Mayfly min	max	mean	stdev	Vegetation Shoreline & Emergent min	max	mean	stdev	Fish Shad (whole body) min	max	mean	stdev	Amphibians Chorus and Peeper min	max	mean	stdev	Body Weight Range [b] max	mean	stdev	mean	stdev	Food Ingestion Rate (IR) [c] (kg/day)	Dietary Ingestion Dose [d] (mg/kg-day)	NOAEL-based TRV Range [e] mean	stdev	distribution	Hazard Quotient (HQ) [f] (unitless)	Probability of HQ Exceeding 0.1	0.5	1	2	3	5	7	10
	lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg)				lognormal (mg/kg-day)			Normal (kg)				(mg/kg-day)										
ER_A																																							
Selenium	1.23	3.05	1.629	0.57	6.3	11.9	10	3.205	0.173	0.833	0.406	0.248	1.9	2.7	2.2	0.436	0.869	3.858	1.884	0.672	1	1	1	1.158	0.112	0.0801	5.29E-01	0.4	1	triangle	0.8	1	0.8	0.02	0	0	0	0
ER_R																																							
Selenium	1.19	1.6	1.392	0.179	2.6	4.2	3.383	0.655	0.165	0.539	0.322	0.125	1.9	2.6	2.183	0.264	26.1	69.78	38.64	10.23	1	1	1	1.158	0.112	0.0801	1.00E-01	0.4	1	triangle	0.1	0.4	0	0	0	0	0	0

kg kilogram
max maximum
mg milligram
TRV Toxicity Reference Value
[a] Table 3 in Dietary Uptake Document.
[b] Table 10 in Dietary Uptake Document.
[c] The IR was calculated per Nagy (2001).
[d] Table 9 in Dietary Uptake Document.
[e] Assuming the diet proportions and fraction ingestion rate that is sediemnt (FIRsed) as shown in box.
[f] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[g] 0 indicates probability is below 0.001.

min minimum
NOAEL No Observed Adverse Effects Level
stdev standard deviation

Diet Proportions		13
V	Vegetation	0.25
I	Invertebrates	0.75
F	Fish	0
A	Amphibians	0
FIRsed		0.033

Table 6-3
Probabilistic Risk Evaluation for the Killdeer
Kingston Fossil Plant
Tennessee Valley Authority

Constituent	Exposure Point Concentration: Exposed Sediment min (Lognormal, mg/kg)	Exposed Sediment max	Exposed Sediment mean	Exposed Sediment stdev	Non-Depurated min (Lognormal, mg/kg)	Non-Depurated max	Non-Depurated mean	Non-Depurated stdev	Sediment Bioaccessibility Range [a] min (Lognormal, mg/kg-day)	Range [a] max	Range [a] mean	Range [a] stdev	Body Weight Range [b] mean (Normal, kg)	Range [b] stdev	Food Ingestion Rate (IR) [c] (kg/day)	Dietary Ingestion Dose [d] (mg/kg-day)	LOAEL-based TRV Range [e] min (mg/kg-day)	Range [e] max	Range [e] mean	Range [e] stdev	Distribution	Hazard Quotient (HQ) [f] (unitless)	Probability of HQ Exceeding 0.1	0.25	0.5	1	2	3	5	7	10	15	20
ER_A																																	
Aluminum	13800	76500	29850	18591	7540	8540	8090	507.4	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.63E+02	--	--	387	110	Normal	0.7	1	1	0.8	0.03	0.005	0.002	0.001	0	0	0	0
Arsenic	5.02	32.3	14.338	8.453	33.5	97	61.67	32.35	1	1	1	1	0.095	0.0169	0.014	9.60E+00	2	37	--	--	Triangular	0.5	1	0.8	0.4	0.05	0.02	0.007	0.000	0	0	0	0
Selenium	1.23	3.05	1.629	0.57	6.3	11.9	10	3.205	1	1	1	1	0.095	0.0169	0.014	1.55E+00	--	--	3.03	1.71	Normal	0.5	1	0.9	0.4	0.1	0.04	0.03	0.02	0.01	0.007	0.006	0.004
ER_B																																	
Aluminum	3320	39400	17585.6	10258	9050	10300	9693	625.8	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	3.12E+02	--	--	387	110	Normal	0.8	1	1.00	0.93	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Selenium	1.18	3.64	1.528	0.563	6.6	7.2	7	0.346	1	1	1	1	0.095	0.0169	0.014	1.09E+00	--	--	3.03	1.71	Normal	0.4	1	0.77	0.25	0.06	0.03	0.02	0.01	0.008	0.00	0.00	0.00
ER_C																																	
Aluminum	1900	27100	9164	8473	5330	6340	5667	583.1	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	1.82E+02	--	--	387	110	Normal	0.5	1	1	0.3	0.010	0.002	0.001	0.001	0.000	0.000	0.000	0.000
Selenium	1.26	1.58	1.38	0.095	3.8	5	4.567	0.666	1	1	1	1	0.095	0.0169	0.014	7.16E-01	--	--	3.03	1.71	Normal	0.2	0.8	0.4	0.1	0.03	0.02	0.01	0.008	0.005	0.002	0.002	0.002
ER_R																																	
Aluminum	2480	14800	8594	4995.3	4090	6380	4942	955.2	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	1.59E+02	--	--	387	110	Normal	0.4	1	0.9	0.2	0.004	0.002	0.001	0.000	0.000	0.000	0	0
Arsenic	1.36	5.4	2.974	1.577	2.8	4.5	3.45	0.606	1	1	1	1	0.095	0.0169	0.014	5.71E-01	2	37	--	--	Triangular	0.03	0.01	0	0	0	0	0	0	0	0	0	0
Selenium	1.19	1.6	1.392	0.179	2.6	4.2	3.383	0.655	1	1	1	1	0.095	0.0169	0.014	5.36E-01	--	--	3.03	1.71	Normal	0.2	0.6	0.3	0.09	0.02	0.01	0.01	0.006	0.005	0.002	0.001	0.001
ER																																	
Aluminum	1900	76500	19159.5	14894	4090	10300	6667	2087	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.16E+02	--	--	387	110	Normal	0.6	1	1.0	0.5	0.03	0.004	0.001	0	0	0	0	0
Selenium	1.18	3.64	1.522	0.49	2.6	11.9	5.667	2.932	1	1	1	1	0.095	0.0169	0.014	8.85E-01	--	--	3.03	1.71	Normal	0.3	0.8	0.5	0.2	0.05	0.03	0.02	0.009	0.007	0.002	0.002	0.002
CR_A																																	
Aluminum	7370	143000	44080.8	38242	6930	10900	8970	1987	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.94E+02	--	--	387	110	Normal	0.8	1	1	0.8	0.05	0.007	0.003	0.002	0	0	0	0
Selenium	1.25	1.64	1.385	0.13	6.5	6.6	6.567	0.058	1	1	1	1	0.095	0.0169	0.014	1.02E+00	--	--	3.03	1.71	Normal	0.3	1	0.7	0.2	0.05	0.03	0.02	0.01	0.007	0.004	0.003	0.002
CR_B																																	
Aluminum	9870	59400	27143.8	14540	8440	9120	8870	374	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.87E+02	--	--	387	110	Normal	0.7	1	1	0.9	0.04	0.009	0.002	0.001	0	0	0	0
Selenium	1.2	2.95	1.472	0.475	6.6	7.4	7.033	0.404	1	1	1	1	0.095	0.0169	0.014	1.09E+00	--	--	3.03	1.71	Normal	0.3	1	0.8	0.2	0.05	0.03	0.02	0.01	0.008	0.003	0.002	0.002
CR_R																																	
Aluminum	2480	14800	8594	4995.3	6610	7620	7150	508.6	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.29E+02	--	--	387	110	Normal	0.6	1	1	0.6	0.02	0.002	0.001	0.001	0	0	0	0
Selenium	1.19	1.6	1.392	0.179	4.2	4.6	4.467	0.231	1	1	1	1	0.095	0.0169	0.014	7.01E-01	--	--	3.03	1.71	Normal	0.2	0.8	0.4	0.1	0.03	0.02	0.01	0.007	0.005	0.002	0.002	0.002
CR																																	
Aluminum	7370	143000	35273.6	29165	6610	10900	8330	1368	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.72E+02	--	--	387	110	Normal	0.7	1	1	0.8	0.04	0.006	0.002	0.001	0.001	0	0	0
Selenium	1.2	2.95	1.43	0.35	4.2	7.4	6.022	1.207	1	1	1	1	0.095	0.0169	0.014	9.38E-01	--	--	3.03	1.71	Normal	0.3	0.9	0.6	0.2	0.04	0.02	0.02	0.010	0.007	0.004	0.003	0.002
TR_A																																	
Aluminum	7370	143000	44080.8	38242	8060	10900	9787	1516	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	3.20E+02	--	--	387	110	Normal	0.8	1	1	0.9	0.06	0.01	0.003	0.001	0.000	0.000	0	0
Selenium	1.25	1.64	1.385	0.13	4.9	5.9	5.467	0.513	1	1	1	1	0.095	0.0169	0.014	8.53E-01	--	--	3.03	1.71	Normal	0.3	0.9	0.6	0.2	0.04	0.02	0.02	0.009	0.006	0.003	0.002	0.002
TR_B																																	
Aluminum	7370	143000	44080.8	38242	9250	10700	9810	779.3	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	3.20E+02	--	--	387	110	Normal	0.8	1	1	1.0	0.05	0.01	0.003	0.001	0	0	0	0
Selenium	1.25	1.64	1.385	0.13	5.6	6	5.8	0.2	1	1	1	1	0.095	0.0169	0.014	9.03E-01	--	--	3.03	1.71	Normal	0.3	1	0.6	0.2	0.04	0.02	0.02	0.010	0.006	0.003	0.002	0.001

kg	kilogram	min	minimum
max	maximum	LOAEL	Lowest Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		
[a]	Table 3 in Dietary Uptake Document.		
[b]	Table 10 in Dietary Uptake Document.		
[c]	The IR was calculated per Nagy (2001).		
[d]	Assuming the diet is 100% larval mayfly with a 10.4% incidental sediment ingestion rate.		
[e]	Table 9 in Dietary Uptake Document.		
[f]	Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).		
[g]	0 indicates probability is below 0.001.		

Diet Proportions		
V	Vegetation	0
I	Invertebrat	1
F	Fish	0
A	Amphibians	0
FIRsed		0

Table 6-4
Probabilistic Risk Evaluation for the Killdeer
Kingston Fossil Plant
Tennessee Valley Authority

Constituent	Exposure Point Concentration: Exposed Sediment min (mg/kg) Lognormal	Exposed Sediment max (mg/kg)	Exposed Sediment mean (mg/kg)	Exposed Sediment stdev (mg/kg)	Non-Depurated min (mg/kg) Lognormal	Non-Depurated max (mg/kg)	Non-Depurated mean (mg/kg)	Non-Depurated stdev (mg/kg)	Sediment Bioaccessibility Range [a] min (mg/kg-BW-day) Lognormal	Range [a] max (mg/kg-BW-day)	Range [a] mean (mg/kg-BW-day)	Range [a] stdev (mg/kg-BW-day)	Body Weight Range [b] mean (kg) Normal	Range [b] stdev (kg)	Food Ingestion Rate (IR) [c] (kg/day)	Dietary Ingestion Dose [d] (mg/kg-day)	NOAEL-based TRV Range [e] min (mg/kg-day)	Range [e] max (mg/kg-day)	Range [e] mean (mg/kg-day)	Range [e] stdev (mg/kg-day)	Range [e] Distribution	Hazard Quotient (HQ) [f] (unitless)	Probability of HQ Exceeding 0.1	0.25	0.5	1	2	3	5	7	10	15	20
ER_A																																		
Aluminum	13800	76500	29850	18591	7540	8540	8090	507.4	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.63E+02	--	--	137	39	Normal	2	1	1	1	0.8	0.2	0.06	0.01	0.005	0.001	0	0
Arsenic	5.02	32.3	14.34	8.453	33.5	97	61.67	32.35	1	1	1	1	0.095	0.0169	0.014	9.60E+00	2	24	--	--	Triangular	0.7	1	1.0	0.6	0.1	0.03	0.014	0.003	0	0	0	0
Selenium	1.23	3.05	1.629	0.57	6.3	11.9	10	3.205	1	1	1	1	0.095	0.0169	0.014	1.55E+00	--	--	1.69	1.11	Normal	0.8	1	1.0	0.8	0.2	0.1	0.07	0.05	0.03	0.01	0.01	0.007
ER_B																																		
Aluminum	3320	39400	17586	10258	9050	10300	9693	625.8	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	3.12E+02	--	--	137	39	Normal	2	1	1	1.00	1.0	0.4	0.1	0.04	0.006	0.000	0.000	0.00
Selenium	1.18	3.64	1.528	0.563	6.6	7.2	7	0.346	1	1	1	1	0.095	0.0169	0.014	1.09E+00	--	--	1.69	1.11	Normal	0.6	1	1.0	0.6	0.1	0.07	0.05	0.04	0.02	0.011	0.010	0.005
ER_C																																		
Aluminum	1900	27100	9164	8473	5330	6340	5667	583.1	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	1.82E+02	--	--	137	39	Normal	1	1	1	1	0.4	0.05	0.02	0.006	0.001	0	0	0
Selenium	1.26	1.58	1.38	0.095	3.8	5	4.567	0.666	1	1	1	1	0.095	0.0169	0.014	7.16E-01	--	--	1.69	1.11	Normal	0.4	1	0.8	0.3	0.08	0.04	0.03	0.02	0.01	0.006	0.005	0.004
ER_R																																		
Aluminum	2480	14800	8594	4995.3	4090	6380	4942	955.2	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	1.59E+02	--	--	137	39	Normal	1	1	1	1	0.2	0.04	0.01	0.005	0.001	0.001	0.001	0.001
Arsenic	1.36	5.4	2.974	1.577	2.8	4.5	3.45	0.606	1	1	1	1	0.095	0.0169	0.014	5.71E-01	2	24	--	--	Triangular	0.04	0.01	0.000	0	0	0	0	0	0	0	0	0
Selenium	1.19	1.6	1.392	0.179	2.6	4.2	3.383	0.655	1	1	1	1	0.095	0.0169	0.014	5.36E-01	--	--	1.69	1.11	Normal	0.3	0.94	0.6	0.2	0.05	0.03	0.02	0.01	0.011	0.005	0.004	0.001
ER																																		
Aluminum	1900	76500	19160	14894	4090	10300	6667	2087	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.16E+02	--	--	137	39	Normal	2	1	1	1	0.5	0.1	0.05	0.01	0.005	0.001	0	0
Selenium	1.18	3.64	1.522	0.49	2.6	11.9	5.667	2.932	1	1	1	1	0.095	0.0169	0.014	8.85E-01	--	--	1.69	1.11	Normal	0.5	1	0.8	0.4	0.1	0.06	0.04	0.03	0.02	0.008	0.007	0.004
CR_A																																		
Aluminum	7370	143000	44081	38242	6930	10900	8970	1987	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.94E+02	--	--	137	39	Normal	2	1	1	1	0.8	0.4	0.1	0.02	0.009	0.002	0.001	0.000
Selenium	1.25	1.64	1.385	0.13	6.5	6.6	6.567	0.058	1	1	1	1	0.095	0.0169	0.014	1.02E+00	--	--	1.69	1.11	Normal	0.6	1	1	0.5	0.1	0.06	0.04	0.02	0.02	0.009	0.008	0.005
CR_B																																		
Aluminum	9870	59400	27144	14540	8440	9120	8870	374	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.87E+02	--	--	137	39	Normal	2	1	1	1	0.9	0.3	0.08	0.02	0.005	0.001	0	0
Selenium	1.2	2.95	1.472	0.475	6.6	7.4	7.033	0.404	1	1	1	1	0.095	0.0169	0.014	1.09E+00	--	--	1.69	1.11	Normal	0.6	1	1	0.6	0.1	0.07	0.05	0.03	0.02	0.009	0.008	0.006
CR_R																																		
Aluminum	2480	14800	8594	4995.3	6610	7620	7150	508.6	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.29E+02	--	--	137	39	Normal	2	1	1	1	0.7	0.1	0.04	0.008	0.003	0.001	0	0
Selenium	1.19	1.6	1.392	0.179	4.2	4.6	4.467	0.231	1	1	1	1	0.095	0.0169	0.014	7.01E-01	--	--	1.69	1.11	Normal	0.4	1	0.8	0.3	0.08	0.04	0.03	0.02	0.01	0.006	0.005	0.004
CR																																		
Aluminum	7370	143000	35274	29165	6610	10900	8330	1368	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	2.72E+02	--	--	137	39	Normal	2	1	1	1	0.8	0.3	0.08	0.01	0.007	0.001	0.001	0.000
Selenium	1.2	2.95	1.43	0.35	4.2	7.4	6.022	1.207	1	1	1	1	0.095	0.0169	0.014	9.38E-01	--	--	1.69	1.11	Normal	0.5	1	0.9	0.5	0.1	0.06	0.04	0.02	0.02	0.01	0.005	0.005
TR_A																																		
Aluminum	7370	143000	44081	38242	8060	10900	9787	1516	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	3.20E+02	--	--	137	39	Normal	2	1	1	1	0.9	0.4	0.1	0.03	0.01	0.001	0.000	0
Selenium	1.25	1.64	1.385	0.13	4.9	5.9	5.467	0.513	1	1	1	1	0.095	0.0169	0.014	8.53E-01	--	--	1.69	1.11	Normal	0.5	1	0.9	0.4	0.11	0.05	0.03	0.02	0.02	0.007	0.006	0.004
TR_B																																		
Aluminum	7370	143000	44081	38242	9250	10700	9810	779.3	0.003	0.0263	0.01171	0.00631035	0.095	0.0169	0.014	3.20E+02	--	--	137	39	Normal	2	1	1	1	1	0.4	0.1	0.03	0.009	0.002	0.001	0.001
Selenium	1.25	1.64	1.385	0.13	5.6	6	5.8	0.2	1	1	1	1	0.095	0.0169	0.014	9.03E-01	--	--	1.69	1.11	Normal	0.5	1	1	0.5	0.1	0.05	0.04	0.02	0.02	0.007	0.006	0.005

kg	kilogram	min	minimum
max	maximum	NOAEL	No Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		
[a]	Table 3 in Dietary Uptake Document.		
[b]	Table 10 in Dietary Uptake Document.		
[c]	The IR was calculated per Nagy (2001).		
[d]	Assuming the diet is 100% larval mayfly with a 10.4% incidental sediment ingestion rate.		
[e]	Table 9 in Dietary Uptake Document.		
[f]	Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).		
[g]	0 indicates probability is below 0.001.		

Diet Proportions		
V	Vegetation	0
I	Invertebrat	1
F	Fish	0
A	Amphibian	0
FIRsed		0

Table 6-5
Probabilistic Risk Evaluation for the Raccoon
Kingston Fossil Plant
Tennessee Valley Authority

Constituent	Seasonally Exposed Sediment min	Seasonally Exposed Sediment max	Seasonally Exposed Sediment mean	Seasonally Exposed Sediment stdev	Invertebrates Larval Mayfly min	Invertebrates Larval Mayfly max	Invertebrates Larval Mayfly mean	Invertebrates Larval Mayfly stdev	Vegetation Shoreline & Emergent min	Vegetation Shoreline & Emergent max	Vegetation Shoreline & Emergent mean	Vegetation Shoreline & Emergent stdev	Fish Shad (whole body) min	Fish Shad (whole body) max	Fish Shad (whole body) mean	Fish Shad (whole body) stdev	Amphibians Chorus and Peeper min	Amphibians Chorus and Peeper max	Amphibians Chorus and Peeper mean	Amphibians Chorus and Peeper stdev	Sediment Bioaccessibility Range [a] min	Sediment Bioaccessibility Range [a] max	Sediment Bioaccessibility Range [a] mean	Sediment Bioaccessibility Range [a] stdev	Body Weight Range [b] mean	Body Weight Range [b] stdev	Food Ingestion Rate (IR) [c]	Dietary Ingestion Dose [d]	LOAEL-based TRV Range [e] mean	LOAEL-based TRV Range [e] stdev	LOAEL-based TRV Range [e] distribution	Hazard Quotient (HQ) [f]	Probability of HQ Exceeding 0.1	0.5	1	2	3	5	7	10
	lognormal				lognormal				lognormal				lognormal				lognormal				lognormal				Normal																
	(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg-day)				(kg)		(kg/day)	(mg/kg-day)	(mg/kg-day)			(unitless)								
ER_A																																									
Aluminum	13800	76500	29850	18591	7540	8540	8090	507.4	35.34	200.8	82.18	61.83	1670	1970	1780	165.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.61E+01	96	103	Normal	0.2	0.7	0.2	0.06	0.04	0.03	0.02	0.01	0.005
ER_B																																									
Aluminum	3320	39400	17586	10258	9050	10300	9693	625.8	18.99	167.3	64.71	56.51	44.6	2590	940.9	1023	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	3.01E+01	96	103	Normal	0.2	0.8	0.2	0.07	0.04	0.03	0.02	0.01	0.006
ER_C																																									
Aluminum	1900	27100	9164	8473	5330	6340	5667	583.1	31.82	440.1	166.3	142.2	18.81	573	258.9	262	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.01E+01	96	103	Normal	0.2	0.6	0.1	0.04	0.03	0.02	0.01	0.009	0.004
ER_R																																									
Aluminum	2480	14800	8594	4995.3	4090	6380	4942	955.2	37.25	955	423.9	392.9	706	1970	1411	430.2	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.37E+01	96	103	Normal	0.2	0.6	0.2	0.06	0.03	0.02	0.02	0.01	0.006
ER																																									
Aluminum	1900	76500	19160	14894	4090	10300	6667	2087	18.99	440.1	104.4	100.5	18.81	2590	1000	797.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.21E+01	96	103	Normal	0.2	0.6	0.1	0.05	0.02	0.02	0.01	0.01	0.003
CR_A																																									
Aluminum	7370	1E+05	44081	38242	6930	10900	8970	1987	26.21	450.8	121.5	163.3	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.96E+01	96	103	Normal	0.2	0.8	0.2	0.07	0.04	0.03	0.02	0.01	0.005
CR_B																																									
Aluminum	9870	59400	27144	14540	8440	9120	8870	374	25.91	154.1	84.41	46.11	602.7	1560	959.5	403.4	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.82E+01	96	103	Normal	0.2	0.8	0.2	0.06	0.04	0.03	0.02	0.01	0.006
CR_R																																									
Aluminum	2480	14800	8594	4995.3	6610	7620	7150	508.6	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.50E+01	96	103	Normal	0.2	0.7	0.2	0.06	0.03	0.02	0.01	0.01	0.006
TR_A																																									
Aluminum	7370	1E+05	44081	38242	8060	10900	9787	1516	14.49	362.2	119.7	135.6	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	3.19E+01	96	103	Normal	0.2	0.8	0.2	0.07	0.04	0.03	0.02	0.02	0.007
TR_B																																									
Aluminum	7370	1E+05	44081	38242	9250	10700	9810	779.3	18.58	223.4	121.4	88.37	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	3.20E+01	96	103	Normal	0.2	0.9	0.2	0.07	0.04	0.03	0.02	0.01	0.006
TR_R																																									
Aluminum	2480	14800	8594	4995.3	6710	9420	8160	1365	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.80E+01	96	103	Normal	0.2	0.8	0.2	0.06	0.03	0.03	0.02	0.01	0.006

kg kilogram
max maximum
mg milligram
TRV Toxicity Reference Value
[a] Table 3 in Dietary Uptake Document.
[b] Table 10 in Dietary Uptake Document.
[c] The IR was calculated per Nagy (2001).
[d] Table 9 in Dietary Uptake Document.
[e] Assuming the diet proportions and fraction ingestion rate that is sediemnt (FIRsed) as shown in box.
[f] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[g] 0 indicates probability is below 0.001.

min minimum
LOAEL Lowest Observed Adverse Effects Level
stdev standard deviation

Diet Proportions		43
V	Vegetation	0.58
I	Invertebrates	0.39
F	Fish	0.03
A	Amphibians	0
FIRsed		0.02

Table 6-6
Probabilistic Risk Evaluation for the Raccoon
Kingston Fossil Plant
Tennessee Valley Authority

	Seasonally Exposed Sediment				Invertebrates				Vegetation				Fish				Amphibians				Sediment Bioaccessibility				Body Weight		Food	Dietary	NOAEL-based TRV			Hazard	Probability of HQ Exceeding								
					Larval Mayfly				Shoreline & Emergent				Shad (whole body)				Chorus and Peeper				Range [a]				Range [b]		Ingestion	Ingestion	Range [e]			Quotient								
	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	mean	stdev	Rate	Dose [d]	mean	stdev	distribution	(HQ) [f]	0	0.1	0.5	1	2	3	5	7	10
	lognormal				lognormal				lognormal				lognormal				lognormal				lognormal				Normal		(IR) [c]														
Constituent	(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg-day)				(kg)		(kg/day)	(mg/kg-day)	(mg/kg-day)			(unitless)									
ER_A																																									
Aluminum	13800	76500	29850	18591	7540	8540	8090	507.4	35.34	200.8	82.18	61.83	1670	1970	1780	165.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.61E+01	16	10	Normal	1	1	1	0.5	0.2	0.1	0.08	0.05	0.02
ER_B																																									
Aluminum	3320	39400	17586	10258	9050	10300	9693	625.8	18.99	167.3	64.71	56.51	44.6	2590	940.9	1023	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	3.01E+01	16.367	10.26	Normal	2	1	1	0.6	0.3	0.2	0.1	0.07	0.03
ER_C																																									
Aluminum	1900	27100	9164	8473	5330	6340	5667	583.1	31.82	440.1	166.3	142.2	18.81	573	258.9	262	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.01E+01	16.367	10.26	Normal	1	1	1	0.4	0.2	0.1	0.06	0.04	0.02
ER_R																																									
Aluminum	2480	14800	8594	4995.3	4090	6380	4942	955.2	37.25	955	423.9	392.9	706	1970	1411	430.2	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.37E+01	16.367	10.26	Normal	1	1	1	0.4	0.2	0.1	0.08	0.05	0.02
ER																																									
Aluminum	1900	76500	19160	14894	4090	10300	6667	2087	18.99	440.1	104.4	100.5	18.81	2590	1000	797.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.21E+01	16.367	10.26	Normal	1	1	1.0	0.4	0.2	0.1	0.06	0.04	0.02
CR_A																																									
Aluminum	7370	1E+05	44081	38242	6930	10900	8970	1987	26.21	450.8	121.5	163.3	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.96E+01	16.367	10.26	Normal	2	1	1	0.6	0.3	0.2	0.10	0.06	0.03
CR_B																																									
Aluminum	9870	59400	27144	14540	8440	9120	8870	374	25.91	154.1	84.41	46.11	602.7	1560	959.5	403.4	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.82E+01	16.367	10.26	Normal	2	1	1	0.6	0.3	0.2	0.09	0.06	0.03
CR_R																																									
Aluminum	2480	14800	8594	4995.3	6610	7620	7150	508.6	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.50E+01	16.367	10.26	Normal	1	1	1	0.5	0.2	0.1	0.07	0.05	0.02
TR_A																																									
Aluminum	7370	1E+05	44081	38242	8060	10900	9787	1516	14.49	362.2	119.7	135.6	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	3.19E+01	16.367	10.26	Normal	2	1	1	0.7	0.3	0.2	0.11	0.07	0.03
TR_B																																									
Aluminum	7370	1E+05	44081	38242	9250	10700	9810	779.3	18.58	223.4	121.4	88.37	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	3.20E+01	16.367	10.26	Normal	2	1	1	0.7	0.3	0.2	0.1	0.07	0.03
TR_R																																									
Aluminum	2480	14800	8594	4995.3	6710	9420	8160	1365	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	5.44	1.363	0.1943	2.80E+01	16.367	10.26	Normal	2	1	1	0.6	0.3	0.2	0.09	0.06	0.02

kg kilogram
max maximum
mg milligram
TRV Toxicity Reference Value
[a] Table 3 in Dietary Uptake Document.
[b] Table 10 in Dietary Uptake Document.
[c] The IR was calculated per Nagy (2001).
[d] Table 9 in Dietary Uptake Document.
[e] Assuming the diet proportions and fraction ingestion rate that is sediemnt (FIRsed) as shown in box.
[f] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[g] 0 indicates probability is below 0.001.

min minimum
NOAEL No Observed Adverse Effects Level
stdev standard deviation

Diet Proportions		**43**
V	Vegetation	0.58
I	Invertebrates	0.39
F	Fish	0.03
A	Amphibians	0
FIRsed		0.02

Table 6-7
Probabilistic Risk Evaluation for the Mink
Kingston Fossil Plant
Tennessee Valley Authority

Constituent	Seasonally Exposed Sediment (mg/kg) min	max	mean	stdev	Invertebrates Larval Mayfly (mg/kg) min	max	mean	stdev	Vegetation Shoreline & Emergent (mg/kg) min	max	mean	stdev	Fish Shad (whole body) (mg/kg) min	max	mean	stdev	Amphibians Chorus and Peeper (mg/kg) min	max	mean	stdev	Sediment Bioaccessibility Range [a] (mg/kg-day) min	max	mean	stdev	Body Weight Range [b] (kg) mean	stdev	Food Ingestion Rate (IR) [c] (kg/day)	Dietary Ingestion Dose [d] (mg/kg-day)	NOAEL-based TRV Range [e] (mg/kg-day) mean	stdev	distribution	Hazard Quotient (HQ) [f] (unitless)	Probability of HQ Exceeding 0.1	0.5	1	2	3	5	7	10
	lognormal				lognormal				lognormal				lognormal				lognormal				lognormal				Normal														
ER_A																																							
Aluminum	13800	76500	29850	18591.029	7540	8540	8090	507.4	35.34	200.8	82.18	61.83	1670	1970	1780	165.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.32E+01	96	103	Normal	0.3	0.9	0.2	0.07	0.04	0.03	0.02	0.01	0.007
ER_B																																							
Aluminum	3320	39400	17586	10257.694	9050	10300	9693	625.8	18.99	167.3	64.71	56.51	44.6	2590	940.9	1023	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.38E+01	96	103	Normal	0.2	0.6	0.2	0.05	0.03	0.02	0.01	0.01	0.006
ER_C																																							
Aluminum	1900	27100	9164	8472.974	5330	6340	5667	583.1	31.82	440.1	166.3	142.2	18.81	573	258.9	262	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	1.07E+01	96	103	Normal	0.08	0.3	0.06	0.02	0.01	0.01	0.01	0.004	0.002
ER_R																																							
Aluminum	2480	14800	8594	4995.306	4090	6380	4942	955.2	37.25	955	423.9	392.9	706	1970	1411	430.2	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.62E+01	96	103	Normal	0.2	0.7	0.2	0.06	0.04	0.03	0.01	0.01	0.005
ER																																							
Aluminum	1900	76500	19160	14894.406	4090	10300	6667	2087	18.99	440.1	104.4	100.5	18.81	2590	1000	797.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.13E+01	96	103	Normal	0.2	0.6	0.1	0.05	0.03	0.02	0.01	0.01	0.005
CR_A																																							
Aluminum	7370	1E+05	44081	38242.407	6930	10900	8970	1987	26.21	450.8	121.5	163.3	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.18E+01	96	103	Normal	0.2	0.8	0.2	0.07	0.04	0.03	0.02	0.02	0.009
CR_B																																							
Aluminum	9870	59400	27144	14539.853	8440	9120	8870	374	25.91	154.1	84.41	46.11	602.7	1560	959.5	403.4	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.33E+01	96	103	Normal	0.2	0.6	0.2	0.05	0.03	0.02	0.01	0.01	0.005
CR_R																																							
Aluminum	2480	14800	8594	4995.306	6610	7620	7150	508.6	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	1.33E+01	96	103	Normal	0.1	0.4	0.09	0.03	0.02	0.01	0.006	0.005	0.003
TR_A																																							
Aluminum	7370	1E+05	44081	38242.407	8060	10900	9787	1516	14.49	362.2	119.7	135.6	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.27E+01	96	103	Normal	0.3	0.8	0.2	0.07	0.04	0.03	0.02	0.02	0.007
TR_B																																							
Aluminum	7370	1E+05	44081	38242.407	9250	10700	9810	779.3	18.58	223.4	121.4	88.37	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.27E+01	96	103	Normal	0.3	0.8	0.2	0.08	0.04	0.03	0.02	0.01	0.008
TR_R																																							
Aluminum	2480	14800	8594	4995.306	6710	9420	8160	1365	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	1.45E+01	96	103	Normal	0.1	0.4	0.1	0.03	0.02	0.01	0.006	0.005	0.003

kg	kilogram	min	minimum
max	maximum	LOAEL	Lowest Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		
[a]	Table 3 in Dietary Uptake Document.		
[b]	Table 10 in Dietary Uptake Document.		
[c]	The IR was calculated per Nagy (2001).		
[d]	Table 9 in Dietary Uptake Document.		
[e]	Assuming the diet proportions and fraction ingestion rate that is sediemnt (FIRsed) as shown in box.		
[f]	Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).		
[g]	0 indicates probability is below 0.001.		

Diet Proportions		**49**
V	Vegetation	0.09
I	Invertebrates	0.1
F	Fish	0.79
A	Amphibians	0.02
FIRsed		0.02

Table 6-8
Probabilistic Risk Evaluation for the Mink
Kingston Fossil Plant
Tennessee Valley Authority

	Seasonally Exposed Sediment				Invertebrates				Vegetation				Fish				Amphibians				Sediment Bioaccessibility				Body Weight		Food	Dietary	NOAEL-based TRV			Hazard	Probability of HQ Exceeding							
					Larval Mayfly				Shoreline & Emergent				Shad (whole body)				Chorus and Peeper				Range [a]				Range [b]		Ingestion	Ingestion	Range [e]			Quotient							
	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	min	max	mean	stdev	mean	stdev	Rate	Dose [d]	mean	stdev	distribution	(HQ) [f]	0.1	0.5	1	2	3	5	7	10
	lognormal				lognormal				lognormal				lognormal				lognormal				lognormal				Normal		(IR) [c]													
Constituent	(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg)				(mg/kg-day)				(kg)		(kg/day)	(mg/kg-day)	(mg/kg-day)			(unitless)								
ER_A																																								
Aluminum	13800	76500	29850	18591	7540	8540	8090	507.4	35.34	200.8	82.18	61.83	1670	1970	1780	165.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.32E+01	16	10	Normal	2	1	1	0.7	0.4	0.2	0.1	0.07	0.03
ER_B																																								
Aluminum	3320	39400	17586	10258	9050	10300	9693	625.8	18.99	167.3	64.71	56.51	44.6	2590	940.9	1023	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.38E+01	16.367	10.26	Normal	1	1	0.9	0.4	0.2	0.1	0.08	0.05	0.02
ER_C																																								
Aluminum	1900	27100	9164	8473	5330	6340	5667	583.1	31.82	440.1	166.3	142.2	18.81	573	258.9	262	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	1.07E+01	16.367	10.26	Normal	0.6	1	0.6	0.1	0.08	0.04	0.03	0.02	0.007
ER_R																																								
Aluminum	2480	14800	8594	4995.3	4090	6380	4942	955.2	37.25	955	423.9	392.9	706	1970	1411	430.2	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.62E+01	16.367	10.26	Normal	1	1	1	0.5	0.2	0.2	0.08	0.06	0.02
ER																																								
Aluminum	1900	76500	19160	14894	4090	10300	6667	2087	18.99	440.1	104.4	100.5	18.81	2590	1000	797.2	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.13E+01	16.367	10.26	Normal	1	1	0.9	0.4	0.2	0.1	0.07	0.04	0.02
CR_A																																								
Aluminum	7370	1E+05	44081	38242	6930	10900	8970	1987	26.21	450.8	121.5	163.3	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.18E+01	16.367	10.26	Normal	2	1	1	0.6	0.3	0.2	0.1	0.07	0.03
CR_B																																								
Aluminum	9870	59400	27144	14540	8440	9120	8870	374	25.91	154.1	84.41	46.11	602.7	1560	959.5	403.4	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	2.33E+01	16.367	10.26	Normal	1	1	1	0.4	0.2	0.1	0.07	0.04	0.02
CR_R																																								
Aluminum	2480	14800	8594	4995.3	6610	7620	7150	508.6	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	1.33E+01	16.367	10.26	Normal	0.8	1	0.8	0.2	0.1	0.06	0.04	0.02	0.01
TR_A																																								
Aluminum	7370	1E+05	44081	38242	8060	10900	9787	1516	14.49	362.2	119.7	135.6	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.27E+01	16.367	10.26	Normal	2	1	1	0.6	0.4	0.2	0.1	0.07	0.03
TR_B																																								
Aluminum	7370	1E+05	44081	38242	9250	10700	9810	779.3	18.58	223.4	121.4	88.37	441	3074	1571	1018	30.68	187.1	41.84	27.24	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	3.27E+01	16.367	10.26	Normal	2	1	1	0.6	0.3	0.2	0.1	0.07	0.03
TR_R																																								
Aluminum	2480	14800	8594	4995.3	6710	9420	8160	1365	26.35	506.8	192.6	202.7	101.7	645	323.3	201.7	26.1	69.78	38.64	10.23	0.003	0.026	0.012	0.006	1.11	0.165	0.0596	1.45E+01	16.367	10.26	Normal	0.8	1	0.8	0.2	0.1	0.06	0.04	0.02	0.01

kg kilogram
max maximum
mg milligram
TRV Toxicity Reference Value
[a] Table 3 in Dietary Uptake Document.
[b] Table 10 in Dietary Uptake Document.
[c] The IR was calculated per Nagy (2001).
[d] Table 9 in Dietary Uptake Document.
[e] Assuming the diet proportions and fraction ingestion rate that is sediemnt (FIRsed) as shown in box.
[f] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[g] 0 indicates probability is below 0.001.

min minimum
NOAEL No Observed Adverse Effects Level
stdev standard deviation

Diet Proportions		49
V	Vegetation	0.09
I	Invertebrates	0.1
F	Fish	0.79
A	Amphibians	0.02
FIRsed		0.02

Table 6-9
Probabilistic Risk Evaluation for the Tree Swallow
Kingston Fossil Plant
Tennessee Valley Authority

Area	Exposure Point Concentration Selenium in Adult Mayfly				Body Weight BW [a]		Food Ingestion Rate (IR) [b]	Dietary Ingestion Dose [c]	LOAEL-based TRV [d]		Hazard Quotient (HQ) [e]	Probability of HQ Exceeding Target HQ							
	min	max	mean	stdev	mean	stdev			mean	stdev									
	Logmormal Distribution				Normal				Normal										
	(mg/kg)				(kg)		(kg/day)	(mg/kg-day)	(mg/kg-day)		(unitless)	0.1	0.5	1.0	2.0	3.0	5.0	7.0	10.0
ER_A	5.6	8.2	7.1	0.6	0.020	0.001	0.005	1.75E+00	3.03	1.71	0.6	1	0.5	0.1	0.05	0.03	0.02	0.01	0.007
ER_B	6.5	8.4	7.6	0.7	0.020	0.001	0.005	1.86E+00	3.03	1.71	0.6	1	0.6	0.1	0.05	0.04	0.02	0.01	0.006
ER_C	6.5	7.5	6.9	0.4	0.020	0.001	0.005	1.70E+00	3.03	1.71	0.5	1	0.5	0.1	0.05	0.03	0.02	0.01	0.006
ER_R	3.7	4.1	3.9	0.1	0.020	0.001	0.005	9.57E-01	3.03	1.71	0.3	1	0.2	0.05	0.02	0.02	0.01	0.007	0.003
ER	5.6	8.4	7.3	0.7	0.020	0.001	0.005	1.81E+00	3.03	1.71	0.6	1	0.5	0.1	0.05	0.03	0.02	0.01	0.006
CR_A	5.2	6.7	5.9	0.6	0.020	0.001	0.005	1.45E+00	3.03	1.71	0.5	1	0.4	0.08	0.04	0.02	0.02	0.01	0.006
CR_B	5.8	6.6	6.2	0.3	0.020	0.001	0.005	1.53E+00	3.03	1.71	0.5	1	0.4	0.09	0.04	0.03	0.02	0.01	0.005
CR_R	3.7	4.1	3.9	0.1	0.020	0.001	0.005	9.57E-01	3.03	1.71	0.3	1	0.2	0.05	0.02	0.02	0.009	0.007	0.003
CR	3.7	6.7	5.5	1.1	0.020	0.001	0.005	1.34E+00	3.03	1.71	0.4	1	0.3	0.07	0.04	0.03	0.01	0.01	0.004
TR_A	2.9	4.1	3.4	0.4	0.020	0.001	0.005	8.32E-01	3.03	1.71	0.3	0.9	0.2	0.04	0.02	0.01	0.008	0.005	0.003
TR_B	3.3	5.3	3.9	0.5	0.020	0.001	0.005	9.62E-01	3.03	1.71	0.3	1	0.2	0.05	0.02	0.02	0.009	0.007	0.004
TR_R	1.5	2	1.8	0.2	0.020	0.001	0.005	4.35E-01	3.03	1.71	0.1	0.5	0.06	0.02	0.008	0.007	0.004	0.003	0.002
TR	1.5	5.3	3.2	1.0	0.020	0.001	0.005	7.98E-01	3.03	1.71	0.3	0.8	0.2	0.04	0.02	0.01	0.009	0.006	0.002

kg	kilogram	min	minimum
max	maximum	LOAEL	Lowest Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		

[a] Table 10 in Dietary Uptake Document.
[b] Food Ingestion Rate was calculated per Nagy (2001).
[c] Assuming the diet is 100% adult mayfly.
[d] Table 9 in Dietary Uptake Document.
[e] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[f] 0 indicates probability is below 0.001.

Diet Proportions		
V	Vegetation	0
I	Invertebrates	1
F	Fish	0
A	Amphibians	0
FIRsed		0

Table 6-10
Probabilistic Risk Evaluation for the Tree Swallow
Kingston Fossil Plant
Tennessee Valley Authority

Area	Exposure Point Concentration Selenium in Adult Mayfly (Logmormal Distribution) (mg/kg)				Body Weight BW [a] (Normal) (kg)		Food Ingestion Rate (IR) [b] (kg/day)	Dietary Ingestion Dose [c] (mg/kg-day)	NOAEL-based TRV [d] (Normal) (mg/kg-day)		Hazard Quotient (HQ) [e] (unitless)	Probability of HQ Exceeding Target HQ							
	min	max	mean	stdev	mean	stdev			mean	stdev		0.1	0.5	1.0	2.0	3.0	5.0	7.0	10.0
ER_A	5.6	8.2	7.1	0.6	0.020	0.001	0.005	1.75E+00	1.69	1.11	1	1	0.9	0.3	0.1	0.08	0.05	0.03	0.02
ER_B	6.5	8.4	7.6	0.7	0.020	0.001	0.005	1.86E+00	1.69	1.11	1	1	0.9	0.3	0.1	0.09	0.05	0.04	0.02
ER_C	6.5	7.5	6.9	0.4	0.020	0.001	0.005	1.70E+00	1.69	1.11	0.9	1	0.9	0.3	0.1	0.08	0.05	0.03	0.02
ER_R	3.7	4.1	3.9	0.1	0.020	0.001	0.005	9.57E-01	1.69	1.11	0.5	1	0.5	0.1	0.06	0.04	0.02	0.02	0.008
ER	5.6	8.4	7.3	0.7	0.020	0.001	0.005	1.81E+00	1.69	1.11	1	1	0.9	0.3	0.1	0.09	0.05	0.03	0.02
CR_A	5.2	6.7	5.9	0.6	0.020	0.001	0.005	1.45E+00	1.69	1.11	0.8	1	0.8	0.2	0.1	0.06	0.04	0.03	0.01
CR_B	5.8	6.6	6.2	0.3	0.020	0.001	0.005	1.53E+00	1.69	1.11	0.8	1	0.8	0.2	0.1	0.07	0.04	0.03	0.01
CR_R	3.7	4.1	3.9	0.1	0.020	0.001	0.005	9.57E-01	1.69	1.11	0.5	1	0.5	0.1	0.06	0.04	0.02	0.02	0.007
CR	3.7	6.7	5.5	1.1	0.020	0.001	0.005	1.34E+00	1.69	1.11	0.7	1	0.7	0.2	0.09	0.06	0.04	0.03	0.01
TR_A	2.9	4.1	3.4	0.4	0.020	0.001	0.005	8.32E-01	1.69	1.11	0.5	1	0.4	0.1	0.05	0.03	0.02	0.01	0.007
TR_B	3.3	5.3	3.9	0.5	0.020	0.001	0.005	9.62E-01	1.69	1.11	0.5	1	0.5	0.1	0.06	0.04	0.02	0.02	0.009
TR_R	1.5	2	1.8	0.2	0.020	0.001	0.005	4.35E-01	1.69	1.11	0.2	0.8	0.2	0.04	0.03	0.02	0.01	0.007	0.003
TR	1.5	5.3	3.2	1.0	0.020	0.001	0.005	7.98E-01	1.69	1.11	0.4	1.0	0.4	0.1	0.05	0.04	0.02	0.01	0.007

kg	kilogram	min	minimum
max	maximum	NOAEL	No Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		

[a] Table 10 in Dietary Uptake Document.
[b] Food Ingestion Rate was calculated per Nagy (2001).
[c] Assuming the diet is 100% adult mayfly.
[d] Table 9 in Dietary Uptake Document.
[e] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[f] 0 indicates probability is below 0.001.

Diet Proportions		
V	Vegetation	0
I	Invertebrates	1
F	Fish	0
A	Amphibians	0
FIRsed		0

Table 6-11
Probabilistic Risk Evaluation for the Gray Bat
Kingston Fossil Plant
Tennessee Valley Authority

Area	Exposure Point Concentration Selenium in Adult Mayfly				Body Weight BW [a]		Food Ingestion Rate (IR) [b]	Dietary Ingestion Dose [c]	LOAEL-based TRV [d]		Hazard Quotient (HQ) [e]	Probability of HQ Exceeding Target HQ							
	min	max	mean	stdev	mean	stdev			mean	stdev									
	Lognormal (mg/kg)				Normal (kg)		(kg/day)	(mg/kg-day)	Triangle (mg/kg-day)		(unitless)	0.1	0.5	1.0	2.0	3.0	5.0	7.0	10.0
ER_A	5.6	8.2	7.1	0.6	0.010	0.002	0.002	1.29E+00	0.16	14	0.2	0.7	0.06	0	0	0	0	0	0
ER_B	6.5	8.4	7.6	0.7	0.010	0.002	0.002	1.37E+00	0.16	14	0.2	0.8	0.06	0	0	0	0	0	0
ER_C	6.5	7.5	6.9	0.4	0.010	0.002	0.002	1.25E+00	0.16	14	0.2	0.7	0.05	0	0	0	0	0	0
ER_R	3.7	4.1	3.9	0.1	0.010	0.002	0.002	7.05E-01	0.16	14	0.1	0.24	0.015	0	0	0	0	0	0
ER	5.6	8.4	7.3	0.7	0.010	0.002	0.002	1.33E+00	0.16	14	0.2	0.24	0.05	0	0	0	0	0	0
CR_A	5.2	6.7	5.9	0.6	0.010	0.002	0.002	1.07E+00	0.16	14	0.2	0.5	0.04	0	0	0	0	0	0
CR_B	5.8	6.6	6.2	0.3	0.010	0.002	0.002	1.13E+00	0.16	14	0.2	0.6	0.04	0	0	0	0	0	0
CR_R	3.7	4.1	3.9	0.1	0.010	0.002	0.002	7.05E-01	0.16	14	0.1	0.24	0.013	0	0	0	0	0	0
CR	3.7	6.7	5.5	1.1	0.010	0.002	0.002	9.91E-01	0.16	14	0.1	0.5	0.04	0	0	0	0	0	0
TR_A	2.9	4.1	3.4	0.4	0.010	0.002	0.002	6.13E-01	0.16	14	0.09	0.18	0.010	0	0	0	0	0	0
TR_B	3.3	5.3	3.9	0.5	0.010	0.002	0.002	7.09E-01	0.16	14	0.1	0.25	0.016	0	0	0	0	0	0
TR_R	1.5	2	1.8	0.2	0.010	0.002	0.002	3.21E-01	0.16	14	0.05	0.04	0	0	0	0	0	0	0
TR	1.5	5.3	3.2	1.0	0.010	0.002	0.002	5.88E-01	0.16	14	0.09	0.18	0.008	0	0	0	0	0	0

kg	kilogram	min	minimum
max	maximum	LOAEL	Lowest Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		

[a] Table 10 in Dietary Uptake Document.
[b] Food Ingestion Rate was calculated per Nagy (2001).
[c] Assuming the diet is 100% adult mayfly.
[d] Table 9 in Dietary Uptake Document.
[e] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[f] 0 indicates probability is below 0.001.

Diet Proportions		
V	Vegetation	0
I	Invertebrates	1
F	Fish	0
A	Amphibians	0
FIRsed		0

Table 6-12
Probabilistic Risk Evaluation for the Gray Bat
Kingston Fossil Plant
Tennessee Valley Authority

Area	Exposure Point Concentration Selenium in Adult Mayfly				Body Weight BW [a]		Food Ingestion Rate (IR) [b]	Dietary Ingestion Dose [c]	NOAEL-based TRV [d]		Hazard Quotient (HQ) [e]	Probability of HQ Exceeding Target HQ							
	min	max	mean	stdev	mean	stdev			min	max									
	Lognormal (mg/kg)				Normal (kg)		(kg/day)	(mg/kg-day)	Triangle (mg/kg-day)		(unitless)	0.1	0.5	1.0	2.0	3.0	5.0	7.0	10.0
ER_A	5.6	8.2	7.1	0.6	0.010	0.002	0.002	1.29E+00	0.11	13	0.2	0.8	0.06	0.009	0	0	0	0	0
ER_B	6.5	8.4	7.6	0.7	0.010	0.002	0.002	1.37E+00	0.11	13	0.2	0.8	0.08	0.010	0.003	0	0	0	0
ER_C	6.5	7.5	6.9	0.4	0.010	0.002	0.002	1.25E+00	0.11	13	0.2	0.8	0.07	0.008	0	0	0	0	0
ER_R	3.7	4.1	3.9	0.1	0.010	0.002	0.002	7.05E-01	0.11	13	0.1	0.28	0.018	0.002	0	0	0	0	0
ER	5.6	8.4	7.3	0.7	0.010	0.002	0.002	1.33E+00	0.11	13	0.2	0.28	0.07	0.007	0	0	0	0	0
CR_A	5.2	6.7	5.9	0.6	0.010	0.002	0.002	1.07E+00	0.11	13	0.2	0.6	0.05	0.005	0	0	0	0	0
CR_B	5.8	6.6	6.2	0.3	0.010	0.002	0.002	1.13E+00	0.11	13	0.2	0.7	0.05	0.005	0	0	0	0	0
CR_R	3.7	4.1	3.9	0.1	0.010	0.002	0.002	7.05E-01	0.11	13	0.1	0.3	0.020	0	0	0	0	0	0
CR	3.7	6.7	5.5	1.1	0.010	0.002	0.002	9.91E-01	0.11	13	0.2	0.6	0.038	0.006	0	0	0	0	0
TR_A	2.9	4.1	3.4	0.4	0.010	0.002	0.002	6.13E-01	0.11	13	0.1	0.22	0.012	0	0	0	0	0	0
TR_B	3.3	5.3	3.9	0.5	0.010	0.002	0.002	7.09E-01	0.11	13	0.1	0.3	0.019	0	0	0	0	0	0
TR_R	1.5	2	1.8	0.2	0.010	0.002	0.002	3.21E-01	0.11	13	0.05	0.06	0.003	0	0	0	0	0	0
TR	1.5	5.3	3.2	1.0	0.010	0.002	0.002	5.88E-01	0.11	13	0.09	0.22	0.014	0	0	0	0	0	0

kg	kilogram	min	minimum
max	maximum	NOAEL	No Observed Adverse Effects Level
mg	milligram	stdev	standard deviation
TRV	Toxicity Reference Value		

[a] Table 10 in Dietary Uptake Document.
[b] Food Ingestion Rate was calculated per Nagy (2001).
[c] Assuming the diet is 100% adult mayfly.
[d] Table 9 in Dietary Uptake Document.
[e] Hazard quotient (HQ) = (estimated dietary ingestion)/(toxicity reference value).
[f] 0 indicates probability is below 0.001.

Diet Proportions		
V	Vegetation	0
I	Invertebrate	1
F	Fish	0
A	Amphibians	0
FIRsed		0

ARCADIS

Attachment 7

Uncertainty Analysis

Table 7-1
Total versus Dissvoled Metals in Surface Water
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River Reach A				Emory River Reach B				Emory River Reach C			
	Surface Water				Surface Water				Surface Water			
	FOD	min		max	FOD	min		max	FOD	min		max
Constituent		(mg/L)				(mg/L)				(mg/L)		
Inorganics (Total)												
Aluminum	14 / 16	0.081	-	0.255	13 / 16	0.124	-	0.319	6 / 8	0.082	-	0.339
Arsenic	16 / 16	5E-04	-	0.0025	16 / 16	0.001	-	0.0028	8 / 8	0.001	-	0.0026
Copper	16 / 16	6E-04	-	0.0021	16 / 16	7E-04	-	0.0017	8 / 8	6E-04	-	0.001
Iron	16 / 16	0.078	-	0.22	15 / 16	0.121	-	0.251	8 / 8	0.097	-	0.316
Lead	1 / 16	4E-04	-	0.0004	8 / 16	3E-04	-	0.0004	1 / 8	6E-04	-	0.0006
Manganese	16 / 16	0.021	-	0.0393	16 / 16	0.008	-	0.101	8 / 8	0.06	-	0.225
Selenium	7 / 16	4E-04	-	0.0009	8 / 16	3E-04	-	0.0006	0 / 8	0	-	0
Vanadium	10 / 16	0.001	-	0.003	15 / 16	0.001	-	0.0022	4 / 8	0.001	-	0.0015
Zinc	2 / 16	0.01	-	0.0137	0 / 16	0	-	0	0 / 8	0	-	0
Inorganics (Dissolved)												
Aluminum	0 / 16	0	-	0	0 / 16	0	-	0	0 / 8	0	-	0
Arsenic	16 / 16	5E-04	-	0.0023	16 / 16	9E-04	-	0.0023	8 / 8	1E-03	-	0.0017
Copper	16 / 16	5E-04	-	0.0014	16 / 16	4E-04	-	0.0029	7 / 8	3E-04	-	0.0021
Iron	0 / 16	0	-	0	2 / 16	0.025	-	0.0304	0 / 8	0	-	0
Lead	0 / 16	0	-	0	0 / 16	0	-	0	0 / 8	0	-	0
Manganese	16 / 16	4E-04	-	0.0137	16 / 16	5E-04	-	0.0269	7 / 8	0.001	-	0.15
Selenium	8 / 16	3E-04	-	0.0007	7 / 16	3E-04	-	0.0006	2 / 8	4E-04	-	0.0004
Silver	0 / 16	0	-	0	0 / 16	0	-	0	0 / 8	0	-	0
Strontium	16 / 16	0.106	-	0.124	16 / 16	0.107	-	0.125	8 / 8	0.098	-	0.11
Thallium	0 / 16	0	-	0	0 / 16	0	-	0	0 / 8	0	-	0
Vanadium	8 / 16	0.001	-	0.0025	6 / 16	0.001	-	0.0013	0 / 8	0	-	0
Zinc	1 / 16	0.009	-	0.0085	0 / 16	0	-	0	0 / 8	0	-	0

Table 7-1
Total versus Dissvoled Metals in Surface Water
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River Reach A				Clinch River Reach B				Tennessee River Reach A			
	Surface Water				Surface Water				Surface Water			
	FOD	min		max	FOD	min		max	FOD	min		max
Constituent		(mg/L)				(mg/L)				(mg/L)		
Inorganics (Total)												
Aluminum	7 / 8	0.066	-	0.214	7 / 9	0.079	-	0.139	6 / 8	0.068	-	0.263
Arsenic	8 / 8	8E-04	-	0.0015	8 / 9	5E-04	-	0.002	8 / 8	5E-04	-	0.0013
Copper	8 / 8	9E-04	-	0.002	8 / 9	8E-04	-	0.0026	8 / 8	6E-04	-	0.0022
Iron	8 / 8	0.068	-	0.15	8 / 9	0.07	-	0.133	7 / 8	0.081	-	0.236
Lead	1 / 8	4E-04	-	0.0004	0 / 9	0	-	0	1 / 8	5E-04	-	0.0005
Manganese	8 / 8	0.025	-	0.0326	9 / 10	0.026	-	0.0391	7 / 8	0.039	-	0.0943
Selenium	3 / 8	4E-04	-	0.0008	4 / 9	3E-04	-	0.0004	0 / 8	0	-	0
Vanadium	8 / 8	0.001	-	0.002	5 / 9	0.001	-	0.0022	2 / 8	0.001	-	0.0015
Zinc	0 / 8	0	-	0	0 / 9	0	-	0	0 / 8	0	-	0
Inorganics (Dissolved)												
Aluminum	0 / 8	0	-	0	1 / 9	0.142	-	0.142	1 / 8	0.065	-	0.065
Arsenic	8 / 8	6E-04	-	0.0014	8 / 9	5E-04	-	0.0016	8 / 8	5E-04	-	0.001
Copper	7 / 8	7E-04	-	0.0027	7 / 9	6E-04	-	0.0024	7 / 8	5E-04	-	0.0032
Iron	0 / 8	0	-	0	1 / 9	0.129	-	0.129	1 / 8	0.084	-	0.0839
Lead	0 / 8	0	-	0	0 / 9	0	-	0	0 / 8	0	-	0
Manganese	7 / 8	4E-04	-	0.0089	9 / 10	5E-04	-	0.0077	6 / 8	4E-04	-	0.0387
Selenium	4 / 8	4E-04	-	0.0007	3 / 9	3E-04	-	0.0004	1 / 8	4E-04	-	0.0004
Silver	0 / 8	0	-	0	0 / 9	0	-	0	0 / 8	0	-	0
Strontium	8 / 8	0.106	-	0.123	8 / 9	0.108	-	0.119	8 / 8	0.075	-	0.104
Thallium	0 / 8	0	-	0	0 / 9	0	-	0	0 / 8	0	-	0
Vanadium	3 / 8	0.001	-	0.0015	3 / 9	0.001	-	0.002	1 / 8	0.001	-	0.001
Zinc	0 / 8	0	-	0	0 / 9	0	-	0	0 / 8	0	-	0

Surface water data was not collected in Clinch Reach C, Tennessee Reach B and C
Frequency of detection (FOD) = number of detects/ total number of samples analyzed
min = minimum; max = maximum
mg/L - milligram per liter

Table 7-2
Whole Body Gizzard Shad Data Versus Whole Body Blue Gill Data
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River Reach A									Emory River Reach B									Emory River Reach C								
	Gizzard Shad				Blue Gill					Gizzard Shad				Blue Gill					Gizzard Shad				Blue Gill				
	FOD	min		max	FOD	min		max		FOD	min		max	FOD	min		max		FOD	min		max	FOD	min		max	
Constituent		(mg/kg)				(mg/L)					(mg/kg)				(mg/L)					(mg/kg)				(mg/kg)			
Inorganics																											
Aluminum	3/3	1670	-	1970	3/3	253	-	992		6/6	44.6	-	2590	4/4	166	-	690		5/6	25.66	-	573	3/3	109	-	190	
Antimony	0/3	0	-	0	0/3	0	-	0		2/6	0.097	-	0.12	0/4	0	-	0		0/6	0	-	0	0/3	0	-	0	
Arsenic	3/3	2	-	2.1	3/3	1.4	-	1.8		6/6	2	-	4.3	4/4	1.1	-	1.6		6/6	1.1	-	1.81	3/3	0.64	-	0.72	
Barium	3/3	30	-	32	3/3	8.5	-	18.1		6/6	13.43	-	43.4	4/4	8.1	-	17.2		6/6	10.55	-	16.7	3/3	10.2	-	11.7	
Beryllium	0/3	0	-	0	0/3	0	-	0		2/6	0.16	-	0.25	0/4	0	-	0		0/6	0	-	0	0/3	0	-	0	
Boron	1/3	1.9	-	1.9	0/3	0	-	0		2/6	2.2	-	2.2	0/4	0	-	0		0/6	0	-	0	0/3	0	-	0	
Cadmium	0/3	0	-	0	3/3	0.063	-	0.072		4/6	0.056	-	0.11	4/4	0.038	-	0.067		3/6	0.046	-	0.059	3/3	0.054	-	0.057	
Chromium	3/3	3.5	-	5.9	3/3	0.78	-	2.2		3/6	3	-	4	2/4	1	-	1.6		3/6	1.5	-	2	2/3	0.58	-	0.78	
Cobalt	3/3	1.5	-	1.7	3/3	0.26	-	0.86		6/6	0.216	-	2.2	4/4	0.18	-	0.56		6/6	0.206	-	0.65	3/3	0.23	-	0.25	
Copper	3/3	5.5	-	6	3/3	2.5	-	2.9		6/6	5.7	-	9.1	4/4	1.7	-	2.8		6/6	4.2	-	7.522	3/3	1.7	-	2.2	
Iron	3/3	1610	-	2020	3/3	283	-	1070		6/6	101.4	-	2480	4/4	144	-	564		6/6	79.36	-	714	3/3	163	-	235	
Lead	3/3	1.7	-	2	3/3	0.37	-	0.84		6/6	0.148	-	2.8	4/4	0.21	-	0.9		5/6	0.199	-	0.71	3/3	0.18	-	0.93	
Manganese	3/3	144	-	149	3/3	74	-	164		6/6	122	-	218	4/4	87.5	-	124		6/6	99.08	-	153	3/3	116	-	169	
Mercury	3/3	0.061	-	0.095	3/3	0.071	-	0.11		3/6	0.08	-	0.092	4/4	0.077	-	0.12		3/6	0.056	-	0.059	3/3	0.13	-	0.13	
Molybdenum	0/3	0	-	0	3/3	0.22	-	0.36		3/6	0.16	-	0.26	4/4	0.21	-	0.27		0/6	0	-	0	0/3	0	-	0	
Nickel	3/3	2.1	-	2.4	3/3	0.54	-	1.3		2/6	4.2	-	6.5	3/4	0.81	-	2.2		3/6	0.84	-	1	1/3	0.48	-	0.48	
Selenium	3/3	1.9	-	2.7	3/3	3.1	-	4.6		6/6	2.2	-	3.951	4/4	2.4	-	4.2		6/6	1.8	-	3.213	3/3	1.8	-	1.9	
Silver	0/3	0	-	0	0/3	0	-	0		3/6	0.019	-	0.023	0/4	0	-	0		1/6	0.012	-	0.012	0/3	0	-	0	
Strontium	3/3	47.6	-	52.6	3/3	67.8	-	88.8		6/6	37.4	-	47.6	4/4	59.5	-	110		6/6	28.9	-	33.94	3/3	63.7	-	69.9	
Thallium	0/3	0	-	0	0/3	0	-	0		0/6	0	-	0	0/4	0	-	0		0/6	0	-	0	0/3	0	-	0	
Vanadium	3/3	2.7	-	3.1	3/3	1	-	2.8		6/6	0.319	-	6.3	4/4	0.86	-	2.2		5/6	0.257	-	1	3/3	0.36	-	0.46	
Zinc	3/3	86.8	-	91.5	3/3	156	-	198		6/6	74.7	-	139	4/4	115	-	149		6/6	73.9	-	97.29	3/3	134	-	157	

Table 7-2
Whole Body Gizzard Shad Data Versus Whole Body Blue Gill Data
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River Reach A								Clinch River Reach B							
	Gizzard Shad				Blue Gill				Gizzard Shad				Blue Gill			
	FOD	min		max	FOD	min		max	FOD	min		max	FOD	min		max
Constituent		(mg/kg)				(mg/L)				(mg/kg)				(mg/L)		
Inorganics																
Aluminum	6/6	441	-	3074	3/3	251	-	1980	6/6	602.7	-	1560	8/8	91.1	-	361
Antimony	4/6	0.064	-	0.107	1/3	0.075	-	0.075	2/6	0.065	-	0.084	0/8	0	-	0
Arsenic	6/6	1.6	-	5.116	3/3	1.3	-	3.2	6/6	1.9	-	3.1	8/8	1	-	1.4
Barium	6/6	18.1	-	43.26	3/3	8.1	-	28.5	6/6	16.89	-	25.7	8/8	4.9	-	9.6
Beryllium	3/6	0.162	-	0.2698	1/3	0.21	-	0.21	2/6	0.1	-	0.13	0/8	0	-	0
Boron	2/6	1.982	-	2.372	1/3	2.2	-	2.2	0/6	0	-	0	0/8	0	-	0
Cadmium	6/6	0.046	-	0.09	3/3	0.073	-	0.17	6/6	0.05	-	0.094	8/8	0.05	-	0.1
Chromium	5/6	1.6	-	4.651	3/3	0.71	-	2.8	6/6	1.142	-	4.2	5/8	0.62	-	1.3
Cobalt	6/6	0.47	-	2.047	3/3	0.26	-	1.4	6/6	0.682	-	1.6	8/8	0.12	-	0.36
Copper	6/6	5.4	-	14.75	3/3	2.2	-	6.1	6/6	5.1	-	9.545	8/8	2	-	9.2
Iron	6/6	448	-	1395	3/3	251	-	1970	6/6	616.4	-	1870	8/8	98.5	-	353
Lead	6/6	0.75	-	3.209	3/3	0.4	-	2.1	6/6	0.685	-	3.2	8/8	0.17	-	0.61
Manganese	6/6	140	-	326.7	3/3	51.1	-	160	6/6	133.8	-	233	8/8	51.8	-	95.9
Mercury	6/6	0.06	-	0.1475	3/3	0.13	-	0.16	4/6	0.055	-	0.11	8/8	0.018	-	0.14
Molybdenum	2/6	0.161	-	0.1814	0/3	0	-	0	2/6	0.15	-	0.19	4/8	0.19	-	0.28
Nickel	6/6	1.2	-	12.44	3/3	0.49	-	2.6	6/6	1.05	-	5.7	5/8	0.44	-	1.8
Selenium	6/6	2	-	3.442	3/3	3.5	-	4	6/6	1.6	-	3.349	8/8	2.8	-	4.1
Silver	5/6	0.014	-	0.0386	0/3	0	-	0	4/6	0.014	-	0.0159	0/8	0	-	0
Strontium	6/6	37.3	-	46.54	3/3	69.6	-	95.1	6/6	29.3	-	42.79	8/8	43.3	-	83.6
Thallium	0/6	0	-	0	0/3	0	-	0	0/6	0	-	0	0/8	0	-	0
Vanadium	6/6	1.1	-	6.977	3/3	1.2	-	5.7	6/6	1.826	-	3.8	8/8	0.4	-	1.3
Zinc	6/6	73.7	-	130.9	3/3	173	-	203	6/6	50.2	-	111.2	8/8	121	-	212

Fish data was not collected in the Tennessee River.
Frequency of detection (FOD) = number of detects/ total number of samples analyzed
min = minimum; max = maximum
mg/kg = milligram per kilogram (dry weight)
mg/L = milligram per liter (wet weight)

Table 7-3
Whole Body Nymph Data Versus Whole Body Snail Data
Kingston Fossil Plant
Tennesse Valley Authority

	Emory River Reach A						Emory River Reach B						Emory River Reach R					
	WB Nymph mayfly			WB Snail			WB Nymph mayfly			WB Snail			WB Nymph mayfly			WB Snail		
Constituent	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**
Inorganics																		
Aluminum	3/3	7540 -	8540	3/3	1960 -	2240	3/3	9050 -	10300	3/3	2690 -	4630	6/6	4090 -	6380	3/3	1310 -	1800
Antimony	3/3	0.26 -	0.53	3/3	0.066 -	0.091	3/3	0.2 -	0.22	2/3	0.073 -	0.1	6/6	0.057 -	0.085	3/3	0.026 -	0.26
Arsenic	3/3	33.5 -	97	3/3	11.9 -	13.9	3/3	13.1 -	17.6	3/3	10.5 -	13.6	6/6	2.8 -	4.5	3/3	6.1 -	8.6
Barium	3/3	91.3 -	140	3/3	36.7 -	42.4	3/3	84.9 -	93	3/3	36.4 -	66.7	6/6	43.2 -	58.6	3/3	39.6 -	52.4
Beryllium	3/3	0.77 -	0.96	3/3	0.13 -	0.16	3/3	0.74 -	0.88	3/3	0.17 -	0.31	6/6	0.19 -	0.29	3/3	0.095 -	0.12
Boron	3/3	5.4 -	8.7	3/3	2.7 -	3.4	2/3	5 -	5.4	3/3	6.4 -	9.5	6/6	2.5 -	4	3/3	2.8 -	5.2
Cadmium	3/3	0.24 -	1.1	3/3	1.3 -	1.8	3/3	0.45 -	0.68	3/3	0.63 -	1.5	6/6	0.35 -	2.4	3/3	0.75 -	1
Chromium	3/3	10.8 -	12	3/3	3.3 -	4.6	3/3	10.9 -	12.4	3/3	4.5 -	6.9	6/6	4.5 -	6.8	3/3	2.3 -	10.1
Cobalt	3/3	7.4 -	8.1	3/3	11.2 -	17.3	3/3	8.9 -	9.8	3/3	6.6 -	18.1	6/6	4.1 -	7.2	3/3	8.4 -	12.3
Copper	3/3	19.5 -	21.2	3/3	102 -	175	3/3	17.8 -	19.4	3/3	102 -	121	6/6	9.5 -	12.8	3/3	95.4 -	127
Iron	3/3	8760 -	11600	3/3	1660 -	2120	3/3	10200 -	11400	3/3	2710 -	4620	6/6	5930 -	8430	3/3	2090 -	3090
Lead	3/3	8.6 -	10.3	3/3	1.5 -	2	3/3	8.8 -	9.7	3/3	2.3 -	4.1	6/6	4.5 -	6.8	3/3	1.4 -	11.3
Manganese	3/3	482 -	535	3/3	293 -	505	3/3	454 -	520	3/3	345 -	817	6/6	378 -	1380	3/3	544 -	686
Mercury	3/3	0.095 -	0.14	3/3	0.095 -	0.13	3/3	0.076 -	0.078	3/3	0.074 -	0.12	6/6	0.052 -	0.066	3/3	0.091 -	0.16
Molybdenum	3/3	1.6 -	2.9	3/3	0.45 -	0.73	3/3	1.2 -	1.4	3/3	0.52 -	0.74	6/6	0.5 -	0.72	3/3	0.52 -	0.69
Nickel	3/3	12.4 -	13.3	3/3	23.6 -	30.7	3/3	14.1 -	15.6	3/3	14.2 -	35.9	6/6	5.3 -	7.4	3/3	18.8 -	32.7
Selenium	3/3	6.3 -	11.9	3/3	4.9 -	5.7	3/3	6.6 -	7.2	3/3	3.3 -	4.2	6/6	2.6 -	4.2	3/3	2.5 -	3.8
Silver	0/3	0 -	0	3/3	0.068 -	0.1	2/3	0.037 -	0.048	3/3	0.21 -	0.31	6/6	0.03 -	0.16	3/3	0.96 -	1.2
Strontium	3/3	27.5 -	57.2	3/3	46.8 -	55.6	3/3	22.1 -	25	3/3	41.6 -	47.8	6/6	4.5 -	6.7	3/3	35.6 -	43.1
Thallium	3/3	0.23 -	0.56	3/3	0.51 -	0.63	3/3	0.21 -	0.26	3/3	0.38 -	0.4	0/6	0 -	0	0/3	0 -	0
Vanadium	3/3	19.1 -	25.5	3/3	3.9 -	5.8	3/3	17.3 -	19.7	3/3	5.1 -	8.4	6/6	6.7 -	9.4	3/3	2.4 -	3.8
Zinc	3/3	137 -	155	3/3	148 -	204	3/3	174 -	187	3/3	88.5 -	140	6/6	167 -	316	3/3	144 -	166

Table 7-3
Whole Body Nymph Data Versus Whole Body Snail Data
Kingston Fossil Plant
Tennesse Valley Authority

	Clinch River Reach A						Clinch River Reach B						Clinch River Reach B					
	WB Nymph mayfly			WB Snail			WB Nymph mayfly			WB Snail			WB Nymph mayfly			WB Snail		
Constituent	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**	**FOD**	**min (mg/kg)**	**max**
Inorganics																		
Aluminum	3/3	6930 -	10900	3/3	185 -	590	3/3	8440 -	9120	3/3	235 -	2050	3/3	6610 -	7620	3/3	220 -	1060
Antimony	3/3	0.19 -	0.27	3/3	0.031 -	0.048	3/3	0.23 -	0.25	2/3	0.048 -	0.08	3/3	0.091 -	0.098	3/3	0.019 -	0.037
Arsenic	3/3	12.6 -	14.6	3/3	11.6 -	20.1	3/3	13.6 -	16.4	3/3	13.8 -	15.2	3/3	4.7 -	5.2	3/3	12.6 -	14.1
Barium	3/3	75.9 -	104	3/3	24.5 -	40.6	3/3	92.5 -	96.9	3/3	17.6 -	42.3	3/3	56.4 -	59.8	3/3	24.9 -	44.7
Beryllium	3/3	0.55 -	0.84	2/3	0.047 -	0.053	3/3	0.72 -	0.77	2/3	0.075 -	0.16	3/3	0.33 -	0.36	1/3	0.056 -	0.056
Boron	3/3	6.6 -	9	3/3	1.5 -	3	3/3	6.2 -	7.2	3/3	2.1 -	3.3	3/3	5.7 -	7.9	3/3	1.8 -	1.9
Cadmium	3/3	1.1 -	2.1	3/3	1.7 -	5	3/3	0.76 -	1.2	3/3	1.4 -	2	3/3	0.74 -	0.95	3/3	0.97 -	2
Chromium	3/3	8.7 -	13.4	3/3	3.2 -	7.1	3/3	10.8 -	11.7	3/3	3.3 -	4.3	3/3	9 -	9.9	3/3	2.5 -	3.7
Cobalt	3/3	5.7 -	8.3	3/3	11 -	16.1	3/3	7.3 -	7.7	3/3	5.1 -	8.5	3/3	5.7 -	6.2	3/3	6 -	8.8
Copper	3/3	18.6 -	23.4	3/3	102 -	166	3/3	20.4 -	21	3/3	134 -	170	3/3	18.3 -	19.3	3/3	147 -	165
Iron	3/3	7180 -	11900	3/3	858 -	1460	3/3	9160 -	9560	3/3	483 -	2000	3/3	8640 -	9230	3/3	666 -	1300
Lead	3/3	6.7 -	10.5	3/3	0.64 -	6.8	3/3	8.6 -	8.9	3/3	0.43 -	2.6	3/3	9.2 -	9.8	3/3	0.44 -	3.3
Manganese	3/3	733 -	959	3/3	340 -	814	3/3	759 -	807	3/3	219 -	450	3/3	905 -	1040	3/3	148 -	322
Mercury	3/3	0.27 -	0.31	3/3	0.19 -	0.24	3/3	0.26 -	0.3	3/3	0.1 -	0.16	3/3	0.81 -	1.2	3/3	0.25 -	0.29
Molybdenum	3/3	1.5 -	1.6	3/3	0.67 -	0.98	3/3	1.5 -	1.6	3/3	0.81 -	1.1	3/3	0.67 -	0.79	3/3	0.81 -	0.85
Nickel	3/3	9.6 -	14.1	3/3	24 -	44.1	3/3	11.9 -	12.4	3/3	14.4 -	19	3/3	9.6 -	10.4	3/3	15.1 -	18.8
Selenium	3/3	6.5 -	6.6	3/3	4.3 -	7.9	3/3	6.6 -	7.4	3/3	4.7 -	6.8	3/3	4.2 -	4.6	3/3	4.3 -	4.8
Silver	3/3	0.054 -	0.08	3/3	0.097 -	0.37	3/3	0.061 -	0.065	3/3	0.1 -	0.13	0/3	0 -	0	3/3	0.14 -	0.19
Strontium	3/3	22.9 -	31	3/3	50 -	65.2	3/3	26.1 -	31.1	3/3	42.2 -	59.4	3/3	8.9 -	9.4	3/3	50.6 -	63
Thallium	0/3	0 -	0	3/3	0.42 -	0.57	0/3	0 -	0	3/3	0.4 -	0.59	0/3	0 -	0	2/3	0.29 -	0.38
Vanadium	3/3	13.6 -	20.7	3/3	1.8 -	3	3/3	17.1 -	18.9	3/3	1.8 -	5.4	3/3	10.9 -	11.9	3/3	0.92 -	3.2
Zinc	3/3	175 -	194	3/3	127 -	236	3/3	172 -	182	3/3	165 -	178	3/3	168 -	197	3/3	134 -	140

Snail data was not collected in Emory Reach C or the Tennessee River.
All data were freeze dried prior to submission to the lab and are assumed to be dry weight.
Frequency of detection (FOD) = number of detects/ total number of samples analyzed
min = minimum; max = maximum
mg/kg = milligram per kilogram

Table 7-4
Probabilistic Analysis for the Tree Swallow Assuming Constant versus Variable Concentration Terms
Kingston Fossil Plant
Tennesse Valley Authority

	Probability for Hazard Quotient Exceeding Target of 1 Based on Input Concentration		
	Distribution		Point Estimate
	Normal	Lognormal	EPC
Emory River_Reach A	0.28	0.28	0.28
Emory River_Reach B	0.30	0.31	0.32
Emory River_Reach C	0.26	0.26	0.32
Emory River_Reach R	0.12	0.12	0.13
Emory River	0.28	0.29	0.35
Clinch River_Reach A	0.20	0.21	0.25
Clinch River_Reach B	0.23	0.23	0.23
Clinch River_Reach R	0.12	0.12	0.13
Clinch River	0.19	0.18	0.25
Tennessee River_Reach A	0.10	0.10	0.11
Tennessee River_Reach B	0.12	0.12	0.13
Tennessee River_Reach R	0.04	0.04	0.05
Tennessee River	0.10	0.09	0.18

EPC Exposure Point Concentration. Set at the upper confidence limit (UCL) on the mean or the maximum concentration.

Table 7-5
Probabilistic Analysis for the Killdeer Assuming Constant versus Variable Concentration Terms
Kingston Fossil Plant
Tennesse Valley Authority

	Probability for Hazard Quotiet Exceeding Target of 1 Based on Input Concentration		
	Distribution		Point Estimate
	Normal	Lognormal	EPC
Emory River_Reach A			
Aluminum	0.83	0.82	0.89
Arsenic	0.13	0.11	0.27
Selenium	0.23	0.24	0.30
Emory River_Reach B			
Aluminum	0.94	0.96	0.98
Selenium	0.14	0.14	0.16
Emory River_Reach C			
Aluminum	0.37	0.36	0.50
Selenium	0.08	0.09	0.09
Emory River_Reach R			
Aluminum	0.26	0.24	0.50
Selenium	0.05	0.06	0.07
Emory River			
Aluminum	0.55	0.53	0.98
Arsenic	0.05	0.03	0.26
Selenium	0.12	0.11	0.29
Clinch River_Reach A			
Aluminum	0.86	0.84	1.00
Selenium	0.13	0.13	0.12
Clinch River_Reach B			
Aluminum	0.90	0.91	0.93
Selenium	0.14	0.14	0.15
Clinch River_Reach R			
Aluminum	0.66	0.66	0.74
Selenium	0.08	0.08	0.08
Clinch River			
Aluminum	0.82	0.81	0.99
Selenium	0.11	0.12	0.14
Tennessee River_Reach A			
Aluminum	0.92	0.93	0.99
Selenium	0.10	0.10	0.11
Tennessee River_Reach B			
Aluminum	0.96	0.96	1.00
Selenium	0.12	0.11	0.11

EPC Exposure Point Concentration.
Set at the upper confidence limit (UCL) on the mean or the maximum concentration.

ARCADIS

Attachment 8

Response to Comments from
USEPA Region 4, on the
Wildlife Dietary Exposure Models Methodology Document,
dated March 2012

MEMORANDUM

August 3, 2012

To: Craig Zeller, EPA Region 4

Subject: Response to Comments dated May 8th from Black & Veatch, on behalf of USEPA Region 4, on the *Wildlife Dietary Exposure Models Methodology,* TVA Kingston Fly Ash Recovery project, prepared by ARCADIS, dated March 2012.

ARCADIS, on behalf of the Tennessee Valley Authority (TVA), has reviewed and respectfully submits the following responses to the comments made by Black & Veatch in the memorandum dated May 8th, 2012. The memorandum provided comments, on behalf of EPA Region 4, on the *Wildlife Dietary Exposure Models Methodology*, TVA Kingston Fly Ash Recovery project, prepared by ARCADIS, dated March 2012. ARCADIS provided an initial response to these comments within the *River System Baseline Ecological Risk Assessment* (BERA) report dated May 18th, 2012. ARCADIS notes that the Wildlife Dietary Exposure Models Appendix in the BERA (Appendix W) provided a more complete and accurate discussion of the methods used in the assessment of wildlife, in addition to providing results and uncertainties. Typographical corrections and minor editorial changes provided in Black & Veatch's comments were incorporated into the Wildlife Dietary Exposure Models Appendix in the BERA report dated May 2012. However, to adhere to the schedule of delivery for the BERA, comments that required further analysis and explanation were not addressed in the May version of the BERA but are addressed in this version.

Black & Veatch's comments and our responses are as follows:

1. Section 2.1, page 2-2. To the last sentence in this Section, add the following after the word spill*, and are detailed in the following subsections.*

Response: The text was revised as suggested.

2. Section 2.1.2, page 2-3. Sometimes the filtered concentration may be higher than the unfiltered samples. If this is the case, then add a sentence that discusses this potential uncertainty.

Response: The text now states that review of the raw data indicates that concentrations of metals were higher in the unfiltered (total) samples than in the filtered samples (dissolved). Therefore, using total metal concentration from unfiltered samples is protective. Table 7-1 presents the concentrations of selected constituents of potential concern (COPECs) in filtered versus unfiltered surface water samples in the Emory River. A detailed discussion of the uncertainty associated with surface water data inputs in provided in the uncertainty section.

3. Section 2.1.3.1, page 2-4. Please provide a table that compares the concentrations of selected COPECs in gizzard shad, redear sunfish, and bluegill sunfish that will help substantiate why only gizzard shad was used in the dietary models. In addition, a discussion of the uncertainty associated with selecting only the shad should be included.

Response: Gizzard shad was used in the dietary models because it is one of the most abundant bottom-feeding fish at the site and because gizzard shad maintains a high level of exposure to COPECs in sediment based on its detritus-feeding behavior. The redear sunfish whole body dataset was very limited which precluded using it for the first version of the BERA. Table 7-2 presents the concentrations

in the gizzard shad and the bluegill sunfish. A detailed discussion of the uncertainty associated with using gizzard shad data is discussed in the uncertainty section.

4. Section 2.1.3.2, page 2-4. A table comparing the selected COPEC concentrations between mayflies and snails should be presented to help justify why only the mayflies were used in the exposure models as representative of all invertebrates.

Response: Nymph mayfly data were available for more reaches than snail data, which is partly the reason that nymph mayfly data were used in the assessment. Table 7-3 presents the concentrations of selected COPECs in snails and mayflies. A comparison of nymph data versus mayfly data and the uncertainty introduced into the risk assessment from using the larval mayfly data is discussed in the uncertainty section.

5. Section 2.1.3.3, page 2-4. A sentence or two should be added regarding the uncertainty associated with ingestion of leaves relative to roots, tubers, nuts, and seeds that may be preferentially consumed by the receptors of interest (ROIs).

Response: This uncertainty is addressed in the Wildlife Dietary Uptake Models Appendix within the BERA.

6. Section 2.1.4, page 2-5. The second paragraph mentions how missing data are treated. The discussion should add that this method of addressing missing data assumes that downstream reaches of the rivers are less impacted, which is actually unknown.

Response: The text was updated to clarify that the treatment of missing data was conservative as it was based on the fact that the amount of ash in downstream reaches was less than that in upstream reaches, which is supported by sampling of ash depths in the river and sediment transport modeling (Jacobs 2011).

7. Section 2.1.4, page 2-6. The first bullet on this page states that the exposure point concentrations (EPCs) for the probabilistic risk assessment will be based on an assumed lognormal distribution. This may not be the case. Instead, use the ProUCL software outputs that provide the data distribution as potentially normal, non-parametric or lognormal. Also, provide a detailed rationale as to how the probabilistic EPC distributions account for distinct spatial differences within or between river reaches. Furthermore, the ProUCL output tables should be provided on a compact disk appendix so the reader can verify the outputs.

Response: Many of the datasets used in the probabilistic analysis were not of adequate size to distinguish data distribution. The datasets with sufficient sample size (selenium in adult mayfly, aluminum and arsenic in sediment) were either normally distributed, gamma distributed, or did not follow a discernible distribution, based on the reach-level analysis using USEPA ProUCL software.

Because many of the datasets used in the probabilistic analysis were not of adequate size to distinguish data distribution, a sensitivity analysis was conducted to determine a suitable assumption. The probabilistic analysis was conducted twice, first assuming the data was lognormal and then a second time assuming the data was normally distributed. Results for the probability of the HQ exceeding one demonstrated that there was a very slight difference (at most 1% change in probability for selenium and aluminum, and 2% for arsenic) between the two assumptions when evaluated by reach, with the assumption of normally distributed data being less conservative for selenium. Given the distribution is unknown in most cases, the probabilistic analysis assumed lognormal distribution for all exposure concentration datasets, which was conservative for the constituent of most concern in the dietary exposure models, selenium.

Risk can depend on spatial relationships in the concentrations, particularly when clustering of high concentrations exists. Thus, further sensitivity analysis was conducted to evaluate whether EPCs stratified at the reach level using lognormal distributions gave results much different than point-scale

reach maximums or conservative UCLs of the mean. The probabilistic analysis was conducted holding the EPC at a single value using a conservative point value of the 95%-97% upper confidence limit (UCL) of the mean or maximum value for the reach (if UCL was incalculable due to sample size and/or frequency of detection). The results indicated that the difference in the probability of the HQ exceeding 1 between the lognormal distribution and a conservative single value approach for killdeer and tree swallow was relatively small in impacted reaches, -1 to 6% probability increase for selenium (e.g., 6% increase from 24% to 30%). There was a 2 to 16% difference for aluminum and 16% for the one reach affected by arsenic (from 11 to 27%). If evaluated at the river scale, the differences are much larger, likely due to high variation in EPCs among reaches. Thus, evaluating exposure at the reach level to reduce within-river variation appears to sufficiently stratify EPCs spatially and almost approximates risk estimated with overly conservative point estimates. This analysis is presented in Tables 7-4 and 7-5, that summarize the probabilities of the HQ exceeding the target of 1 for both the killdeer and the tree swallow, respectively, under three assumptions: holding the EPC constant, assuming a normal distribution and finally assuming a lognormal distribution for the EPC. The results of this analysis are discussed in the uncertainty section.

In addition, ProUCL outputs will be included in a CD with the revised BERA.

8. Section 2.2.6.1, page 2-9, related discussion in Section 2.2.6.2, and Attachment 2. The sequential extraction procedure (SEP) is a tool to assess potential bioavailability; however, there are inherent problems that need to be discussed in an uncertainty section. The literature is mixed regarding the usefulness of SEP methods to determine the bioavailability of metals (e.g., see Zimmerman and Weindorf, 2010 and Filguieras et al. 2002). Some issues include the limited selectivity of extractants, and trace element redistribution among phases during the extraction procedure, which can lead to some errors in the final results. The SEP for Kingston followed an unspecified method that was included in the Filguieras et al. 2002 paper. The specifics of the method actually used need to be presented and a discussion as to its applicability to aluminum and iron (copper, lead, manganese, and vanadium were considered 100 percent bioavailable). There is a significant amount of literature on SEP for copper and lead, but little regarding aluminum and iron. While the SEP results may be deemed appropriate, at a minimum, the specific procedures and uncertainties associated with aluminum and iron SEP will need to be presented.

Response:

The text describing the SEP method provided in Attachment 2 of the Wildlife Dietary Uptake Models Appendix within the BERA now has additional details about the method and the uncertainty associated with it. Additionally, the actual method used by the laboratory, based on Querol et al. (1996), is now included as an exhibit in Attachment 2.

Sediment bioavailability factors were conservatively set to equal sediment bioaccessibility factors. The sediment bioaccessibility fractions for the metals were estimated using chemical extractions (water-soluble, exchangeable, carbonate-bound, and manganese-iron-oxide bound) using all but the organic-sulfide-extraction step from an SEP procedure based on that established by Querol et al. (1996). The SEP procedure was conducted on the full range of bulk sediment samples (18 samples) that were collected for toxicity testing from the Emory and Clinch Rivers.

While, as noted by the reviewer, there is uncertainty in estimating bioaccessibility using SEP data; this particular SEP procedure decreases some of that uncertainty (Attachment 2). Major limitations of some SEP procedures are associated with the non-selectivity of extractants and trace element redistribution among phases during the extraction procedure (Zimmerman and Weindorf 2010; Filguieras et al. 2002). In our application of the Querol SEP method to data to estimate bioavailability, the bioaccessibility factors were estimated using the total cumulative metal extracted from the first four steps that extracted water-soluble, exchangeable, carbonate-bound, and manganese-iron-oxide bound fractions. Redistribution of metals can occur for each individual step, but summing the four steps at a pH of 1.5 at the last step decreases redistribution (low pH limits readsorption). Moreover, the last step was for a long period of 15 hours at 95ºC, increasing the likelihood of liberating more metals and increasing bioavailability estimates. ,The SEP procedure's fourth step may overestimate bioaccessibility because some of the iron

and manganese is dissolved in step 4 at a pH lower than some animal stomachs (e.g. bird stomachs are typically at a pH of 2 to 3) and thus might not be bioaccessible in the gastrointestinal tract. However, the hydrogen peroxide included in the fifth step in Querol et al. (1996) for extracting organic-bound metals was not incorporated into bioaccessibility estimates, and the gastrointestinal tract has enzymes that can release some of this fraction. Therefore, the SEP method may only approximate bioaccessibility, and it is unknown if it underestimated bioaccessibility. Karadas and Kara's (2012) data suggests the SEP method used for TVA (similar to steps 1 and 2 of the Community Bureau of Reference method in Karadas and Kara) produces results approximately similar to in vitro bioavailability tests simulating animal stomachs/intestines for many metals with some exceptions (chromium and to some extent copper). They did not test many of the metals used in the dietary exposure models (vanadium, iron, aluminum), and it is possible bioavailability is underestimated. A more detailed discussion of the uncertainty associated with using the SEP to estimate bioaccessibility is included in Attachment 2.

9. Section 4.1.2, page 4-1. In the second paragraph, it is stated that abiotic media concentrations are generally represented by a lognormal distribution. This is not true in all cases. Use the ProUCL distribution output to determine the EPCs. See also comment #7.

Response: See response to comment 7.

10. Section 4.1.2, page 4-2. In the third sentence of the second paragraph, please replace "...are better..." with 'provide alternative' since probability analyses are not necessarily better for assessing risks.

Response: The text was revised as suggested.

The following comments are associated with Attachment 3 - Toxicity Reference Values.

11. Section 2.1, page 2. It is unclear why the 1975 study by Damron and Wilson regarding lead toxicity of bobwhite quail was used to derive a TRV for antimony. This study was rejected by EPA to derive TRVs for antimony because it was largely related to lead shot. If no other alternative research papers are found, then at a minimum, a discussion of the large uncertainty associated with this antimony dose needs to be provided.

Response: Chronic antimony avian toxicity studies, other than the one used to derive a TRV, were not available in the literature. This uncertainty is discussed in Attachment 3 of the Wildlife Dietary Uptake Appendix in the BERA and is discussed in the uncertainty section of the main text of the Appendix.

12. Sections 2.2 and 2.3, page 2. Please correct the inconsistency in the avian and mammalian TRVs listed in the text with those listed in Table 3-2.

Response: This inconsistency has been corrected in the Wildlife Dietary Uptake Models Appendix in the BERA.

13. Section 3.2, page 4. Correct the mammalian LOAEL for aluminum of 212.6 mg/kg-day, as it does not match with Table 3-4.

Response: The mammalian LOAEL for aluminum of 212.6 mg/kg-day, was derived from the same study from which the NAOEL was derived. The LOAEL was included in Table 3-4 in the BERA.

14. Section 3.3, page 4. In the 4th sentence of this section, change organo-selenium to organo-arsenic.

Response: This typographical error has been corrected.

15. Section 3.3, page 5, first and second paragraphs. This section relies almost exclusively on the 1932 PhD Dissertation by Whitehead. This study was not listed among the 1,173 papers with possible arsenic toxicity to wildlife in the literature review conducted by EPA for the ecological soil screening levels (Eco-SSL). The calculated arsenic dose of 131 mg/kg-day is based on a mortality endpoint rather than reproduction or growth and is two orders of magnitude higher than the other studies listed in Table 3-5. In addition, the mallard duck endpoint was based on loss of body weight, which is a poor predictor of population-level effects. It is also highly unlikely that birds in the wild would spit out their prey because they tasted too much arsenic.

Response: A USEPA research report (Stopinski and National Research Council 1976) lends credence to evaluating and not ignoring Whitehead's data on the success of the sensitive nestling stage. Within that report is a chapter on "Biologic Effects of Arsenic on Plants and Animals", which cites five studies supporting the position that arsenic-poisoned insects have no lethal effect on domestic fowl, pheasants, or songbird nestlings. The report concludes there is little danger to songbirds from consumption of arsenic-poisoned grasshoppers. They also state organic species of arsenic are less toxic than inorganic species.

The approach used to derive a NOAEL TRV in USEPA's EcoSSL focused on laboratory studies that measured effects of inorganic arsenic only on growth of chicks or adult birds, with chick growth being the most sensitive endpoint. Those studies did not demonstrate whether those chicks would successfully mature to full size and fledge (or leave the brood) and later reproduce, or whether growth would be reduced if fed prey tissue with elevated arsenic concentrations. Such information is required to determine whether population-level effects occur in the wild.

Nestling survival, measured as fledglings produced per female (size of young is not incorporated into population viability models, only survival, reproduction, and dispersal), is considered by population biologists to be an important measure of reproductive success. Growth effects are meaningless at the population level unless growth is demonstrated to have some effect on survival or reproduction. Whitehead's study focused on the key reproductive parameter of nestling survival and demonstrated that nestlings will at least mature and fledge if fed arsenic-poisoned grasshoppers. Whitehead's study did not address fledgling survival.

Fledglings that consume arsenic-contaminated invertebrates could be smaller than a control bird. However, if the chick does not spit up the food provided by the parent, there is little reason to expect a significant difference in fledgling size since food consumption has the greatest influence on body weight. Nevertheless, that uncertainty was taken into account by our calculations of the NOAEL and LOAEL described below, which show that the calculation is not influenced by the 131 mg/kg-day dose, and almost half of the weighting of the TRV (49%) is based on a conservative effect level for inorganic arsenic.

The toxicity of the form of arsenic that the receptor takes up was considered in the derivation of the refined arsenic avian TRV for receptor species with screening HQs greater than 1. For example, the arsenic dose for the killdeer is from sediment, water (miniscule), invertebrate gut, and invertebrate tissue. To calculate a TRV that is weighted by proportions of organic and inorganic arsenic consumed, all arsenic in invertebrate tissue was assumed to be organic arsenic and all arsenic in sediment (including that in prey gut) was assumed to be inorganic. Based on the dietary model, 2% of the assumed dose for the killdeer in Emory River Reach A (ER_A) was from sediment and the rest (98%) was from arsenic in the invertebrate prey. Since 49% of the arsenic in the invertebrates at ER_A is in the gut (Table 1-7 in Attachment 1 of Appendix W in BERA) and 68% of the sediment is inorganic (Appendix A, Table 1-7 in Attachment 1 of Appendix W), the inorganic arsenic portion of the killdeer dose was calculated to be (0.49 x 98%) + (0.68 x 2%) = 49%. During internal review of the BERA, an error was corrected and the 58% inorganic and 42% organic contributions used in the earlier version of the document are now 51% organic and 49% inorganic. These percentages were used to weight the TRV.

A LOAEL for growth effects of 1.49 mg/kg-day was used for inorganic arsenic based on Camardese et al. 1990. This is very a conservative value, the lowest of the NOAELs or LOAELs reported in the EcoSSL document for growth, reproduction, or survival. The inorganic arsenic NOAEL was selected as slightly lower at 1.4 mg/kg. A NOAEL of 10 mg/kg was used as a conservative estimate of organic arsenic effects, even though the lowest effect levels for a diet of arsenic-poisoned insects (lost weight due to reduced food consumption) were much higher at 18 mg/kg in Whitehead (for growth of adult ducks) and as high as 131 mg/kg-day for growth of red-winged blackbird nestlings to sufficient maturity to allow successful fledging in the wild. The arsenic NOAEL was calculated as a weighted average of the inorganic and organic forms equal to 5.6 mg/kg-day (weighted average is 0.49*1.4 + 0.51*10 = 5.8).

Reduced growth of young birds from low-dose arsenic consumption was shown by Whitehead not to inhibit fledging. Other reproductive measures might be of concern but have higher inorganic NOAELs than the Camardese et al. (1990) LOAEL value of 1.49 mg/kg-day for growth. Stanley et al. (1994, 1996) showed mallard egg production, eggshell thinning, egg weight, onset of reproduction, hatching success and duckling survival were less sensitive to inorganic arsenic consumption than the growth endpoint for ducklings. The NOAEL for these measures is estimated as 7.46 mg/kg-day (100 mg/kg arsenic in diet) and the LOAEL as 29.9 mg/kg-day (400 mg/kg arsenic in diet). The 10 mg/kg used for the organic form of arsenic falls within this range.

Finally, birds may not spit out food with arsenic, but when not force-fed by parents or humans, birds reduce consumption of food containing arsenic, whether in organic form as part of the insect tissue (e.g., poisoned grasshoppers), injected in inorganic form into the insect body, or added to food in inorganic form (Whitehead 1932). Whitehead shows turkeys readily ate 53 arsenic-poisoned grasshoppers the first day offered but reduced their consumption to zero or less than 6 after that. When offered arsenite-injected grasshoppers, turkeys only ate 14 the first day and ate 3 or less the following days. Similarly, chickens readily distinguished between poisoned and un-poisoned grasshoppers and stopped eating poisoned ones. When arsenic is part of the insect tissue, food consumption is greater than when it has been injected into the insect body, indicating at least some birds can readily detect and avoid the more toxic form. Thus, it is correct to say birds may not avoid arsenic as much if it is incorporated into the prey tissue, but Whitehead's results suggest they prefer food with less arsenic contamination. Even if the NOAEL for the organic form were lowered from 10 to 7.46 mg/kg (based on inorganic NOAEL for egg production, eggshell thinning, etc.), the deterministic HQ in the only reach with HQ >1, ER-A (for killdeer), would only change from 3 to 4 (from 3.0 to 3.7).

16. Section 3.3, page 5, third paragraph. The assumption that relatively non-toxic organic arsenic constitutes 42 percent of all arsenic in prey tissues is not convincing without more discussion and supporting material. Factors such as the solubility of inorganic arsenic and metabolism of inorganic forms to methylated arsenic compounds may affect bioavailability and toxicity. In addition, the added assumption that a hypothetical dose of 10 mg/kg-day for organic arsenic is not supported by the literature. Furthermore, it is unclear where the protective dose for arsenite (1.4 mg/kg-day) comes from. Table 3-5 does not include arsenite. The deterministic TRV should be derived from Table 3-5, unless more information is presented that supports the organo-arsenic hypothesis as substantially less toxic.

Response: See response to comment 15. We selected the lowest, most conservative NOAEL for the inorganic arsenic to account for solubility of inorganic arsenic and its metabolism (a more conservative approach than used for the EcoSSL NOAEL). The organic portion is assumed to be confined to the tissue, not the gut, and is assumed to be in a form that occurred in grasshopper tissue, presumably similar to the form (could include methylated forms) it would be in for mayfly and other benthic macroinvertebrate tissues. The raw data for arsenic concentrations in tissue versus whole organisms is provided in Table 1 in Attachment 1 to the Appendix; and the calculations of the percentages are presented in Table 1-7 of Attachment 1 to the Appendix. Further, the estimates that support the percentage of arsenic in the gut versus in the tissue (together with percent of aluminum and iron in the gut versus tissues) are provided in Attachment 1.

17. Section 3.5, page 6. It is stated that >80% of the sediment selenium speciation is organic selenium, and therefore only organo-selenium toxicity studies are considered. Twenty percent of inorganic selenium (e.g., selenite, selenate) may be significant. Suggest adding more discussion regarding the uncertainty associated with potential toxicity from the 20% inorganic selenium species.

Response: Organic selenium is more toxic than inorganic selenium (Heinz et al. 1987). Basing the refined TRV on the more toxic form of selenium biases the risk only slightly high, given that most of the dose is from prey tissue (>96%) and very little is from sediment. This is discussed in the Attachment 3 in the in the Wildlife Dietary Uptake Appendix within the BERA.

18. Section 3.5, page 7. It is unclear why the calculated dose from the Stanley et al. 1996 study was not used (0.35 and 0.7 mg/kg-day) as this study had a longer exposure duration (121 days relative to 46 days than in the Heinz et al. 1989 study) and body weight differences were considered less relevant than the dietary effect levels.

Response: Using a refined avian NOAEL based TRV of 0.35 mg/kg-day from EcoSSL document (which was based on a different average body weight than reported by the authors for mallards) for selenium changes the results slightly but does not change the conclusions significantly. In Emory River Reach B, for example, the HQs of the killdeer and the mallard remain the same when the TRV is changed from 0.4 to 0.35. For the tree swallow the HQ goes from 5 to 6.

19. Section 3.6, page 9. There appears to be an over-reliance on the very high NOAEL dose of selenium to the ornate shrew (from Clark, 1987) in an attempt to be less conservative in calculating a LOAEL dose to a hypothetical mink. The Clark (1997) study was rejected by EPA for development of wildlife TRVs as it was a compilation of data published elsewhere. For the probabilistic assessment, suggest that the NOAEL range be set between 0.112 and 1.96 mg/kg-day based on the range in Table 3-9, excluding the Clark study. The LOAEL range should be set from 0.157 to 3.2 mg/kg-day. The value 3.2 is calculated using the average NOAEL/LOAEL ratio of 0.62 from the studies listed in Table 3-9 and applied to the highest NOAEL dose of 1.96 mg/kg-day.

Response: We respectfully disagree that such an approach would be more accurate. That approach would conclude that mammals are more sensitive than birds. It is doubtful that many researchers of selenium effects would agree with that conclusion. Janz et al. (2010) discusses that there is little evidence for effects on small mammal populations. CH2M HILL (2000), cited in Santolo (2009), reported on long-term biological monitoring of small mammal populations at Kesterson National Wildlife Refuge. They reported small mammal populations have high reproductive rates, likely not affected by the selenium. Thus, the TRVs are not based mainly on the ornate shrew but on several studies showing no effects on various small mammal species at Kesterson.

There is uncertainty in the results of other small mammal population field studies that rely on comparison to reference areas. Santolo (2009) documents differences between Kesterson and reference sites in small mammal populations but states differences could be due to the lower food availability and water at Kesterson, or to selenium effects. Field investigations have not identified obvious effects of selenium on small mammal populations, whereas selenium effects on birds are well-documented. Using estimates of the TRV that are restricted to the very low end of the range of reported values would not adequately account for this uncertainty. Including only laboratory-based TRV studies that meet specific narrow criteria in the EcoSSL approach eliminates informative field studies of actual selenium exposures. The logical step following laboratory toxicity studies is to evaluate whether the laboratory-predicted effects are observed in the field; the available field investigations suggest there is little evidence for selenium effects on populations of small mammals in places where effects on bird populations have been documented.

The BERA remains highly conservative in the deterministic assessment, but the probabilistic assessment should incorporate and display very clearly our great uncertainty about the effects of selenium on mammalian populations. We will add to the uncertainty section an explanation of the level of uncertainty, and concerns about potential effects on the mink since the effect level could be low for that species. It is

re-assuring that studies in selenium-contaminated areas have not shown evidence of significant adverse effects to wild small mammal populations, in contrast to the predictions of laboratory studies showing decreased growth. That finding suggests the laboratory observation of decreased growth of mammals at very low doses of selenium (mostly from reduced food consumption, even in carnivores) does not translate to poor survival or reproduction in wild small mammal populations.

The text in the Attachment 3 – Derivation of Toxicity Reference Values of the Wildlife Dietary Uptake Appendix within the BERA was updated to better explain this issue.

20. Section 3.6, page 9, third paragraph. The statement that the low-end may be over-conservative because avoidance of food with high selenium content may not affect populations should be eliminated or modified because it is highly unlikely that a mammal at the Kingston Site will spit out its prey because it tastes too much like selenium. Most dietary avoidance in waterfowl is related to chemical taste in water and soil/sediment, not in prey tissue.

Response: Food consumption decreased significantly when dogs or mallards were fed selenium in food (selenized wheat or selenized yeast) in the laboratory (Rhian and Moxon 1943, Heinz and Hoffman 1996), which suggests they can taste it in their food. Weight loss, the endpoint, appears to be from not eating. They may not spit out the food but likely will move to another place with less selenium to feed, reducing their toxic load.

21. Section 3.10, page 11. More discussion should be provided regarding the uncertainties associated with PCBs in avians such as exposure to Aroclor mixtures, aryl hydrocarbon receptor differences between species, and why chickens are not a suitable surrogate for more sensitive avians in the affected area.

Response: While PCBs are legacy constituents, the latest scientific knowledge was applied to assess all constituents in the BERA. To create as accurate an assessment as possible, we reviewed current research on avian species on the importance of the form of the aryl hydrocarbon (Ah) receptor to PCB sensitivity that has been recently published (Farmahin et al. 2012). This research identifies three categories of sensitivity of birds to dioxin-like compounds such as PCBs based on the Ah receptor, with the chicken falling into the most sensitive category. A categorization of various wild avian species' sensitivity to dioxin-like compounds is currently being conducted by Sean Kennedy at the University of Ottawa. The results have not been published yet but support few of 76 bird species have the highly sensitive Ah receptor of the chicken (Kennedy, personal communication). The sensitive species found were: gray catbird, starling, ruby-throated humming bird, and jungle fowl. None of the avian piscivores investigated at TVA have had the sensitive version of the receptor. The text in the Attachment 3 – Derivation of Toxicity Reference Values of the Wildlife Dietary Uptake Appendix within the BERA has been updated to better explain this issue.

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