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Trace Element Concentrations in Amphibians: 2009-2010

Tennessee Valley Authority
Ash Recovery Project
Kingston, Tennessee

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Acronyms

ANOVA	Analysis of Variance
dw	dry weight
KIF	Kingston Fossil Plant
LOEC	lowest observed effect concentration
MDL	method detection limit
mg/kg	milligram per kilogram
NAVFAC	Naval Facilities Engineering Command
NOEC	no observed effect concentration
R	correlation coefficient
RL	Reporting Limit
SAS	Statistical Analysis Software
SD	Standard Deviation
SE	Standard Error
TVA	Tennessee Valley Authority
ww	wet weight

1. Introduction

The Tennessee Valley Authority (TVA) Kingston Fossil Plant (KIF), one of TVA's larger fossil plants, is located at the confluence of the Emory and Clinch Rivers on Watts Bar Reservoir in Roane County, Tennessee. Ash, a by-product of the plant's coal combustion, is stored in unlined containment areas. On December 22, 2008, one of the dredge cell containment areas failed, and approximately 5.4 million cubic yards of fly ash was released. Ash covered an estimated 300 acres of the Swan Pond Embayment and nearby shorelines, entered the channel and overbank areas of the riverine section of the Emory River, and finally migrated into parts of the Clinch and Tennessee Rivers. Spatial evaluations have indicated ash migration upstream as far as Emory River Mile 6.0, and as far downstream as Tennessee River Mile 566 (Jacobs 2011).

The fly ash that was released to these areas contains trace amounts of arsenic, chromium, copper, lead, mercury, nickel, selenium, thallium, vanadium, zinc, and other metals which are associated with combusted coal. Various groups of organisms were exposed to ash after the spill. Amphibians are of particular concern because 2.51 acres of wetland habitats in the embayments were covered with ash (Jacobs 2009). Amphibians have been considered a "sensitive sentinel to environmental change" due to their unique life cycle which exposes them to aquatic dissolved metals, as well as metals sequestered to sediments (Hopkins and Roe as cited in: Sparling, et al. 2010). Not only are dermal and ingestion exposure pathways to contaminants significant in wetlands, but amphibians are also exposed to contaminants in a variety of their life stages. As a result, elevated concentrations of metals and metalloids have the potential to elicit adverse effects in amphibians.

Accumulation of these ash-related metals and metalloids may start early on for anurans (frogs and toads), as literature studies have suggested maternal transfer of some contaminants into the egg. Shortly after an egg is deposited into the aquatic environment, aqueous uptake of contaminants into the egg can also occur. Both larval and adult anurans experience dermal and respiratory uptake pathways (Birge 2000, Kadokami, et al. 2002, 2004, Hopkins, et al. 2006 as cited in: Sparling, et al. 2010). In addition, for metals such as mercury and selenium, exposure from food sources and sediment is more substantial than concentrations found in the aqueous phase. Other metals such as aluminum and copper are typically taken up via exposures to the water (Pickhardt, et al. 2006 as cited in: Sparling, et al. 2010).

Beginning in 2009 and continuing yearly, TVA and other agencies collected the American toad (*Bufo americanus)*, spring peeper (*Pseudacris crucifer)*, and the upland chorus frog (*Pseudacris feriarum)* that were found in wetland areas near the TVA Kingston fly ash spill. Study objectives were to 1) quantify tissue concentrations of metals in three different species for among site and between-year comparisons, and 2) assess risk to amphibians by relating concentrations measured at the study sites to reference area concentrations and literature derived effects values, when available.

2. Methods

2.1 Species Selection

American toads, spring peepers, and upland chorus frogs were selected based on a census of spring breeding anuran populations that occur in the wetland areas adjacent to the riverine system. Adult male and female anuran species were identified by vocalizations that were audible throughout the project area. Average adult American toads are 2 to 3.5 inches long with females reaching up to 4.25 inches. Adults hide beneath woody debris, leaf litter, or rocks during the winter and summer, and are mostly active at night during the spring. During the non-breeding season, the adults have a relatively small home-range of a few hundred feet. Their home-range changes, however, during the spring breeding season when migration increases to more than 0.5 miles in order to breed. American toads deposit their eggs on vegetation as well as on the bottom of 2- to 4-inch depths of water. Adults consume small insects, and their predators include snakes, birds, and mammals (Dorcas and Gibbons 2008).

Spring peepers are typically 1 inch in length, they burrow under bark during the winter, and the rest of the year are found living a more arboreal life on vegetation in forested habitats, wetlands, marshes, and farm ponds. Spring peepers begin breeding in early spring and eggs are typically laid out of the water and attached to vegetation. They consume small insects and crawling arthropods and their predators include fish, semi-aquatic snakes, and birds.

Adult chorus frogs are also only 1 inch in length and most active during the winter and spring. They are found on the surface of the water, and burrow and hide during high temperatures to avoid desiccation. Chorus frogs lay their eggs on stems of vegetation. They feed on insects and small arthropods and their predators include garter and ribbon snakes, owls and other birds, water snakes, turtles, and small mammals (Dorcas and Gibbons 2008).

2.2 Collection Locations

Five locations were selected for collecting all three anuran species (Figure 1). Anurans were sampled from impacted sites (West and North Embayments), sites just north of the ash spill identified as unimpacted (Dawson and Rocky Top Farm), and a reference site pond in Knox County, Tennessee (Timberlake Subdivision).

Impacted sites include West and North Embayments. Both embayments were wetlands on TVA land that were previously monitored as part of the Reservoir Operation Study Design (TVA 2004). Both embayments have hydric soils with vernal pools and considered important to various amphibian species. The embayments were surrounded by farm areas, residential areas, and roadways (Jacobs 2009). The West Embayment included 1.55 acres and identified as palustrine emergent wetland and 0.65 acres of palustrine forested wetland using the Cowardin classification system (1979) (TVA 2010). The North Embayment included 0.30 acres of scrub/shrub wetland. Both embayments were covered by ash during the spill, and

had ash in the collection areas during the 2009 sampling event. However, ash in the West Embayment was removed in the summer of 2009, and the area was remediated prior to the 2010 sampling event. The North Embayment was covered with ash and inundated with water during the 2009 and 2010 sampling events (Jacobs 2011).

Both Dawson Farm and Rocky Top Farm are located approximately 0.5 to 1 mile from the North Embayment (Figure 1) and were not considered to be impacted by the spill. The Dawson Farm is classified as a palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded wetland (PSS1A, U.S. Fish and Wildlife Service 2004). Rocky Top Farm is a wetland in a floodplain, adjacent to the northern portion of the North Embayment. Sampling in both farms was conducted in scrub-shrub wetland areas with open water and adjacent hayfields.

The reference site pond was a man-made subdivision pond located in Knox County, Tennessee (Timberlake Subdivision). Amphibians were sampled from the pond in 2009 and 2010 in the wetland areas, as well as small drainage areas nearby. The pond is in a depression area surrounded by suburban development; however, it has no deliberate anthropogenic point sources of contaminants.

2.3 Sampling and Analysis

Field collections of all three amphibian species began approximately 3 months after the spill in the spring of 2009 and continued during the spring of 2010. Adult male and female amphibians were sampled from March 20 through April 9, 2009 and from March 22 through April 6, 2010, with sampling beginning at sunset and/or at the onset of an audible chorus (TVA 2011, Table 1).

A total of ten individuals per species were the targeted collection goal at each location. All anurans were captured by hand, while wearing nitrile gloves, and placed into a decontaminated sample container. Separate containers were used between Bufonids (toads) and Hylids (upland chorus frogs and spring peepers) in order to avoid any cross contamination, with no more than five individuals per container (TVA 2011).

Specimens remained separated by species and were held live for 4 to 7 days in glass or plastic decontaminated holding tanks with a deionized water source in order to clear the gut tract (Figure 2). Once depurated, individual specimens were placed in labeled, individual plastic sample bags, custody sealed, frozen whole (<-10˚C), and shipped to the lab on dry ice for whole body chemical analysis (Figure 2) (TVA 2011).

Both live and dead specimens were frozen whole and sent to the lab for analysis. Only one spring peeper in 2009 and eight spring peepers in 2010 died during the depuration process. These specimens were from both impacted and reference areas. In the event of a death, additional field samples were collected in order to serve as live replacements, and only live specimens were considered as part of the data analysis.

All samples were shipped to Pace Analytical Services, Inc., Green Bay, Wisconsin for analysis of metals and percent moisture. Prior to analysis, Pace Laboratory homogenized the entire specimen (whole body), metals were analyzed using the Method 6020/7471A, and percent moisture was measured according to Pace Laboratory standard operating procedures.

In most instances, spring peeper and upland chorus frog samples either did not meet minimum mass requirements for an accurate percent moisture determination or exceeded the project-specific percent moisture holding time determined by Pace Analytical Services, Inc. and Environmental Standards, Inc. (TVA 2009; ESI 2011). In order to analyze all metal data for all species, all spring peepers and upland chorus frogs were assigned the same default percent moisture value of 77.1 percent. The default value was determined by taking an average of the accepted *Bufo americanus* percent moisture values from the dataset. This percent moisture value is comparable to literature values for *Bufo americanus* of 77.8 percent, *Eurycea bislineata* of 73.9 percent, and *Plethodon cinereus* of 75.9 percent (Bergeron, et al. 2010, 2011).

2.4 Statistical Analysis

Statistical analyses were performed with particular focus on the objective to compare differences between years and between sites for each species. Dawson Farm, Rocky Top Farm, and Timberlake Subdivision sampling sites (hereafter: reference site) were grouped because all were unimpacted by the ash spill. In addition, the target number of anurans sampled was not met for any individual area.

In 2009, Pace Analytical Services, Inc. analyzed the amphibian tissues for a suite of 26 metals and metalloids (Table 2). For those that were below detection limits, the reporting limit (RL) was used in the statistical analysis. In 2009, samples were analyzed to the quantitation limit. In 2010, TVA requested that the labs develop a project-specific RL which consequently decreased the RL for most analytes (Table 2). Project-specific MDLs, also referred to as limit of detection, were calculated based on historical blank concentrations and on the 40 CFR Part 136 MDL procedure (TVA 2009). Statistical tests were chosen and run based on the quantity of samples that were detected, with the goal to evaluate site differences and to separate any differences attributed to the changes in RL. In order to do this, all analytes were examined for frequency of detection. Based on the detection frequency of iron and several other analytes at 85 percent or greater (Table 2), and the next consecutive detection frequency at 56 percent, the detection frequency of 85 percent was chosen as the selection criteria. Those analytes with fewer than 85 percent detections were still considered for statistical analysis. Analytes that were detected with a frequency less than 10 percent were not used for statistical analysis. These analytes include: antimony, beryllium, boron, chromium, molybdenum, nickel, thallium, and vanadium (Table 2; Appendix A).

The analytes with greater than 85 percent detection were evaluated using parametric comparison methods [Analysis of Variance (ANOVA), Statistical Analysis Software (SAS)]. When an analyte was not detected, the sample-specific RL was used. Prior to running the comparison tests, all concentrations were tested for normality and determined to be log normal distributions. The parametric comparison tests (ANOVA, SAS) were run on all log transformed data that was detected greater than 85 percent, and followed by a post-hoc

test using Tukey-Kramer for unequal sample sizes. Correlation analyses were also performed for these analytes. Analytes detected between 10 percent and 85 percent in 2010 were assessed using non-parametric comparison methods (Wilcoxon signed-rank, SAS) and data was not log transformed. The non-parametric comparison methods were conducted for all 2010 detected analytes, and a pairwise post-hoc application of the Wilcoxon test further identified differences among sites. The 2009 data had higher RLs and fewer detected concentrations (Tables 3 through 5). In order to avoid biasing the mean results in the statistical tests, and therefore the decision to reject or accept the test hypothesis, 2009 data with low detections were compared semi-quantitatively to 2010 data. This process avoided any bias that the 2009 and 2010 discrepancies in RLs would have caused when the two years of data were compared. For all parametric and non-parametric statistical tests, the hypothesis was rejected with a p-value < 0.05.

3. Results

Summary results are presented in Tables 3 through 5 and raw data is included in Appendix B. Constituent-specific box plots of trace element concentrations in American toads, spring peepers, and upland chorus frogs are presented on Figures 3 through 23. Additionally, constituent-specific graphs of mean concentrations in American toads, spring peepers, and upland chorus frogs are presented on Figures 24 through 31. Seven analytes were detected >85 percent. Results from the parametric comparisons for these parameters (barium, copper, iron, manganese, selenium, strontium, and zinc) are presented in Tables 6 through 8 for American toad, spring peeper, and upland chorus frog, respectively. The following sections provide a summary of those ANOVA results and the subsequent post-hoc results describing multiple comparisons.

3.1 American Toads

Significant differences in metal concentrations for the American toad whole body analysis exist between years for copper and among sites only for selenium (Table 6). Post-hoc Tukey-Kramer tests provided separation of some of these differences, while also detecting significant differences in manganese, strontium, and zinc when years and sites were compared (Table 6). Copper was significantly higher in 2009; however, the two sites driving this difference are 2009 West Embayment and 2010 reference sites (Figure 5), with West Embayment being the highest [average = 8.73 milligrams per kilogram (mg/kg) ± 2.26 standard deviation (SD)] (Table 3). Manganese concentrations were only statistically different between the 2010 and 2009 North Embayment (Table 6; Figure 7). Selenium concentrations were highest in 2010. Concentrations in the West Embayment were higher than both North Embayment and the reference sites (Table 6; Figure 8). The highest mean selenium concentrations were detected in the 2010 West Embayment, with an average concentration of 2.11 mg/kg ± 0.45 SD (Table 3). Post-hoc testing indicated that 2009 and 2010 West Embayment and 2010 North Embayment selenium concentrations were greater than 2009 North Embayment concentrations (Table 6). When only comparing 2010 data, non-parametrically, both North Embayment and West Embayment selenium concentrations were greater than the reference site concentrations (Table 12; Figure 8). Strontium concentrations were highest in toads collected from 2009 West Embayment and 2010 North Embayment with average concentrations of 114 mg/kg ± 47.7 SD and 112 mg/kg ± 46.3, respectively (Table 3; Figure 9). Both averages were significantly higher when compared to the 2010 reference (Tables 3 and 6). In contrast, concentrations of zinc in the 2010 reference sites were higher than concentrations in the 2010 West Embayment (Table 6; Figure 9).

Correlations between all metals for American toads were evaluated using Pearson correlation coefficients found in Table 7. Constituents were positively correlated when coefficients are positive, and negatively correlated when the inverse is true. For those constituents with significant differences across years and sites, there are a few correlations worth noting. Selenium and strontium are both positively correlated with manganese, and the strongest correlation was between strontium and barium (R=0.63, Table 7)

3.2 Spring Peepers

Significant differences in metal concentrations for the spring peeper whole body analysis between sites exist for barium, copper, iron, selenium, strontium, and zinc (Table 8). The ANOVAs for year are uneven comparisons because spring peepers were not found during the 2009 collections at the North Embayment and were only collected in 2010.(Tables 1 and 4); however, multiple comparison, post-hoc tests found differences in copper, iron, manganese, selenium, strontium, and zinc. The concentrations of copper were highest in the 2009 West Embayment and are significantly higher compared with all other sites (Table 8; Figure 12). Concentrations of copper in the 2009 West Embayment had averages of 27.18 mg/kg ±11.08 SD, and the lowest in the 2010 North Embayment with an average of 9.44 mg/kg ± 3.47 (Table 4). The 2009 West Embayment iron concentrations were significantly elevated compared to the 2010 reference (Figure 13). Manganese concentrations were highest in the 2010 reference; however, differences were only between 2010 and 2009 reference sites (Table 8; Figure 14). Zinc concentrations were highest in the 2009 West Embayment and significantly higher than the 2009 reference (Figure 16). Both selenium and strontium concentrations in spring peepers are higher in the impacted areas compared with the reference sites (Table 8; Figures 15 and 16). Selenium concentrations in spring peepers from the 2009 West Embayment site were significantly higher than the 2009 and 2010 reference sites. Overall, the 2009 and 2010 West Embayment sites had the highest concentrations with maximum detections at 2.89 and 3.86 mg/kg, respectively (Table 4). Strontium concentrations were also significantly higher in the 2009 and 2010 West Embayments compared to the 2009 reference areas, and the 2010 West Embayment is significantly elevated in strontium compared to the 2010 reference areas (Tables 4 and 8).

Correlations between all metals for spring peepers were evaluated using Pearson correlation coefficients found in Table 9. Constituents were positively correlated when coefficients are positive, and negatively correlated when the inverse is true. For those constituents with significant differences across years and sites, there are a few correlations worth noting. Both iron and copper were correlated with each other and to selenium. Strontium was correlated with barium, manganese, and zinc. The strongest correlations were between strontium and barium (R = 0.75), iron and copper (R = 0.76) (Table 9).

3.3 Upland Chorus Frogs

Significant differences in metal concentrations for the upland chorus frog whole body analysis exist between years for copper and manganese, and among sites for manganese and selenium (Table 10). The ANOVAs for year are uneven comparisons because chorus frogs were not found during the 2009 collections at the reference sites and were only collected in 2010. Post-hoc testing indicated multiple differences between years and areas for copper, manganese, and selenium, and strontium. Mean copper concentrations were highest in 2009 West Embayment; however there were no differences between the West Embayment and reference sites (Table 10; Figure 19). The 2009 West Embayment samples were significantly higher in copper compared to 2010 West Embayment locations (Table 10); however, in 2010 copper concentrations in the North Embayment were greater than the West Embayment (Table 12). Zinc in 2010 was lowest in West Embayment and significantly less than North Embayment and reference sites (Table 12; Figure 23).

Strontium concentrations were only significantly different between 2009 North Embayment and the 2010 West Embayment (Table 10; Figure 23). Mean selenium concentrations were highest in the 2010 West Embayment compared to the 2010 reference sites (Table 12). The 2010 West Embayment had a maximum concentration of 2.51 mg/kg (average = 1.96 mg/kg ± 0.53) (Table 5) whereas the reference areas in 2010 had maximum detection at 2.16 mg/kg (average = 1.37 mg/kg ± -0.38) (Table 5; Figure 22).

Correlations between all metals for upland chorus frogs were evaluated using Pearson correlation coefficients found in Table 11. Constituents were positively correlated when coefficients are positive, and negatively correlated when the inverse is true. For those constituents with significant differences across years and sites, there are a few correlations worth noting. Strontium is negatively correlated with barium, copper, and iron and positively correlated with manganese and selenium. The highest correlations were between copper and iron (R = 0.67) and strontium and barium (R = 0.59).

3.4 Results for Constituents with Low Frequency of Detect

There were seven constituents that had a detection frequency greater than 10 percent and less than 85 percent (Table 2). These constituents include: aluminum, arsenic, cadmium, cobalt, lead, mercury, and silver.

When the constituents listed above were not detected, the RL was used in place of non-detects. There were no statistical differences of aluminum, lead, and silver concentrations. American toads were the only species with statistically elevated concentrations of arsenic in 2010 (Wilcoxon pairwise comparisons) (Table 12). When comparing average concentrations across all sites and years, the sites with the highest arsenic concentrations were the reference sites in 2009 (average = 2.38 mg/kg ± 1.68 SD) (Table 3) and the North Embayment in 2010 (average = 3.45 mg/kg ± 7.9) (Table 12; Figure 3). Differences in spring peepers were influenced by some sites having no detected concentrations. In 2009, cadmium was not detected in any samples. The 2010 North Embayment had all non-detects for cadmium, and had RLs that were higher than some of the detected concentrations at other sites. In this case, the statistical difference is driven by the higher RLs compared to detected concentrations (Table 12; Figure 11). The opposite is true for mercury, where the reference site for 2010 was all non-detects; however, these RLs were significantly lower than the West Embayment. In contrast, cobalt was detected and elevated in the reference site compared to the North Embayment (Table 12; Figure 12). Cadmium was also not detected in 2009 for chorus frogs. In 2010, cadmium was highest in the chorus frogs from the impacted sites compared to the reference areas, where there were no detected concentrations of cadmium (Table 5; Figure 18).

4. Discussion of Findings

Several metals (aluminum, silver, and manganese) were not statistically higher in American toads, spring peepers, or upland chorus frogs collected from impacted sites compared with those from reference sites. Differences in iron were significant only in spring peepers; however there was high variability and this difference is only for two different years with no clear trends (Figure 29). Zinc concentrations were only different for spring peepers between West Embayment and reference sites in 2009; however, American toad zinc concentrations were higher in the reference sites in 2010 (Figure 31). The lack of clear trends in concentrations for these constituents was possibly due to the inherent variability of naturally-occurring elements that exists within and between the wetlands. In contrast, trace elements (arsenic, barium, cadmium, copper, mercury, selenium, and strontium) were found to be statistically elevated in at least one of the three anuran species from the ash-impacted sites compared with those from the reference sites.

Analytes with the relatively high frequency of detection that were statistically elevated from the reference sites include barium, copper, selenium, and strontium. Of the analytes with high detection frequency, only barium, selenium, and strontium have been found in higher concentrations in coal ash-impacted areas (Rowe, et al. 1996).

Barium was only significantly elevated in the spring peepers, and this was only for pairwise comparisons between West Embayment and reference sites; however, there are no clear discernable differences when evaluating differences between both years and sites (Figure 25). Based on the limited literature background concentrations, this may be due to natural variation in the river system from year to year. Although these authors did not find copper statistically elevated in anuran tissues at coal ash-impacted areas, for this study differences between coal-ash impacted and reference sites existed (Figure 26). American toads and spring peepers in the 2009 West Embayment had the highest mean concentrations for copper. Copper was statistically elevated above the reference sites at the West Embayment compared with average concentrations in American toads and spring peepers of 8.73 mg/kg and 27.18 mg/kg, respectively.

Few effects levels have been established for copper in anurans, partly because of the protective mechanism by which excess copper is sequestered in lysosomes in the liver, which has been noted to protect the cell from toxic effects from copper (Goldfischer, et al. 1970 as cited in Eisler 1998). NOEC critical body residues for copper have been reported as 16 to 79 mg/kg ww in Rana tadpoles and 93 mg/kg in Bufo tadpoles for both survival and sublethal effects on length and weight (NAVFAC 2004). No effects have been reported in frogs with liver concentrations of >2,000 mg/kg dw of copper and background concentrations have been noted for whole cricket frog tadpoles (9.8 to 15.7 mg/kg dw), whole body gray treefrog (7.4 to 12.6 mg/kg), and whole body adult southern toads (20.80 mg/kg dw) (Eisler 1998; Hopkins, et al. 1998).

All three species of anurans had elevated levels of selenium, and two had elevated levels of strontium compared with the reference sites (Figures 29 and 30). More specifically for selenium, the 2010 North and West Embayments in American toads, the 2009 West Embayment area for the spring peeper, and the 2010 North and West Embayments for the upland chorus frog were all elevated compared with the reference

areas. Strontium in the 2009 West Embayment and 2010 West and North Embayment in American toads and the 2009 and 2010 West Embayment in spring peepers were elevated compared with reference areas. In addition, selenium and strontium were correlated in the American toad and the upland chorus frog. Previous studies have illustrated the ability for both selenium and strontium to bioaccumulate in anurans during the larval period, and to retain those concentrations through the metamorphosis phase (Snodgrass, et al. 2004, Exhibit 1). Bioaccumulation through the various life stages stresses the importance of monitoring both selenium and strontium in anurans, because these concentrations may also cause effects to consumers of anurans. In one study, *R. clamitans* exposed to coal combusted waste accumulated several trace elements (arsenic, cadmium, iron, selenium, strontium, and vanadium); however, while body burden concentrations decreased for most elements following tail reabsorption, selenium concentrations increased and strontium did not change between larvae and metamorphs (Snodgrass, et al. 2004, Exhibit 1).

Exhibit 1. Literature-Derived Concentrations of Selenium and Strontium in Anurans from Control and Impacted Areas.

Analyte	Species/ Life Stage	Literature Concentrations (mg/kg dw)	Source
Selenium	*R. clamitans* Metamorphs	Control- 1.44 Impacted- 20.88	Snodgrass, et al. 2004
Selenium	*B. terrestris* Adult male	Control- 2.19 Impacted- 17.40	Hopkins, et al. 1998
Selenium	*G. carolinensis* Postovopositional	Control-1.85 Impacted- 42.40	Hopkins, et al. 2006
Strontium	*R. clamitans* Metamorphs	Control- 12.53 Impacted- 41.84	Snodgrass, et al. 2004
Strontium	*B. terrestris* Adult male	Control- 132.10 Impacted- 386.70	Hopkins, et al. 1998
Strontium	*G. carolinensis* Postovopositional	Control-44.22 Impacted- 324.23	Hopkins, et al. 2006

In this study, American toads, spring peepers, and upland chorus frogs all had selenium concentrations within the reference/control site ranges found in Exhibit 1. This suggests that significant bioaccumulation of selenium has not occurred and that the statistical differences observed may be a reflection of natural variability. Concentrations at all sites were lower than those concentrations of selenium known to be embryotoxic to some fish and birds at 4-16 mg/kg dw (Lemly 1996; Ohlendorf 2003). While upland chorus frogs had no differences in strontium, concentrations in spring peepers from the 2009 and 2010 West Embayment area and American toads from the 2009 West Embayment and 2010 North Embayment areas were closer to the contaminated site concentrations from previous studies. Reduced survival to metamorphosis in anurans (Snodgrass, et al. 2004) and salamanders (Roe, et al. 2006) has been linked to

exposure to coal combusted waste. However, literature effects values are lacking for selenium and strontium. In the mole salamander (*Ambystoma talpoideum)*, whole body strontium concentrations of 250 mg/kg dw were associated with reduced survival to metamorphosis by 57-77 percent (Roe, et al. 2006). Larval mole salamanders are more sensitive than adult anurans, and therefore provide a protective comparison level. Concentrations of strontium from amphibians at all sites were below this conservative level, as the highest concentrations were from the 2009 and 2010 West Embayment for American toads of 206 mg/kg dw and 241 mg/kg dw, respectively.

Metals that were statistically elevated but had the relatively low detection frequency included: arsenic, cadmium, and mercury. Limited metal and metalloid reference concentrations exist for comparison. In previous studies, cadmium was not detected at higher concentrations in coal ash-impacted sites compared with reference areas (Hopkins, et al. 1998). Cadmium was only detected in 19 percent of samples (Table 2), and upland chorus frogs had concentrations that were elevated in the West and North Embayments (0.14 mg/kg $\pm$ 0.02 SD and 0.15 mg/kg $\pm$ 0.04 SD, respectively). These concentrations were lower than those measured in an ash-impacted area of 0.27 mg/kg $\pm$ 0.05 SE, and an adverse effect of cadmium on anurans has not been well documented (Hopkins, et al. 1998). No observed effect concentration (NOEC) critical body residues for cadmium have been reported as 47 to 110 mg/kg wet weight (ww) in Rana tadpoles and 200 mg/kg in Bufo tadpoles for survival; lowest observed effect concentration (LOEC) critical body residues for sublethal effects on length and weight have been reported as >47 to 100 mg/kg ww in Rana tadpoles and 28 mg/kg ww in Bufo tadpoles (NAVFAC 2004). NOEC critical body residues from this Naval Facilities Engineering Command (NAVFAC) study were reported from the control treatment and are not considered reliable effect concentrations.

Arsenic concentrations also were not clearly distinguishable between impacted and reference areas for all species (Figure 24). Overall, concentrations were highest in American toads, with the concentrations in the 2009 reference sites and the 2010 North Embayment an order of magnitude higher compared to other sites. Both Rocky Top and Dawson Farms are in close proximity to the North Embayment (Figure 1). Elevated concentrations of arsenic found in the reference sites could be attributed to the close proximity between impacted and unimpacted areas, with the potential for movement of American toads between the two locations. Many anurans may travel up to 1 kilometer from their breeding pond (Eigenbrod, et al. 2008). Considering their small size, spring peepers, and upland chorus frogs are the least likely to travel long distances, and the reference sites were not elevated in arsenic for these species. In addition, arsenic concentrations could be the result of other types of anthropogenic input. Anthropogenic input of arsenic on farms is common due to organoarsenicals used for herbicidal applications or as feed additives for poultry and swine, which provides a pathway for arsenic to the nearby environment (NAS 1977 as cited in: Eigenbrod, et al. 2008). There are no arsenic whole body effects levels for anurans, and while some studies have reported differences between anurans from coal ash-impacted sites and reference areas (Hopkins, et al. 1998; Rowe, et al. 1996); others found no differences (Furr, et al. 1979 as cited in: Hopkins, et al. 1998).

Literature studies have documented mercury effects to amphibian populations, including reduced survival, growth, and development (Gerstenberger and Pearson 2002). Mercury can bioaccumulate in organisms, biomagnify up the food chain and is a ubiquitous metal (Bergeron, et al. 2011). Studies have found mercury concentrations to be elevated in anurans from mercuric sulfate impacted sites (Bergeron, et al. 2010) historical mining areas (Hothem, et al. 2010), and one study provided effects levels of mercury in amphibians via dietary exposures (Unrine, et al. 2004). For this study, only concentrations of mercury in spring peepers were elevated at the West Embayment compared to the reference sites; however, mercury was only detected 17 percent of the time (Table 2). Concentrations of mercury in the 2010 West Embayment had an average concentration of 0.12 mg/kg dry weight (dw) and a maximum concentration of 0.2 mg/kg dw. The lowest literature effects level for anurans is 0.24 mg/kg total mercury tissue concentrations, from leopard frog larvae (*Rana sphenocephala)*, where they experienced decreased metamorphic success (Unrine, et al. 2004). In comparison to the larval effects level, which is the more sensitive life-stage, adult anurans from the embayments and reference sites all had less than 0.24 mg/kg dw. Additionally, typical state health advisories for fish and game consumption typically set the mercury concentration to 0.5 mg/kg and federal regulations are set at 1 mg/kg (Gerstenberger and Pearson 2002).

4.1 Summary and Conclusions

As with most field surveys, uncertainties exist when evaluating species that have the ability to migrate, or in systems of complex analyte mixtures. The evaluations in this study focused on comparisons among sites, between years, and with literature derived concentrations in order to assess the relationship between the ash release and trace elements in amphibians. Given the lack of anuran-specific literature-based effects values for many of the trace elements found in fly ash, it is difficult to discern level of effect that the anuran populations have potentially experienced due to the ash spill. Furthermore, the natural variability or historical contamination associated with the sample sites have potentially contributed to the differences found among sites.

A total of 26 metals and metalloids were measured in whole body American toads, spring peepers, and upland chorus frogs. Out of all 26 metals and metalloids, seven analytes were detected infrequently (less than 10 percent) and almost all analytes had concentration ranges that reflected natural system variability. Out of the 11 analytes with high detections, only selenium and strontium showed trends based on comparisons between years and among sites. The clearest trends in selenium were in American toads and upland chorus frogs that had elevated concentrations in 2010 North and West Embayments compared with the reference. For strontium, American toads and spring peepers in the 2010 West Embayment were higher than the reference; however, the clearing and subsequent restoration of the West Embayment occurred in 2009. Recognizing that bioaccumulation can potentially take longer than one or 2 years, other concentration ranges from literature were used for comparisons as well. When selenium and strontium were compared with literature-derived whole body amphibian concentrations measured from impacted areas, only strontium fell within the “impacted” range and selenium was more comparable to the literature reference areas and natural variability. Therefore, literature derived concentrations suggest that amphibians exposed to ash in

the North and West Embayments have significantly accumulated strontium, but have not significantly accumulated selenium.

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Table 1. Summary of Amphibian Collections for 2009 and 2010
Tennessee Valley Authority Kingston, Tennessee

Location			Species					
Site Name	Type	Statistical Groupings	2009 American Toad	2010 American Toad	2009 Spring Peeper	2010 Spring Peeper	2009 Chorus Frog	2010 Chorus Frog
Timberlake	Reference	Reference [2]	0	2	10	10	0	1
Dawson Farm	Unaffected Sites [1]	Reference [2]	0	10	3	11	0	4
Rocky Top Farm	Unaffected Sites [1]	Reference [2]	10	1	10	10	0	8
North Embayment	Potentially Affected Sites	North Embayment	10	10	0	5	9	11
West Embayment	Potentially Affected Sites	West Embayment	11	10	10	9	2	11

[1] Unaffected sites = areas in close proximity to the site that were not impacted by the fly ash spill.

[2] Reference = both unaffected sites and Timberlake were combined for statistical tests and collectively referred to as reference.

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Table 2. Data Used in Determining Appropriate Statistical Hypothesis Testing Methods

Tennessee Valley Authority Kingston, Tennessee

Analyte	Number of Samples	Number of Detects 2009 & 2010	FOD 2009 & 2010	Mean Reporting Limit in 2009 (mg/kg/dw)	Mean Reporting Limit in 2010 (mg/kg/dw)
Aluminum[1]	187	39	21%	107.64	34.92
Antimony[2]	187	1	1%	0.43	0.13
Arsenic[1]	187	48	26%	0.43	0.26
Barium[3]	187	187	100%	0.43	0.4
Beryllium[2]	187	0	0%	0.43	0.38
Boron[2]	187	0	0%	8.61	3.62
Cadmium[1]	187	35	19%	0.43	0.09
Chromium[2]	187	11	6%	0.56	1.11
Cobalt[1]	187	101	54%	0.43	0.12
Copper[3]	187	168	90%	2.75	1.37
Iron[3]	187	162	87%	107.64	114.98
Lead[1]	187	62	33%	0.49	0.3
Manganese[3]	187	187	100%	2.16	1.49
Mercury[1]	187	31	17%	0.09	0.1
Molybdenum[2]	187	6	3%	4.31	0.31
Nickel[2]	187	12	6%	0.45	0.85
Selenium[3]	187	187	100%	0.86	0.59
Silver[1]	187	30	16%	0.22	0.03
Strontium[3]	187	187	100%	0.52	0.38
Thallium[2]	187	1	1%	0.43	0.13
Vanadium[2]	187	8	4%	0.86	0.45
Zinc[3]	187	187	100%	8.61	18.99

1. 10% < Detection < 85%; sample reporting limit substituted for non-detects; evaluated using non-parametric comparison methods.

2. Detection ≤ 10% ; excluded from statistical evaluation.

3. Detection >85% ; sample reporting limit substituted for non-detects; evaluated using parametric comparison methods.

FOD - frequency of detection

mg/kg/dw - milligrams per kilogram dry weight

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Table 3. American Toad Summary Statistics for 2009 and 2010
Tennessee Valley Authority Kingston, Tennessee

Analyte	Site	2009 American Toad Results (mg/kg/dw)				2010 American Toad Results (mg/kg/dw)			
		Number of Detects	Number of Samples	Mean ± SD[1]	Range	Number of Detects	Number of Samples	Mean ± SD[1]	Range
Aluminum	Reference	6	10	308 ± 408	108 - 1430	5	13	282 ± 631	31.1 - 2340
	North Embayment	0	10	NC ± NC	89.6 - 117	5	10	300 ± 607	33 - 1980
	West Embayment	6	11	186 ± 88.8	101 - 378	7	10	85.6 ± 57.5	34.4 - 180
Antimony	Reference	0	10	NC ± NC	0.39 - 0.47	0	13	NC ± NC	0.11 - 0.15
	North Embayment	0	10	NC ± NC	0.36 - 0.47	1	10	0.18 ± 0.15	0.11 - 0.59
	West Embayment	0	11	NC ± NC	0.39 - 0.74	0	10	NC ± NC	0.11 - 0.15
Arsenic	Reference	10	10	2.38 ± 1.68	0.71 - 6.48	6	13	0.4 ± 0.27	0.22 - 1.1
	North Embayment	0	10	NC ± NC	0.36 - 0.47	10	10	3.45 ± 7.9	0.27 - 25.9
	West Embayment	0	11	NC ± NC	0.39 - 0.74	6	10	0.31 ± 0.13	0.22 - 0.65
Barium	Reference	10	10	87.9 ± 24.7	53 - 127	13	13	72.8 ± 27.9	43.9 - 123
	North Embayment	10	10	66.1 ± 25.8	31.5 - 126	10	10	102 ± 52.6	32.8 - 199
	West Embayment	11	11	84.1 ± 30.5	23.6 - 126	10	10	71.8 ± 21.2	45.1 - 111
Beryllium	Reference	0	10	NC ± NC	0.39 - 0.47	0	13	NC ± NC	0.26 - 0.61
	North Embayment	0	10	NC ± NC	0.36 - 0.47	0	10	NC ± NC	0.44 - 0.65
	West Embayment	0	11	NC ± NC	0.39 - 0.74	0	10	NC ± NC	0.23 - 0.3
Boron	Reference	0	10	NC ± NC	7.9 - 9.4	0	13	NC ± NC	3.1 - 4.2
	North Embayment	0	10	NC ± NC	7.2 - 9.4	0	10	NC ± NC	3.1 - 4.5
	West Embayment	0	11	NC ± NC	7.9 - 14.8	0	10	NC ± NC	3.3 - 4.3
Cadmium	Reference	1	10	0.43 ± 0.02	0.39 - 0.47	4	13	0.14 ± 0.06	0.08 - 0.28
	North Embayment	0	10	NC ± NC	0.36 - 0.47	5	10	0.17 ± 0.09	0.07 - 0.29
	West Embayment	0	11	NC ± NC	0.39 - 0.74	5	10	0.15 ± 0.07	0.07 - 0.27
Chromium	Reference	1	10	2.56 ± 5.57	0.44 - 18.4	1	13	1.42 ± 1.14	0.96 - 5.2
	North Embayment	0	10	NC ± NC	0.39 - 0.73	2	10	3.4 ± 7.1	1 - 23.6
	West Embayment	4	11	1.47 ± 2.4	0.41 - 8.6	0	10	NC ± NC	1 - 1.3
Cobalt	Reference	2	10	0.47 ± 0.08	0.39 - 0.63	11	13	0.34 ± 0.31	0.12 - 1.3
	North Embayment	0	10	NC ± NC	0.36 - 0.47	10	10	0.48 ± 0.62	0.14 - 2.2
	West Embayment	1	11	0.48 ± 0.1	0.39 - 0.74	10	10	0.28 ± 0.08	0.16 - 0.45
Copper	Reference	6	10	8.02 ± 2.67	4.53 - 12.1	11	13	5.54 ± 1.57	3.41 - 8.5
	North Embayment	3	10	6.17 ± 2.19	3.9 - 10.4	9	10	6.92 ± 3.7	4.3 - 15.4
	West Embayment	10	11	8.73 ± 2.26	5.1 - 13.1	9	10	6.9 ± 2.25	3.3 - 11.1
Iron	Reference	10	10	440 ± 379	171 - 1470	13	13	336 ± 438	127 - 1770
	North Embayment	7	10	140 ± 44.7	105 - 260	10	10	2070 ± 5810	111 - 18600
	West Embayment	9	11	240 ± 103	103 - 400	1	10	238 ± 150	104 - 634

[1] Mean calculations include reporting limits substituted for non-detects.
mg/kg/dw - milligrams per kilogram dry weight
NC = not calculated because all samples were non-detects; range represents reporting limits only
SD - standard deviation

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Table 3. American Toad Summary Statistics for 2009 and 2010
Tennessee Valley Authority Kingston, Tennessee

Analyte	Site	2009 American Toad Results (mg/kg/dw)				2010 American Toad Results (mg/kg/dw)			
		Number of Detects	Number of Samples	Mean ± SD[1]	Range	Number of Detects	Number of Samples	Mean ± SD[1]	Range
Lead	Reference	9	10	1.03 ± 0.53	0.43 - 2.1	7	13	0.97 ± 0.84	0.38 - 3.1
	North Embayment	4	10	0.56 ± 0.27	0.36 - 1.1	8	10	1.8 ± 2.88	0.27 - 9.9
	West Embayment	6	11	0.74 ± 0.48	0.41 - 2.1	7	10	0.63 ± 0.37	0.25 - 1.5
Manganese	Reference	10	10	85.7 ± 28.3	48.6 - 126	13	13	95.8 ± 53.3	37.2 - 227
	North Embayment	10	10	52.9 ± 38	15.4 - 128	10	10	131 ± 133	28.8 - 489
	West Embayment	11	11	96.8 ± 46.8	44.2 - 174	10	10	73.5 ± 42.6	19.3 - 173
Mercury	Reference	1	10	0.09 ± 0.01	0.08 - 0.12	1	13	0.1 ± 0.01	0.09 - 0.12
	North Embayment	5	10	0.09 ± 0.01	0.07 - 0.11	1	10	0.11 ± 0.01	0.09 - 0.13
	West Embayment	6	11	0.11 ± 0.03	0.08 - 0.18	2	10	0.11 ± 0.02	0.09 - 0.14
Molybdenum	Reference	0	10	NC ± NC	3.9 - 4.7	0	13	NC ± NC	0.27 - 0.36
	North Embayment	0	10	NC ± NC	3.6 - 4.7	1	10	0.38 ± 0.22	0.26 - 1
	West Embayment	0	11	NC ± NC	3.9 - 7.4	0	10	NC ± NC	0.28 - 0.36
Nickel	Reference	3	10	1.46 ± 2.55	0.44 - 8.7	1	13	0.97 ± 0.43	0.74 - 2.4
	North Embayment	0	10	NC ± NC	0.39 - 0.47	1	10	0.92 ± 0.17	0.72 - 1.3
	West Embayment	6	11	1.77 ± 3.77	0.41 - 13.1	0	10	NC ± NC	0.77 - 1
Selenium	Reference	10	10	1.73 ± 0.44	0.89 - 2.3	13	13	1.6 ± 0.29	1.1 - 2.25
	North Embayment	10	10	1.4 ± 0.46	0.93 - 2.3	10	10	2.01 ± 0.54	0.92 - 2.9
	West Embayment	11	11	2.03 ± 0.56	1.18 - 3.3	10	10	2.11 ± 0.45	1.4 - 3
Silver	Reference	0	10	NC ± NC	0.2 - 0.24	2	13	0.03 ± 0	0.02 - 0.03
	North Embayment	0	10	NC ± NC	0.18 - 0.23	2	10	0.03 ± 0.01	0.02 - 0.05
	West Embayment	0	11	NC ± NC	0.2 - 0.37	4	10	0.03 ± 0.01	0.03 - 0.05
Strontium	Reference	10	10	106 ± 34.1	67 - 173	13	13	67 ± 30.4	34.2 - 121
	North Embayment	10	10	81 ± 26.8	42.9 - 133	10	10	112 ± 46.3	61.7 - 186
	West Embayment	11	11	114 ± 47.7	47 - 206	10	10	108 ± 58.7	42.1 - 241
Thallium	Reference	0	10	NC ± NC	0.39 - 0.47	0	13	NC ± NC	0.1 - 0.14
	North Embayment	0	10	NC ± NC	0.36 - 0.47	0	10	NC ± NC	0.1 - 0.15
	West Embayment	0	11	NC ± NC	0.39 - 0.74	0	10	NC ± NC	0.11 - 0.14
Vanadium	Reference	3	10	0.98 ± 0.2	0.79 - 1.4	1	13	0.66 ± 0.94	0.34 - 3.8
	North Embayment	0	10	NC ± NC	NC - NC	3	10	4.11 ± 11.4	0.38 - 36.4
	West Embayment	0	11	NC ± NC	NC - NC	0	10	NC ± NC	0.36 - 0.47
Zinc	Reference	10	10	112 ± 12.2	90 - 134	13	13	139 ± 44	102 - 255
	North Embayment	10	10	112 ± 17.9	80 - 140	10	10	113 ± 14.8	96 - 141
	West Embayment	11	11	124 ± 17.5	106 - 161	10	10	106 ± 14.9	84.9 - 131

[1] Mean calculations include reporting limits substituted for non-detects.
mg/kg/dw - milligrams per kilogram dry weight
NC = not calculated because all samples were non-detects; range represents reporting limits only
SD - standard deviation

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Table 4. Spring Peeper Summary Statistics for 2009 and 2010

Tennessee Valley Authority Kingston, Tennessee

Analyte	Site	2009 Spring Peeper Results (mg/kg/dw)				2010 Spring Peeper Results (mg/kg/dw)			
		Number of Detects	Number of Samples	Mean ± SD[1]	Range	Number of Detects	Number of Samples	Mean ± SD[1]	Range
Aluminum	Reference	0	23	NC ± NC	108.07 - 123.24	6	31	39.44 ± 10.74	26.1 - 69.78
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	32.06 - 35.92
	West Embayment	0	10	NC ± NC	75.5 - 109.46	0	9	NC ± NC	33.03 - 36.25
Antimony	Reference	0	23	NC ± NC	0.43 - 0.49	0	31	NC ± NC	0.09 - 0.13
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.12 - 0.13
	West Embayment	0	10	NC ± NC	0.3 - 0.44	0	9	NC ± NC	0.12 - 0.14
Arsenic	Reference	1	23	0.45 ± 0.05	0.43 - 0.66	2	31	0.25 ± 0.03	0.18 - 0.39
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.23 - 0.25
	West Embayment	0	10	NC ± NC	0.3 - 0.44	0	9	NC ± NC	0.23 - 0.26
Barium	Reference	23	23	51.57 ± 30.03	11.18 - 119.34	31	31	60.88 ± 30.29	24 - 132.38
	North Embayment	NA	NA	NA ± NA	NA - NA	5	5	59.43 ± 19.19	39.14 - 83.28
	West Embayment	10	10	71.91 ± 28.8	39.6 - 123.54	9	9	77.67 ± 23.43	42.75 - 113.67
Beryllium	Reference	0	23	NC ± NC	0.43 - 0.49	0	31	NC ± NC	0.23 - 0.54
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.24 - 0.51
	West Embayment	0	10	NC ± NC	0.3 - 0.44	0	9	NC ± NC	0.24 - 0.55
Boron	Reference	0	23	NC ± NC	8.63 - 9.93	0	31	NC ± NC	2.7 - 3.8
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	3.36 - 3.74
	West Embayment	0	10	NC ± NC	6 - 8.8	0	9	NC ± NC	3.39 - 3.73
Cadmium	Reference	0	23	NC ± NC	0.43 - 0.49	5	31	0.09 ± 0.03	0.07 - 0.18
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.09 - 0.15
	West Embayment	0	10	NC ± NC	0.3 - 0.44	2	9	0.13 ± 0.07	0.06 - 0.27
Chromium	Reference	1	23	0.57 ± 0.52	0.43 - 2.96	1	31	2.02 ± 5.14	0.83 - 29.74
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	1.02 - 1.15
	West Embayment	1	10	1.03 ± 1.08	0.35 - 3.59	0	9	NC ± NC	1.05 - 1.2
Cobalt	Reference	0	23	NC ± NC	0.43 - 0.49	26	31	0.24 ± 0.14	0.09 - 0.62
	North Embayment	NA	NA	NA ± NA	NA - NA	4	5	0.13 ± 0.02	0.11 - 0.17
	West Embayment	2	10	0.43 ± 0.1	0.3 - 0.6	9	9	0.23 ± 0.16	0.12 - 0.61
Copper	Reference	21	23	12.32 ± 6.33	5.97 - 31.1	31	31	10.01 ± 6.43	4.64 - 32.77
	North Embayment	NA	NA	NA ± NA	NA - NA	4	5	9.44 ± 3.47	4.05 - 12.29
	West Embayment	10	10	27.18 ± 11.08	8.53 - 46.87	9	9	15.99 ± 13.05	7.13 - 43.31
Iron	Reference	23	23	182.15 ± 81.48	111.88 - 424	29	31	164.95 ± 58.29	103.69 - 416.96
	North Embayment	NA	NA	NA ± NA	NA - NA	4	5	144.41 ± 32.57	100.55 - 175.44
	West Embayment	10	10	233.55 ± 76.06	147 - 359.3	6	9	224.47 ± 111.43	124.15 - 470.44

[1] Mean calculations include reporting limits substituted for non-detects.

mg/kg/dw - milligrams per kilogram dry weight

NA - not available

NC - not calculated because all samples were non-detects; range represents reporting limits only

SD - standard deviation

ARCADIS

Table 4. Spring Peeper Summary Statistics for 2009 and 2010

Tennessee Valley Authority Kingston, Tennessee

Analyte	Site	2009 Spring Peeper Results (mg/kg/dw)				2010 Spring Peeper Results (mg/kg/dw)			
		Number of Detects	Number of Samples	Mean ± SD[1]	Range	Number of Detects	Number of Samples	Mean ± SD[1]	Range
Lead	Reference	4	23	0.46 ± 0.06	0.43 - 0.72	4	31	0.43 ± 0.53	0.18 - 3.18
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.23 - 0.3
	West Embayment	4	10	0.95 ± 0.95	0.39 - 3.59	1	9	0.32 ± 0.11	0.23 - 0.56
Manganese	Reference	23	23	48.01 ± 24.8	15.79 - 98.77	31	31	74.08 ± 31.44	29.28 - 147
	North Embayment	NA	NA	NA ± NA	NA - NA	5	5	65.88 ± 19.92	50.26 - 99.62
	West Embayment	10	10	62.02 ± 19.54	31.1 - 87.7	9	9	69.08 ± 22.91	42.98 - 107.97
Mercury	Reference	5	23	0.09 ± 0.01	0.09 - 0.12	0	31	NC ± NC	0.08 - 0.11
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.09 - 0.1
	West Embayment	5	10	0.1 ± 0.04	0.06 - 0.18	2	9	0.12 ± 0.04	0.1 - 0.2
Molybdenum	Reference	0	23	NC ± NC	4.3 - 4.91	1	31	0.31 ± 0.03	0.23 - 0.42
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.28 - 0.31
	West Embayment	0	10	NC ± NC	3 - 4.41	1	9	0.33 ± 0.05	0.29 - 0.45
Nickel	Reference	0	23	NC ± NC	0.43 - 0.55	0	31	NC ± NC	0.64 - 0.88
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.78 - 0.88
	West Embayment	0	10	NC ± NC	0.3 - 0.44	0	9	NC ± NC	0.8 - 0.89
Selenium	Reference	23	23	1.54 ± 0.35	0.96 - 2.2	31	31	1.39 ± 0.32	0.86 - 2.32
	North Embayment	NA	NA	NA ± NA	NA - NA	5	5	1.55 ± 0.4	1 - 2.05
	West Embayment	10	10	2.13 ± 0.57	1.2 - 2.89	9	9	1.81 ± 0.86	1.06 - 3.86
Silver	Reference	0	23	NC ± NC	0.21 - 0.25	5	31	0.03 ± 0.01	0.02 - 0.09
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.02 - 0.03
	West Embayment	8	10	0.39 ± 0.17	0.16 - 0.63	3	9	0.04 ± 0.02	0.02 - 0.09
Strontium	Reference	23	23	42.62 ± 21.48	21.53 - 121.47	31	31	48.56 ± 18.03	18 - 94.07
	North Embayment	NA	NA	NA ± NA	NA - NA	5	5	53.1 ± 4.57	49.06 - 58.55
	West Embayment	10	10	69.79 ± 31.14	30.4 - 124.9	9	9	83.69 ± 28.39	44.79 - 132.24
Thallium	Reference	0	23	NC ± NC	0.43 - 0.49	0	31	NC ± NC	0.09 - 0.13
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.11 - 0.12
	West Embayment	0	10	NC ± NC	0.3 - 0.44	0	9	NC ± NC	0.11 - 0.13
Vanadium	Reference	0	23	NC ± NC	0.86 - 0.99	1	31	0.44 ± 0.23	0.3 - 1.68
	North Embayment	NA	NA	NA ± NA	NA - NA	0	5	NC ± NC	0.39 - 0.82
	West Embayment	0	10	NC ± NC	0.6 - 0.88	0	9	NC ± NC	0.37 - 0.42
Zinc	Reference	23	23	104.26 ± 22.13	75.84 - 156.74	31	31	116.69 ± 23.38	87.8 - 204.93
	North Embayment	NA	NA	NA ± NA	NA - NA	5	5	131.74 ± 28.75	108.68 - 181.99
	West Embayment	10	10	126.26 ± 21.47	97.5 - 168.73	9	9	116.85 ± 19.35	97.21 - 156.81

[1] Mean calculations include reporting limits substituted for non-detects.

mg/kg/dw - milligrams per kilogram dry weight

NA - not available

NC - not calculated because all samples were non-detects; range represents reporting limits only

SD - standard deviation

ARCADIS

Table 5. Upland Chorus Frog Summary Statistics for 2009 and 2010

Tennessee Valley Authority Kingston, Tennessee

Analyte	Site	2009 Chorus Frog Results (mg/kg/dw)				2010 Chorus Frog Results (mg/kg/dw)			
		Number of Detects	Number of Samples	Mean ± SD[1]	Range	Number of Detects	Number of Samples	Mean ± SD[1]	Range
Aluminum	Reference	NA	NA	NA ± NA	NA - NA	1	13	50.1 ± 53.3	33.1 - 219
	North Embayment	0	9	NC ± NC	84.5 - 109	3	11	38.7 ± 8.65	30.9 - 56.7
	West Embayment	0	2	NC ± NC	109 - 110	0	11	NC ± NC	30.7 - 36.2
Antimony	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.12 - 0.13
	North Embayment	0	9	NC ± NC	0.34 - 0.44	0	11	NC ± NC	0.11 - 0.14
	West Embayment	0	2	NC ± NC	0.43 - 0.44	0	11	NC ± NC	0.11 - 0.13
Arsenic	Reference	NA	NA	NA ± NA	NA - NA	5	13	0.26 ± 0.02	0.24 - 0.32
	North Embayment	5	9	0.7 ± 0.43	0.42 - 1.64	2	11	0.41 ± 0.19	0.23 - 0.82
	West Embayment	1	2	1.09 ± 0.93	0.43 - 1.74	0	11	NC ± NC	0.22 - 0.91
Barium	Reference	NA	NA	NA ± NA	NA - NA	13	13	63.7 ± 33.9	30.9 - 148
	North Embayment	9	9	57.1 ± 20.2	23.7 - 82	11	11	62.1 ± 19.4	37 - 95.7
	West Embayment	2	2	63.8 ± 6.1	59.5 - 68.1	11	11	73.2 ± 21.8	42 - 106
Beryllium	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.25 - 0.53
	North Embayment	0	9	NC ± NC	0.34 - 0.44	0	11	NC ± NC	0.14 - 0.57
	West Embayment	0	2	NC ± NC	0.43 - 0.44	0	11	NC ± NC	0.46 - 0.55
Boron	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	3.42 - 3.76
	North Embayment	0	9	NC ± NC	6.8 - 8.8	0	11	NC ± NC	3.22 - 4
	West Embayment	0	2	NC ± NC	8.72 - 8.8	0	11	NC ± NC	3.18 - 3.79
Cadmium	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.07 - 0.16
	North Embayment	0	9	NC ± NC	0.34 - 0.44	8	11	0.15 ± 0.04	0.09 - 0.22
	West Embayment	0	2	NC ± NC	0.43 - 0.44	5	11	0.14 ± 0.02	0.12 - 0.17
Chromium	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	1.05 - 1.15
	North Embayment	0	9	NC ± NC	0.34 - 0.44	0	11	NC ± NC	0.98 - 1.2
	West Embayment	0	2	NC ± NC	0.44 - 0.52	0	11	NC ± NC	0.97 - 1.19
Cobalt	Reference	NA	NA	NA ± NA	NA - NA	10	13	0.22 ± 0.15	0.12 - 0.66
	North Embayment	0	9	NC ± NC	0.34 - 0.44	7	11	0.16 ± 0.04	0.11 - 0.25
	West Embayment	0	2	NC ± NC	0.43 - 0.44	10	11	0.21 ± 0.09	0.12 - 0.43
Copper	Reference	NA	NA	NA ± NA	NA - NA	13	13	16.8 ± 12.5	6.23 - 46.4
	North Embayment	9	9	15.4 ± 6.19	7.08 - 26.3	11	11	14.7 ± 4.37	10.2 - 25.3
	West Embayment	2	2	32.4 ± 2.15	30.8 - 33.9	11	11	10.1 ± 3.19	4.5 - 15.4
Iron	Reference	NA	NA	NA ± NA	NA - NA	12	13	168 ± 71.5	102 - 305
	North Embayment	7	9	133 ± 33.8	108 - 208	10	11	136 ± 21.9	93.2 - 167
	West Embayment	2	2	179 ± 40.5	151 - 208	10	11	132 ± 41.4	99.1 - 226

[1] Mean calculations include reporting limits substituted for non-detects.

mg/kg/dw - milligrams per kilogram dry weight

NA - not available

NC - not calculated because all samples were non-detects; range represents reporting limits only

SD - standard deviation

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Table 5. Upland Chorus Frog Summary Statistics for 2009 and 2010

Tennessee Valley Authority Kingston, Tennessee

Analyte	Site	2009 Chorus Frog Results (mg/kg/dw)				2010 Chorus Frog Results (mg/kg/dw)			
		Number of Detects	Number of Samples	Mean ± SD[1]	Range	Number of Detects	Number of Samples	Mean ± SD[1]	Range
Lead	Reference	NA	NA	NA ± NA	NA - NA	3	13	0.4 ± 0.23	0.24 - 0.87
	North Embayment	2	9	0.47 ± 0.14	0.34 - 0.82	0	11	NC ± NC	0.23 - 0.41
	West Embayment	1	2	0.95 ± 0.61	0.52 - 1.38	2	11	0.33 ± 0.13	0.22 - 0.61
Manganese	Reference	NA	NA	NA ± NA	NA - NA	13	13	50 ± 14	23.9 - 70.9
	North Embayment	9	9	42.6 ± 14.3	21.5 - 71.2	11	11	63.7 ± 22.2	44.4 - 118
	West Embayment	2	2	34.2 ± 1.53	33.2 - 35.3	11	11	83.1 ± 30.4	50.7 - 162
Mercury	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.1 - 0.1
	North Embayment	0	9	NC ± NC	0.07 - 0.09	0	11	NC ± NC	0.09 - 0.11
	West Embayment	0	2	NC ± NC	0.09 - 0.09	3	11	0.11 ± 0.02	0.09 - 0.15
Molybdenum	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.3 - 0.32
	North Embayment	0	9	NC ± NC	3.4 - 4.4	3	11	0.31 ± 0.03	0.29 - 0.4
	West Embayment	0	2	NC ± NC	4.34 - 4.36	0	11	NC ± NC	0.27 - 0.32
Nickel	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.81 - 0.88
	North Embayment	1	9	0.44 ± 0.07	0.34 - 0.61	0	11	NC ± NC	0.75 - 0.93
	West Embayment	0	2	NC ± NC	0.43 - 0.44	0	11	NC ± NC	0.75 - 0.88
Selenium	Reference	NA	NA	NA ± NA	NA - NA	13	13	1.37 ± 0.38	0.99 - 2.16
	North Embayment	9	9	1.54 ± 0.23	1.24 - 1.86	11	11	1.72 ± 0.43	1.1 - 2.71
	West Embayment	2	2	1.85 ± 0.06	1.81 - 1.89	11	11	1.96 ± 0.53	0.87 - 2.51
Silver	Reference	NA	NA	NA ± NA	NA - NA	1	13	0.03 ± 0.01	0.02 - 0.06
	North Embayment	0	9	NC ± NC	0.17 - 0.22	1	11	0.03 ± 0.01	0.02 - 0.06
	West Embayment	1	2	0.31 ± 0.13	0.22 - 0.4	3	11	0.03 ± 0.01	0.02 - 0.04
Strontium	Reference	NA	NA	NA ± NA	NA - NA	13	13	60.2 ± 19.3	29.5 - 99.3
	North Embayment	9	9	49.8 ± 12.7	30.5 - 70.6	11	11	64.3 ± 20.6	40.6 - 110
	West Embayment	2	2	61 ± 9.35	54.4 - 67.6	11	11	77.4 ± 22.1	34.9 - 118
Thallium	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.11 - 0.13
	North Embayment	0	9	NC ± NC	0.34 - 0.44	1	11	0.23 ± 0.16	0.11 - 0.64
	West Embayment	0	2	NC ± NC	0.43 - 0.44	0	11	NC ± NC	0.1 - 0.12
Vanadium	Reference	NA	NA	NA ± NA	NA - NA	0	13	NC ± NC	0.38 - 0.41
	North Embayment	0	9	NC ± NC	0.68 - 0.88	0	11	NC ± NC	0.44 - 0.81
	West Embayment	0	2	NC ± NC	0.87 - 0.88	0	11	NC ± NC	0.35 - 0.41
Zinc	Reference	NA	NA	NA ± NA	NA - NA	13	13	174 ± 63.3	110 - 311
	North Embayment	9	9	160 ± 58	116 - 273	11	11	149 ± 20	105 - 174
	West Embayment	2	2	182 ± 53	145 - 220	11	11	136 ± 51.4	96.4 - 283

[1] Mean calculations include reporting limits substituted for non-detects.

mg/kg/dw - milligrams per kilogram dry weight

NA - not available

NC - not calculated because all samples were non-detects; range represents reporting limits only

SD - standard deviation

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Table 6. American Toad ANOVA Results — Comparisons Between Years or Areas

Tennessee Valley Authority Kingston, Tennessee

Analyte	Number	R^2	Year p-value	Area p-value	Year*Area p-value	Pairwise Comparisons [1]	Multiple Comparisons [2]
Barium	64	0.09	0.91	0.95	0.06	–	–
Copper	64	0.20	0.04	0.12	0.12	2009 > 2010	2009 WE > 2010 R
Iron	64	0.14	0.49	0.27	0.04	–	–
Manganese	64	0.19	0.22	0.33	0.01	–	2010 NE > 2009 NE
Selenium	64	0.25	0.09	0.01	0.03	WE > R & NE	2009 & 2010 WE & 2010 NE > 2009 NE
Strontium	64	0.21	0.33	0.17	0.01	–	2009 WE & 2010 NE > 2010 R
Zinc	64	0.20	0.75	0.23	0.007	–	2010 R > 2010 WE

[1] Significant differences from the ANOVA.

[2] Significant differences from the post-hoc Tukey-Kramer test comparing both years and sites.

Shading denotes statistical significance ($p<0.05$).

ANOVA - Analysis of Variance

R^2 - correlation coefficient

– - Indicates no statistical differences

R = Reference, WE = West Embayment, and NE = North Embayment

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Table 7. American Toad Pearson Correlation Coefficients, n=64, all data logged

Tennessee Valley Authority Kingston, Tennessee

Analyte	Barium	Copper	Iron	Manganese	Selenium	Strontium	Zinc
Barium	1	-0.0862	0.1636	0.4888	0.1327	0.6331	0.176
Copper	-0.0862	1	0.099	-0.1454	0.217	-0.012	0.1116
Iron	0.1636	0.099	1	0.4553	0.1438	0.0151	0.1196
Manganese	0.4888	-0.1454	0.4553	1	0.4047	0.5592	0.3954
Selenium	0.1327	0.217	0.1438	0.4047	1	0.4333	0.2385
Strontium	0.6331	-0.012	0.0151	0.5592	0.4333	1	0.1436
Zinc	0.176	0.1116	0.1196	0.3954	0.2385	0.1436	1

Shading denotes statistical significance ($p<0.05$)

n = number

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Table 8. Spring Peeper ANOVA Results — Comparisons Between Years or Areas

Tennessee Valley Authority Kingston, Tennessee

Analyte	Number	R^2	Year p-value	Area p-value	Year*Area p-value	Pairwise Comparisons [1]	Multiple Comparisons [2]
Barium	78	0.12	0.26	0.02	0.71	WE > R	–
Copper	78	0.34	0.00	<.0001	0.09	WE > R	2009 WE > 2009 R & 2010 R & NE & WE
Iron	78	0.15	0.37	0.01	0.93	WE > R	2009 WE > 2010 R
Manganese	78	0.19	0.02	0.43	0.13	–	2010 R > 2009 R
Selenium	78	0.22	0.03	0.00	0.46	WE > R	2009 WE > 2009 & 2010 R
Strontium	78	0.28	0.08	<.0001	0.75	WE > R	2009 & 2010 WE > 2009 R; 2010 WE > 2010R
Zinc	78	0.15	0.69	0.03	0.06	WE > R	2009 WE > 2009 R

[1] Significant differences from the ANOVA.

[2] Significant differences from the post-hoc Tukey-Kramer test comparing both years and sites.

Shading denotes statistical significance ($p<0.05$)

ANOVA - Analysis of Variance

R^2 - correlation coefficient

– - Indicates no statistical differences

R = Reference, WE = West Embayment, and NE = North Embayment

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Table 9. Spring Peeper Pearson Correlation Coefficients, n=64, all data logged

Tennessee Valley Authority Kingston, Tennessee

Analyte	Barium	Copper	Iron	Manganese	Selenium	Strontium	Zinc
Barium	1	0.21218	0.24532	0.53543	0.07013	0.75405	0.43765
Copper	0.21218	1	0.75808	0.04342	0.64278	0.10569	0.209
Iron	0.24532	0.75808	1	0.08849	0.52668	0.04074	0.34408
Manganese	0.53543	0.04342	0.08849	1	-0.01063	0.43002	0.3037
Selenium	0.07013	0.64278	0.52668	-0.01063	1	0.05178	0.11993
Strontium	0.75405	0.10569	0.04074	0.43002	0.05178	1	0.31371
Zinc	0.43765	0.209	0.34408	0.3037	0.11993	0.31371	1

Shading denotes statistical significance ($p<0.05$)

n = number

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Table 10. Upland Chorus Frog ANOVA Results — Comparisons Between Years or Areas

Tennessee Valley Authority Kingston, Tennessee

Analyte	Number	R^2	Year p-value	Area p-value	Year*Area p-value	Pairwise Comparisons [1]	Multiple Comparisons [2]
Barium	45	0.07	0.54	0.41	0.96	–	–
Copper	45	0.28	0.003	0.32	0.003	–	2009 WE> 2010 WE
Iron	45	0.12	0.24	0.14	0.15	–	–
Manganese	45	0.44	<.0001	0.007	0.13	–	2010 NE & WE > 2009 NE; 2010 WE>2009 NE & WE & 2010 R
Selenium	45	0.23	0.62	0.006	0.72	–	2010 WE>2010 R
Strontium	45	0.20	0.11	0.12	0.87	–	2010 WE>2009 NE
Zinc	45	0.12	0.16	0.20	0.24	–	–

[1] Significant differences from the ANOVA.

[2] Significant differences from the post-hoc Tukey-Kramer test comparing both years and sites.

Shading denotes statistical significance ($p<0.05$)

ANOVA - Analysis of Variance

R^2 - correlation coefficient

– - Indicates no statistical differences

R = Reference, WE = West Embayment, and NE = North Embayment

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Table 11. Upland Chorus Frog Pearson Correlation Coefficients, n=64, all data logged
Tennessee Valley Authority Kingston, Tennessee

Analyte	Barium	Copper	Iron	Manganese	Selenium	Strontium	Zinc
Barium	1	-0.0952	-0.0742	0.2838	0.1295	0.5896	0.2594
Copper	-0.0952	1	0.6673	-0.2178	0.0734	-0.3017	0.4677
Iron	-0.0742	0.6673	1	0.0552	0.0228	-0.347	0.5011
Manganese	0.2838	-0.2178	0.0552	1	0.1995	0.3483	0.0078
Selenium	0.1295	0.0734	0.0228	0.1995	1	0.3777	-0.2554
Strontium	0.5896	-0.3017	-0.347	0.3483	0.3777	1	0.0802
Zinc	0.2594	0.4677	0.5011	0.0078	-0.2554	0.0802	1

Shading denotes statistical significance ($p<0.05$)

n = number

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Table 12. Non-Parametric Comparison Results

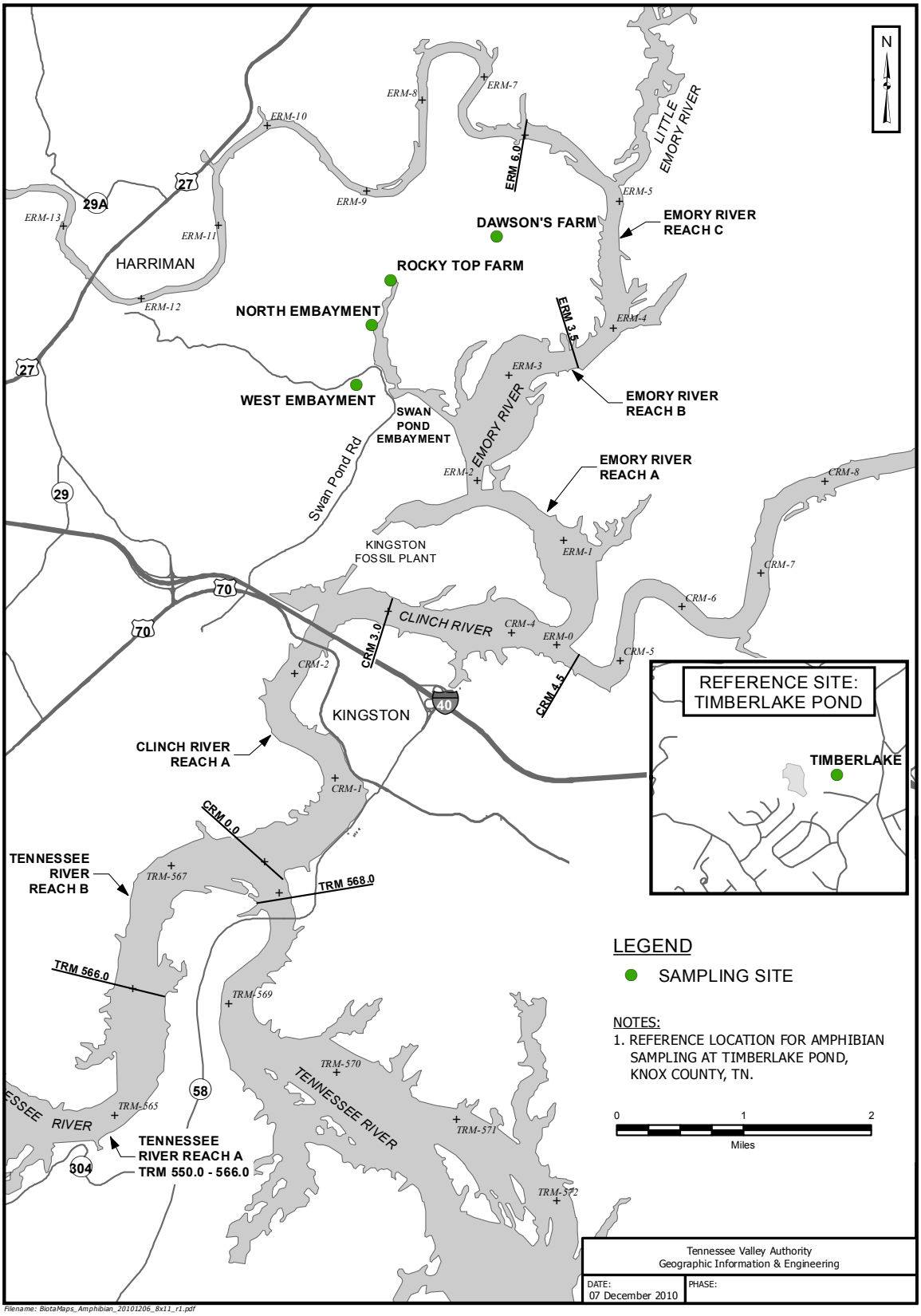
Tennessee Valley Authority **Kingston, Tennessee**

Analyte	American Toad across all sites for 2010	Spring Peeper across all sites for 2010	Upland Chorus Frog across all sites for 2010
Aluminum	–	–	–
Arsenic	NE > R&WE	–	–
Barium	–	–	–
Cadmium	–	NE > R	NE&WE > R
Cobalt	–	R > NE	–
Copper	–	–	NE > WE
Iron	–	–	–
Lead	–	–	–
Manganese	–	–	WE > R
Mercury	–	WE > R	–
Selenium	NE&WE > R	–	NE&WE > R
Silver	–	–	–
Strontium	NE&WE > R	WE > R&NE	–
Zinc	R > WE	–	R&NE > WE

– - Indicates no statistical differences

Shading denotes statistical significance ($p<0.05$)

R = Reference, WE = West Embayment, and NE = North Embayment



TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

AMPHIBIAN SAMPLING LOCATIONS

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FIGURE
1

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVAKIP\Amphibians data\Trace element conc. 2009-2010\F1_AmphibianSamplingLocs.pdf

Amphibians in a holding tank to allow for purging of the gut tract

Sample collection of an American Toad

Sample collection bag with an Upland Chorus Frog

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

SAMPLE PROCESSING

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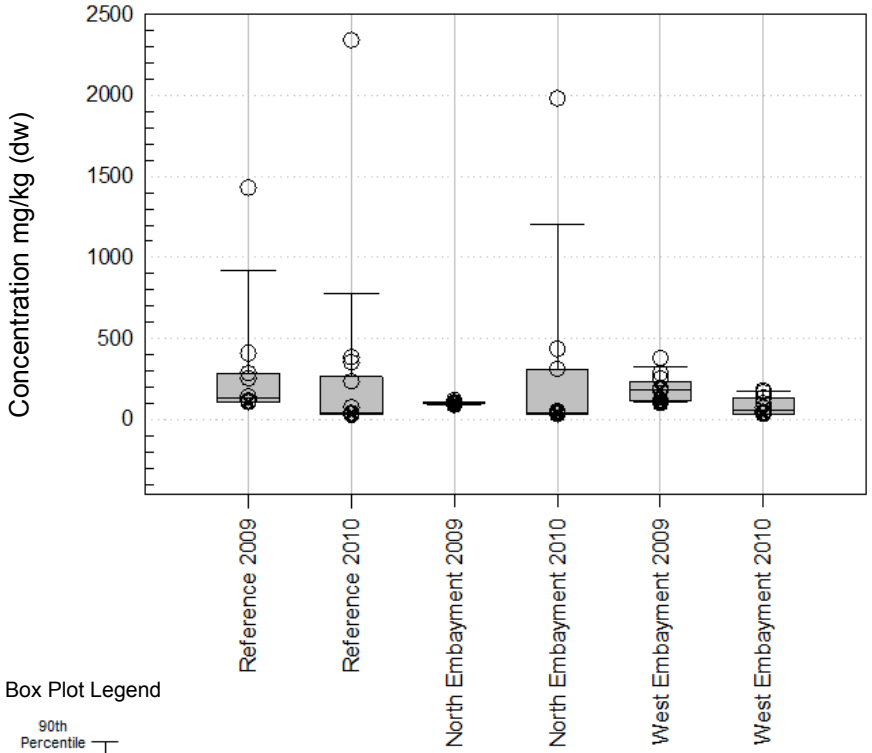
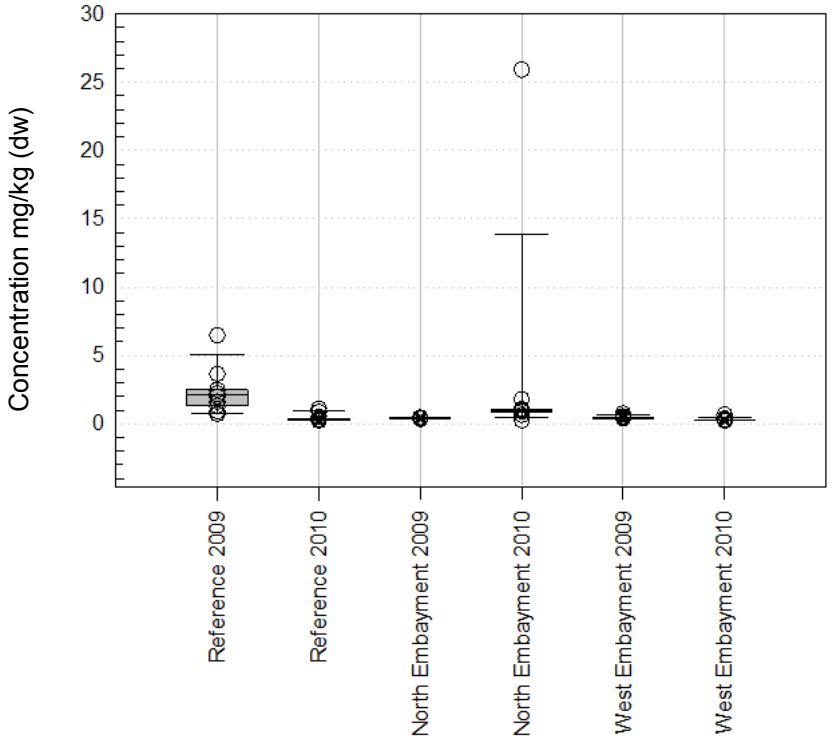
FIGURE
2

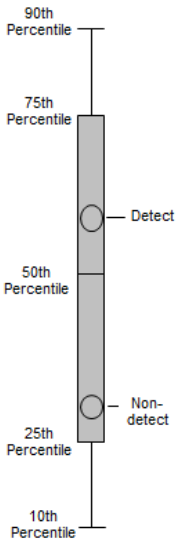
Aluminum



Arsenic



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – ALUMINUM AND ARSENIC

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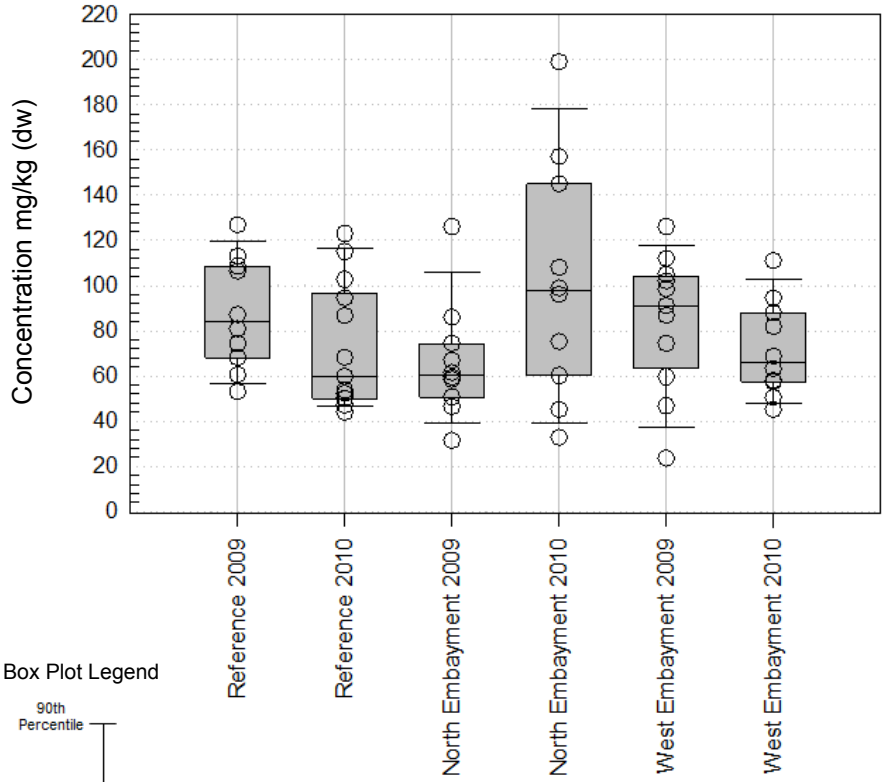
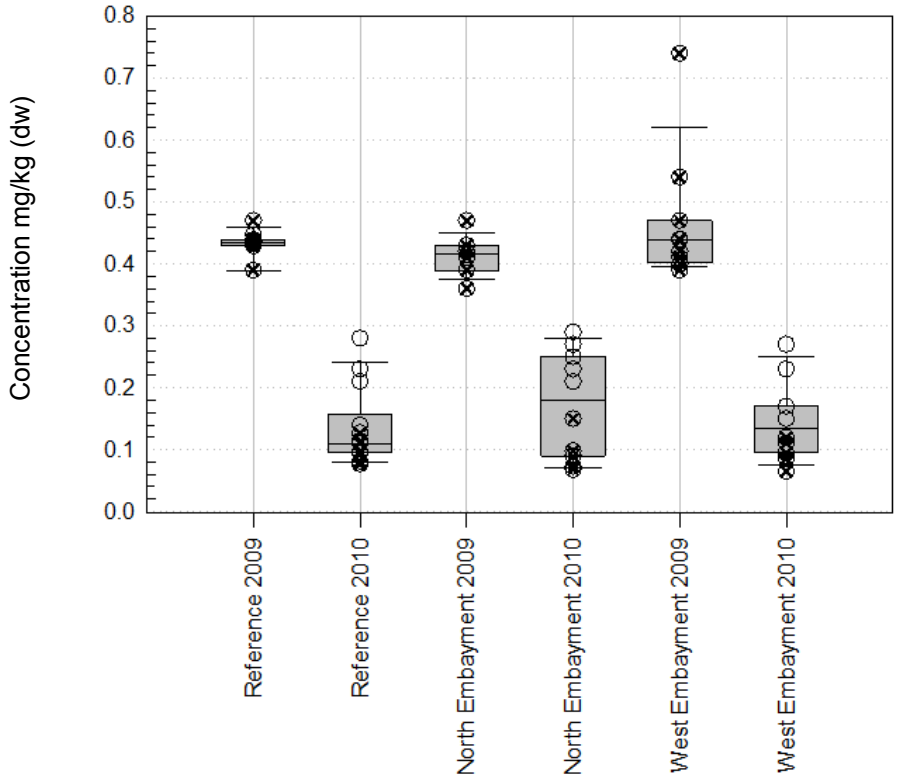
FIGURE
3

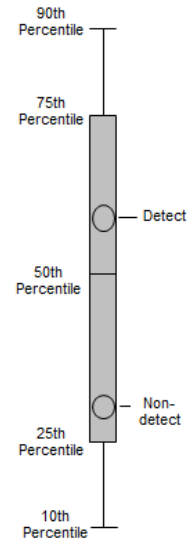
Barium



Cadmium



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – BARIUM AND CADMIUM

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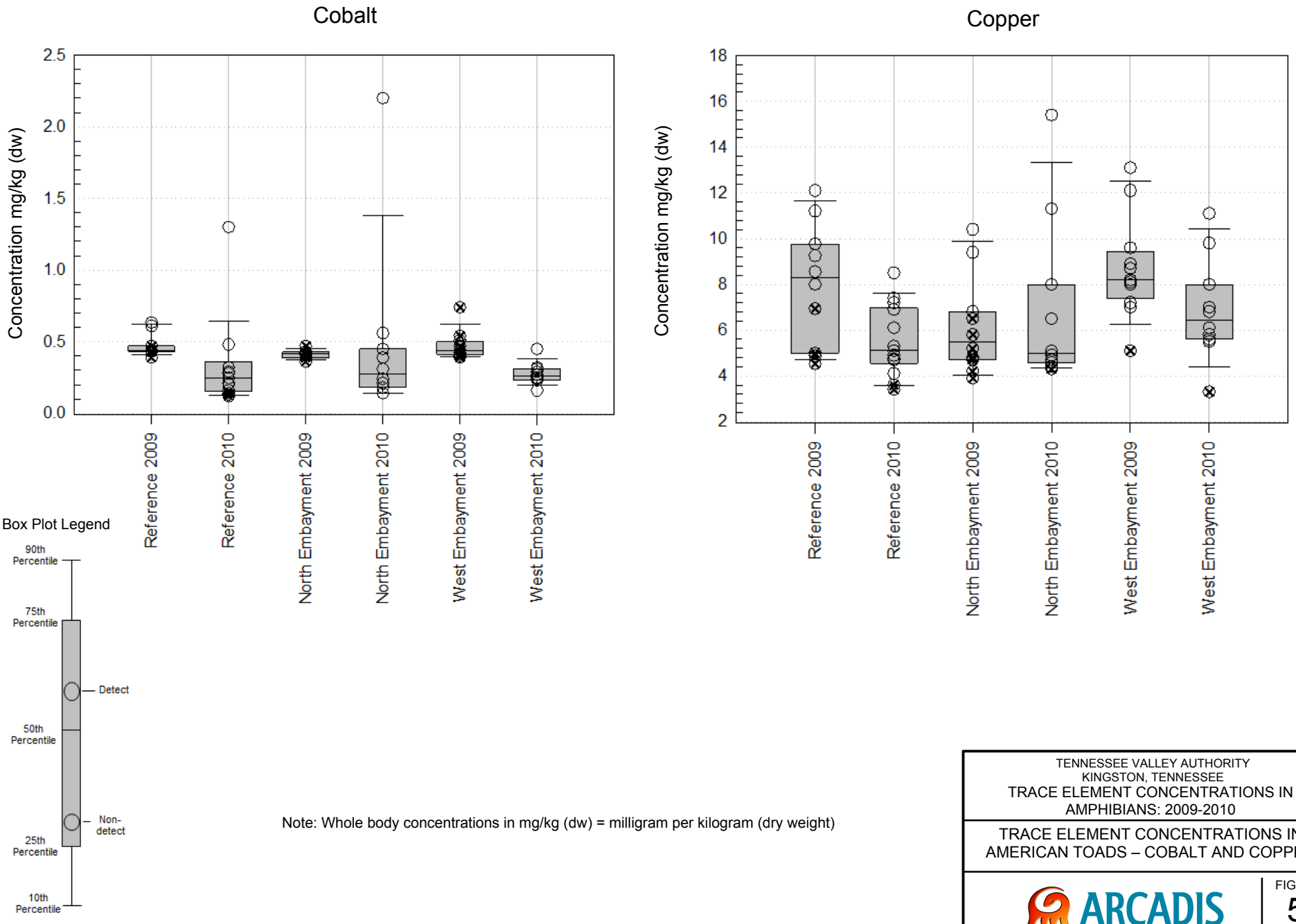
FIGURE
4



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

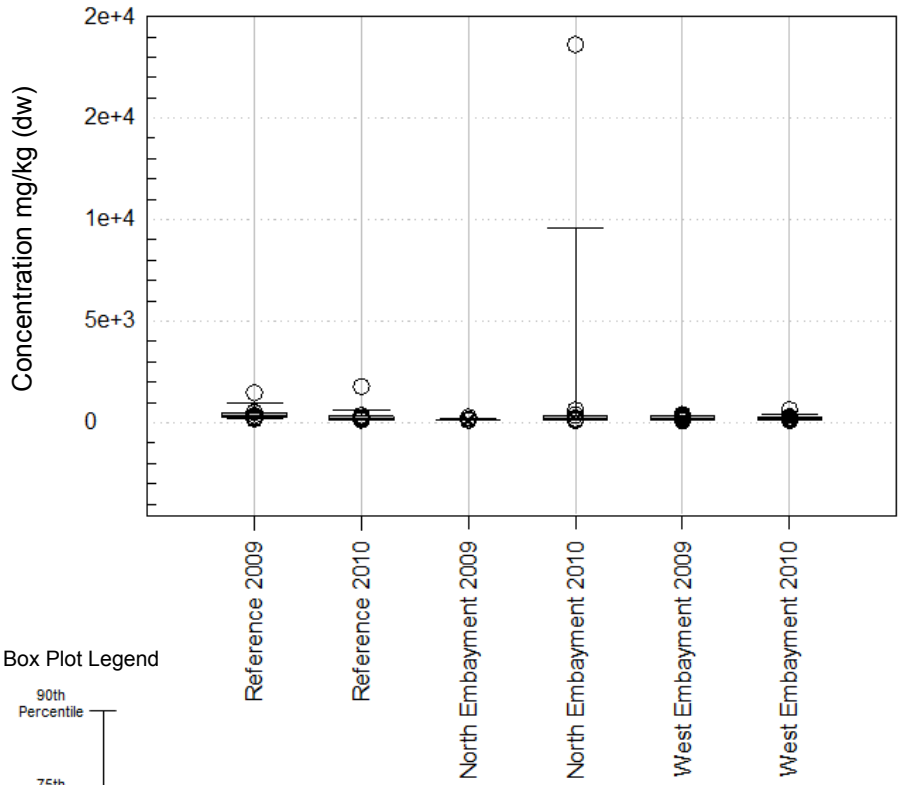
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – COBALT AND COPPER

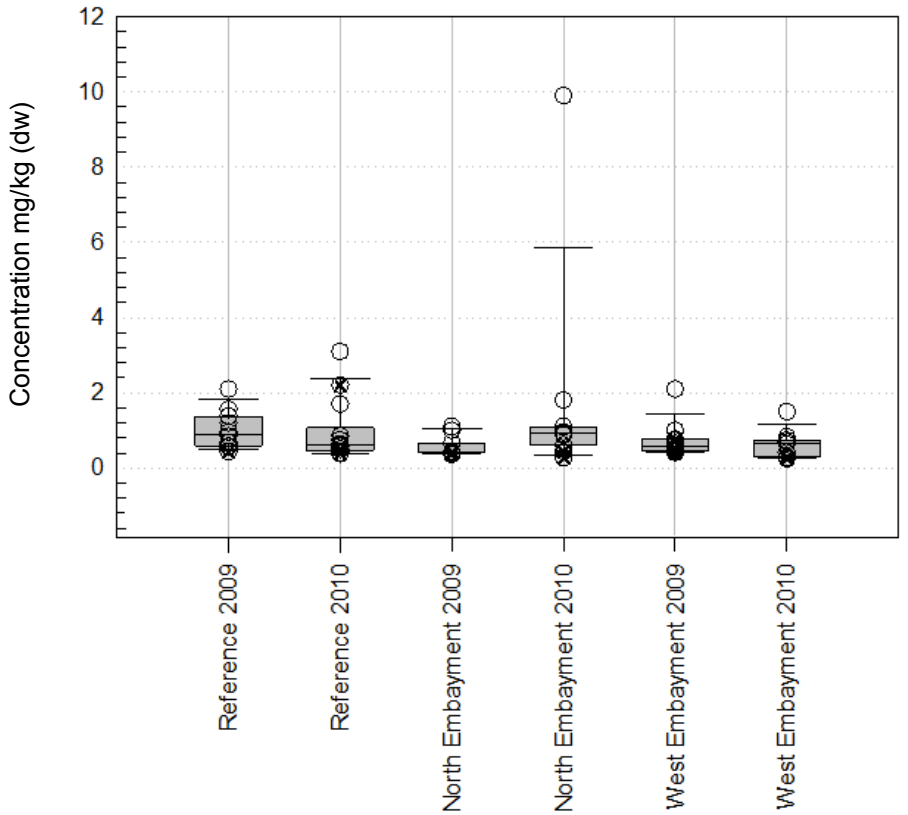
ARCADIS

FIGURE 5

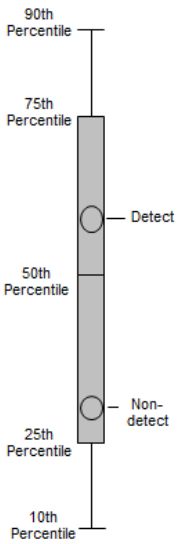
Iron



Lead



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

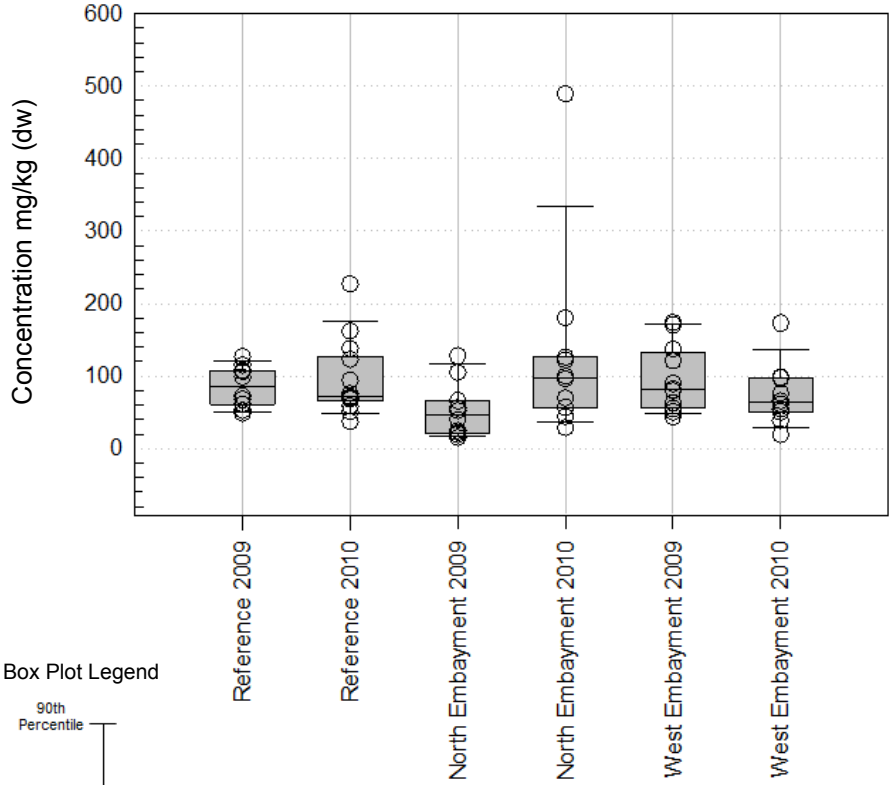
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – IRON AND LEAD

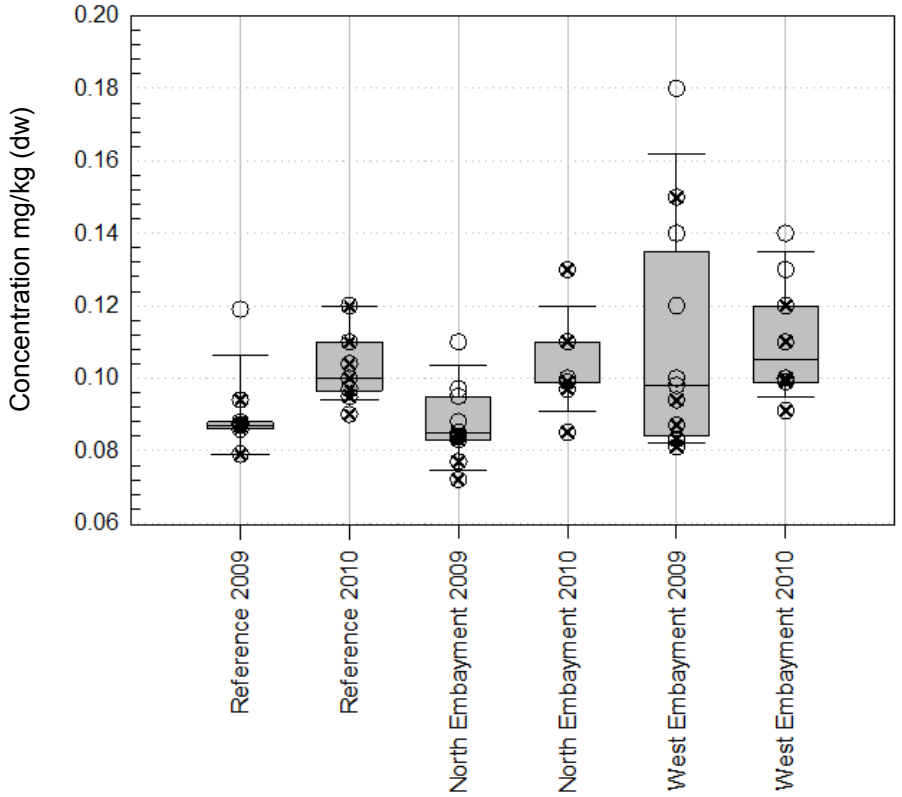
ARCADIS

FIGURE 6

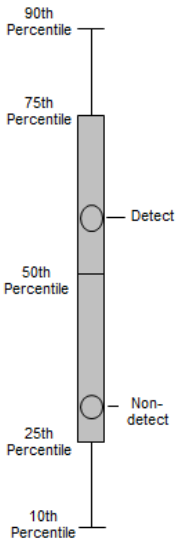
Manganese



Mercury



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

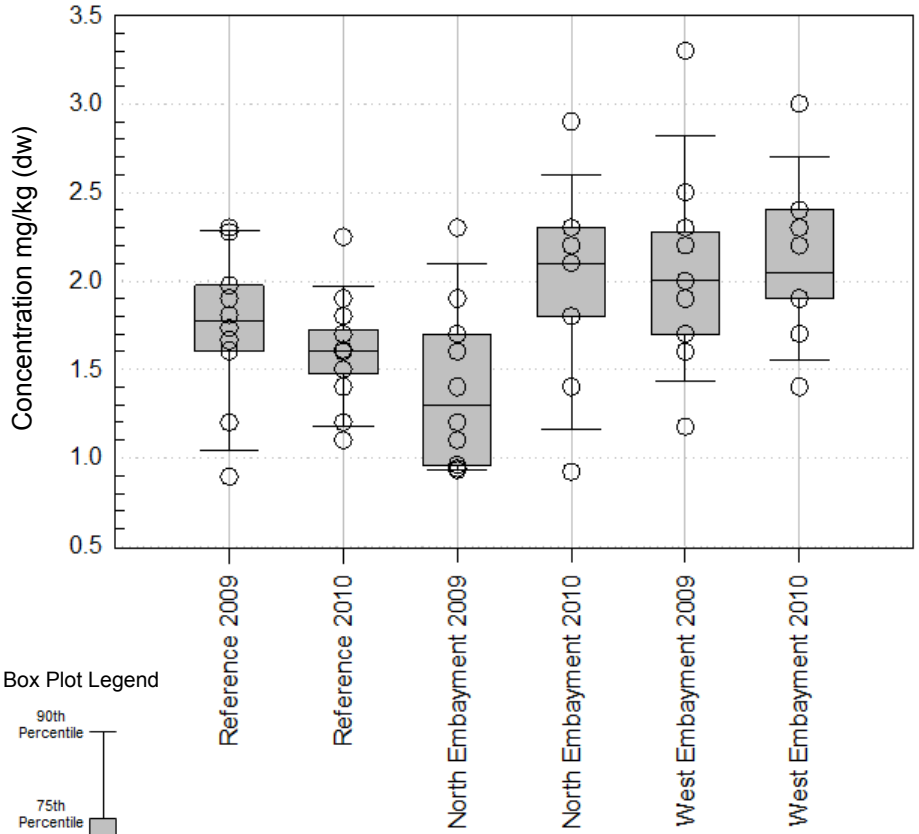
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – MANGANESE AND MERCURY

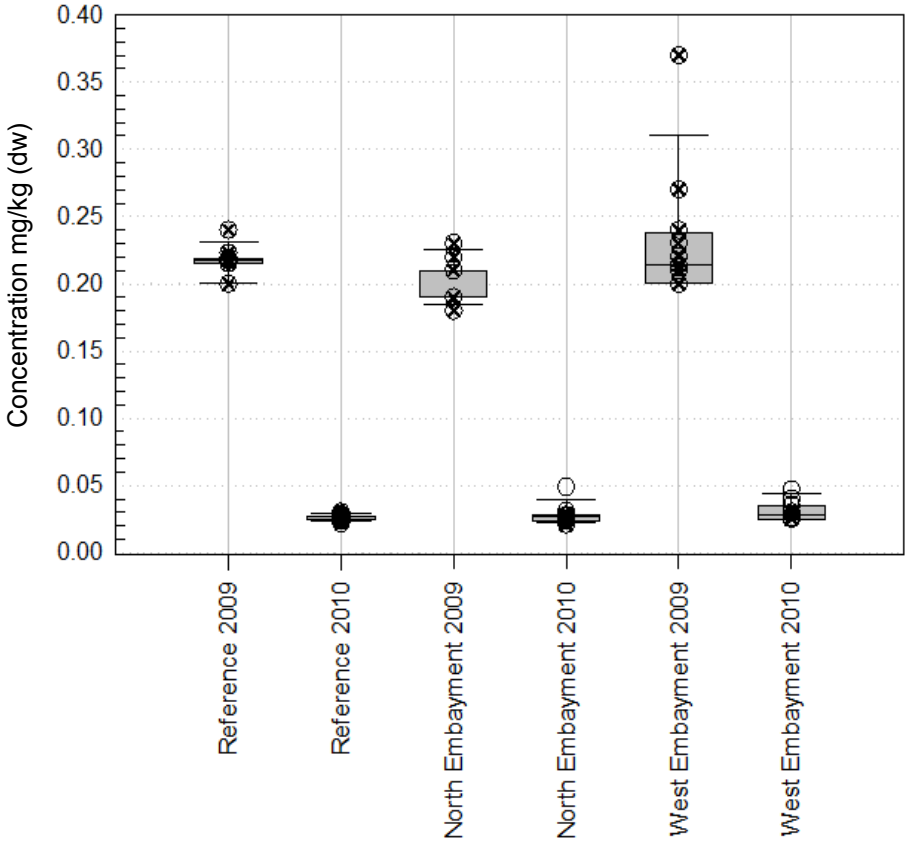
ARCADIS

FIGURE 7

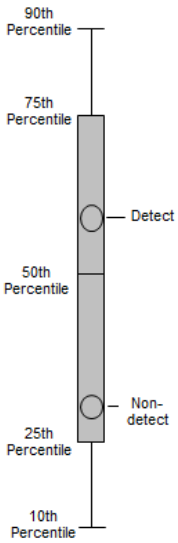
Selenium



Silver



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

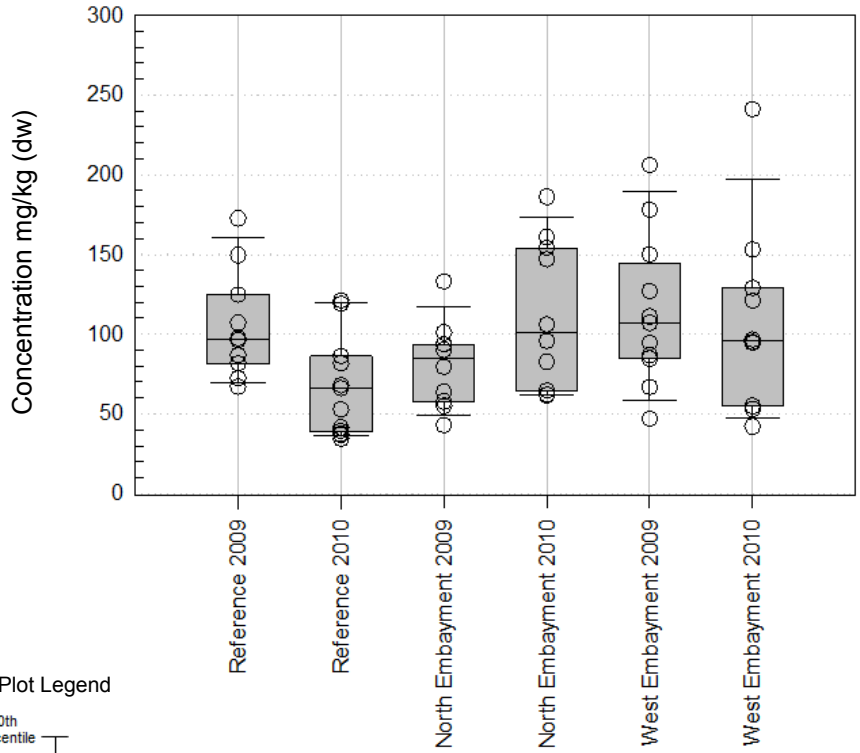
TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – SELENIUM AND SILVER

ARCADIS

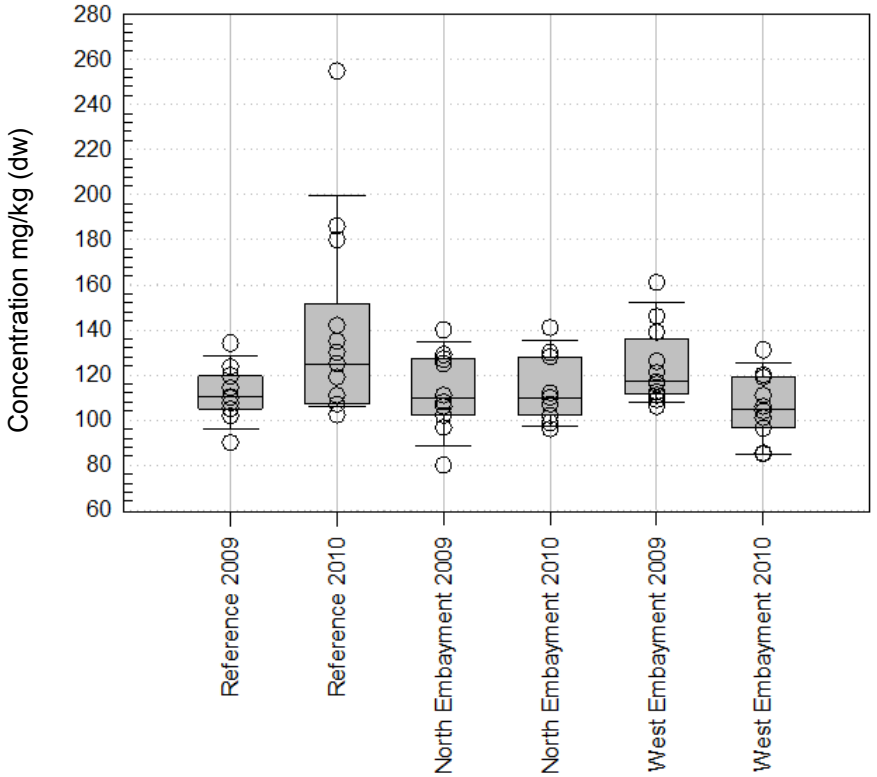
FIGURE 8

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F9_AT_Strontium&Zinc.pdf

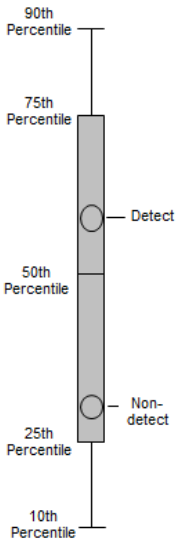
Strontium



Zinc



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)

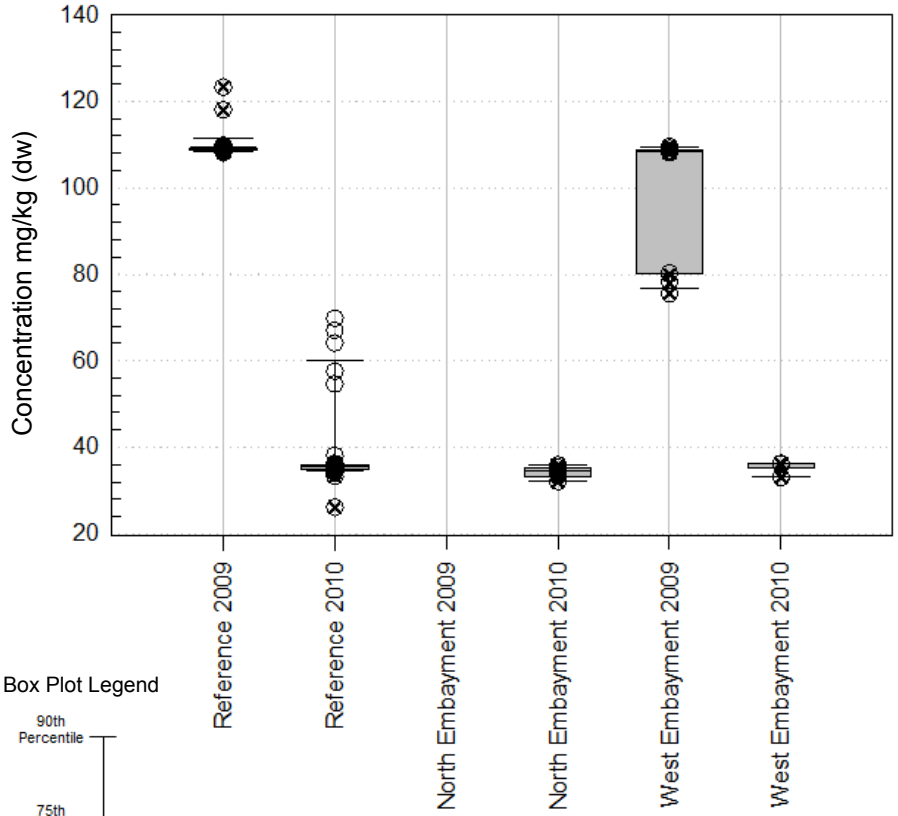
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN AMERICAN TOADS – STRONTIUM AND ZINC

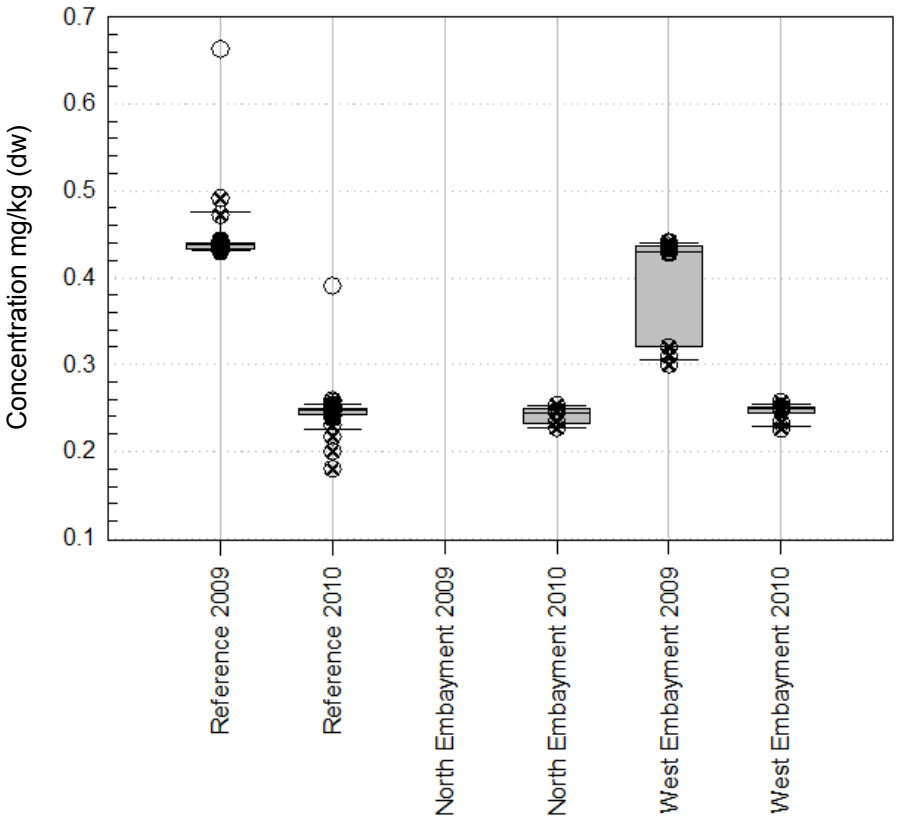
ARCADIS

FIGURE 9

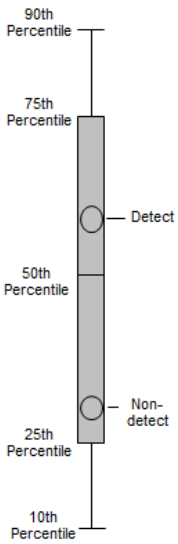
Aluminum



Arsenic



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

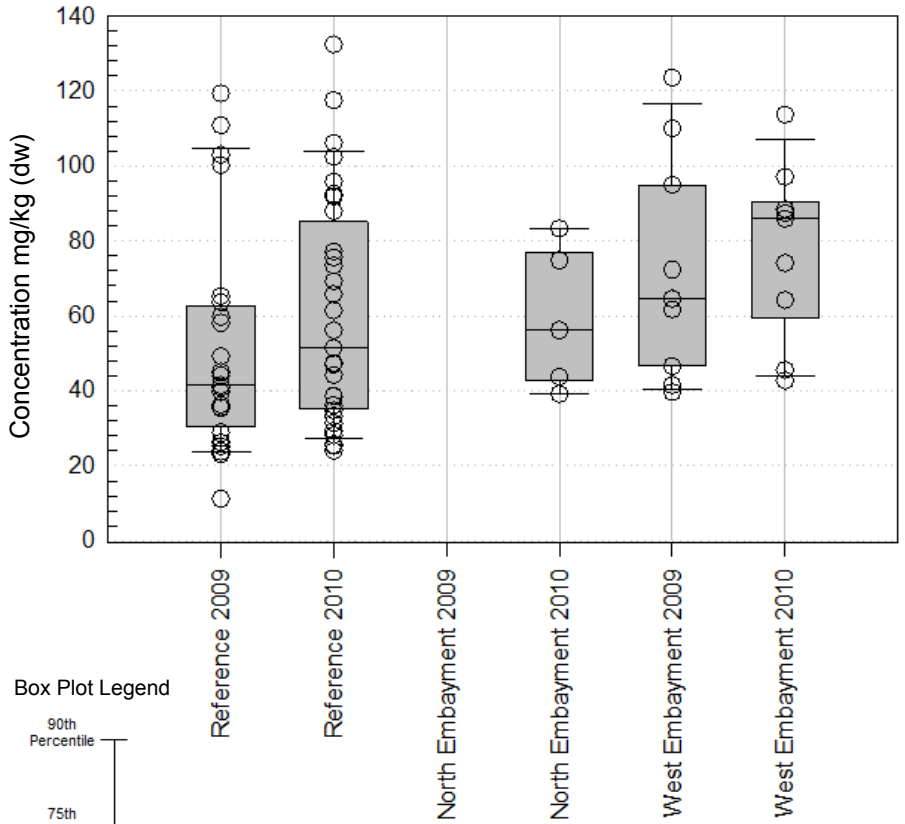
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – ALUMINUM AND ARSENIC

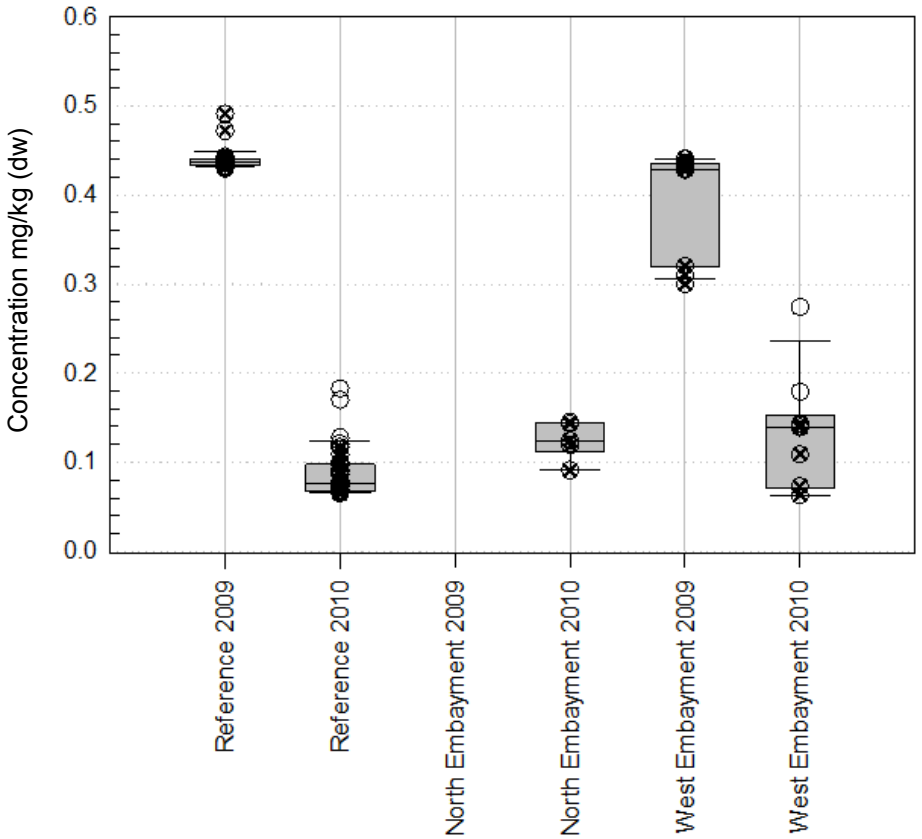
ARCADIS

FIGURE 10

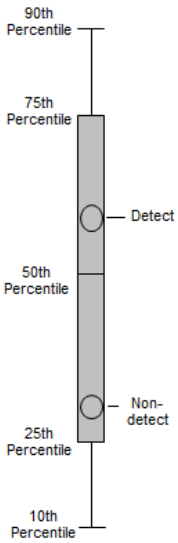
Barium



Cadmium



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

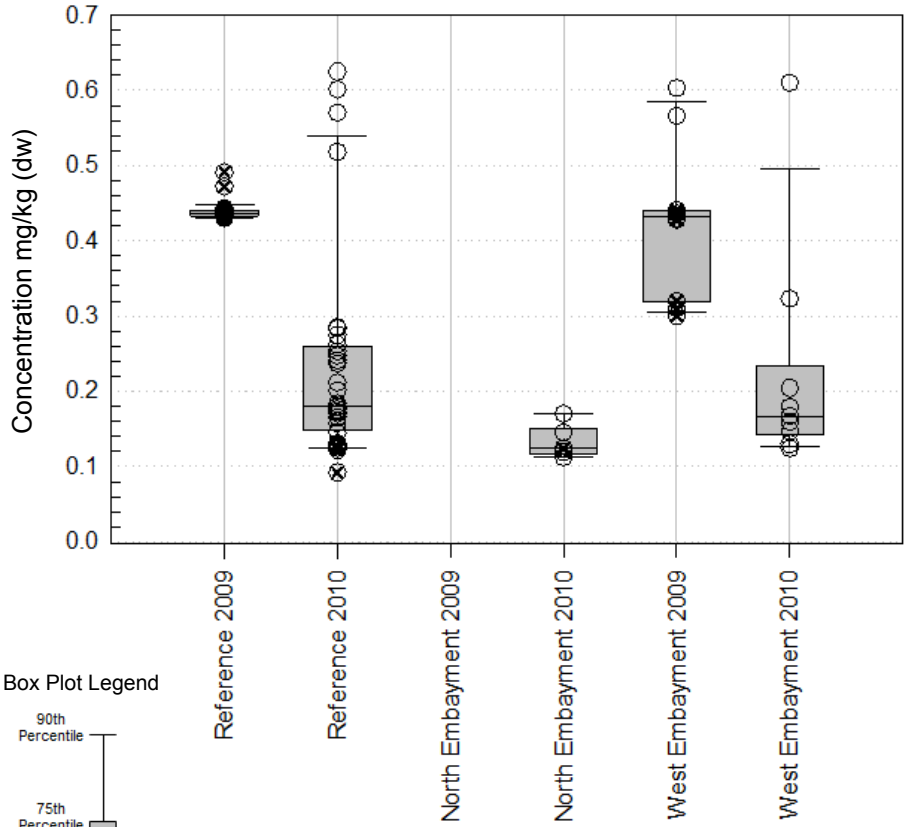
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – BARIUM AND CADMIUM

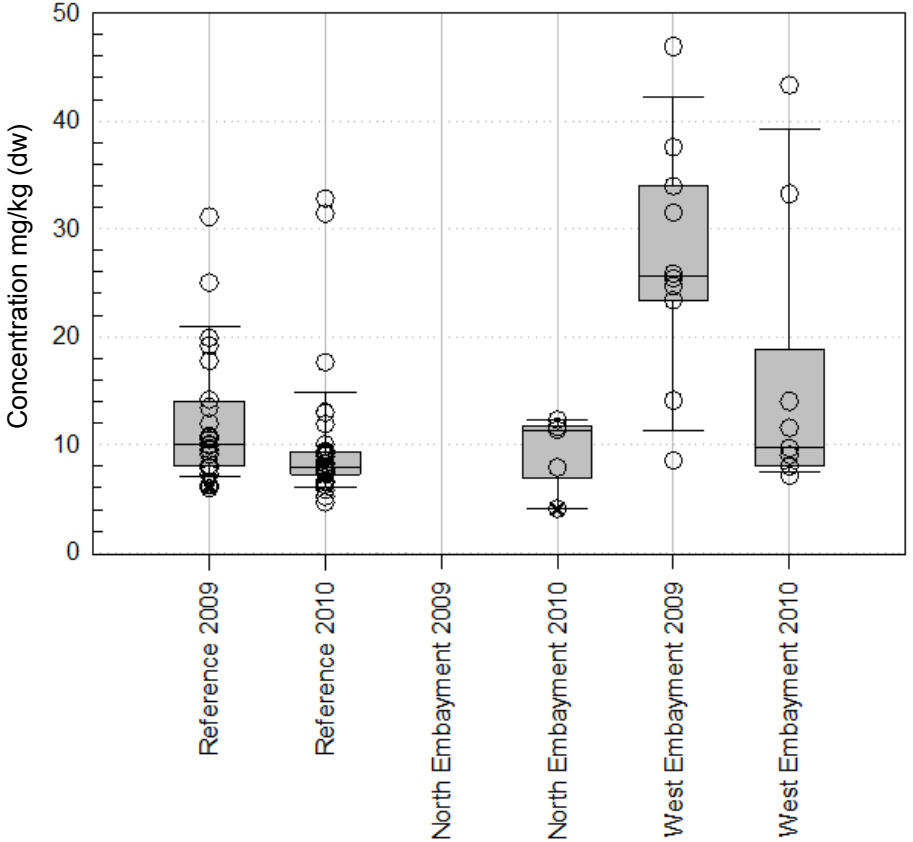
ARCADIS

FIGURE 11

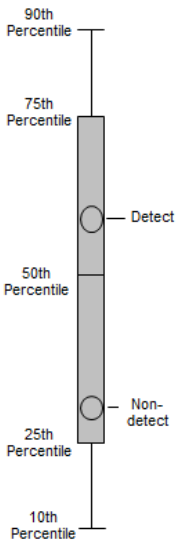
Cobalt



Copper



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

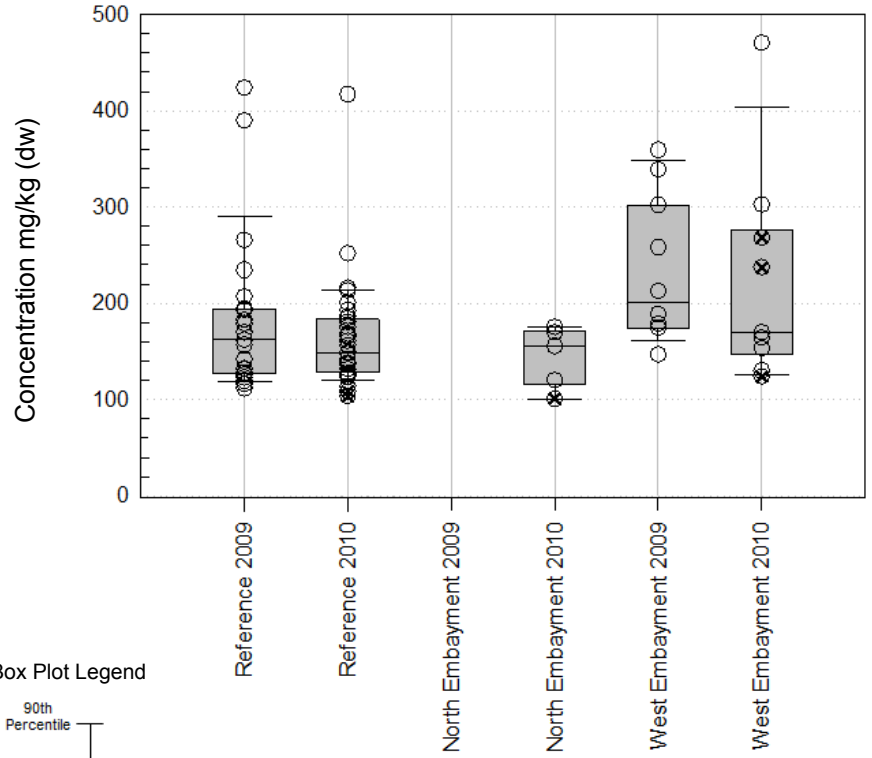
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – COBALT AND COPPER

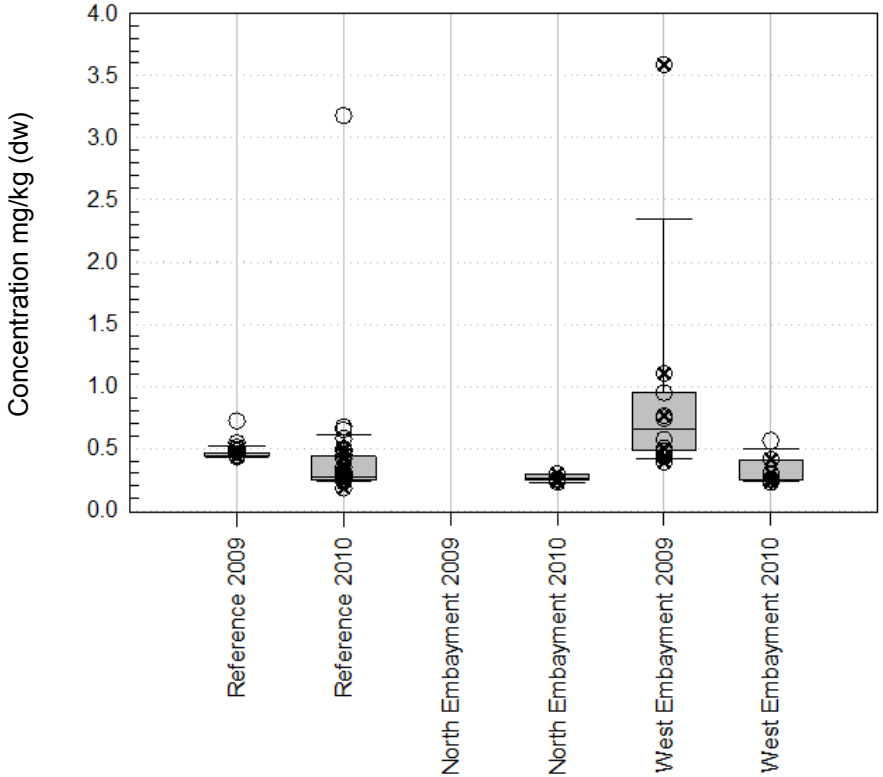
ARCADIS

FIGURE 12

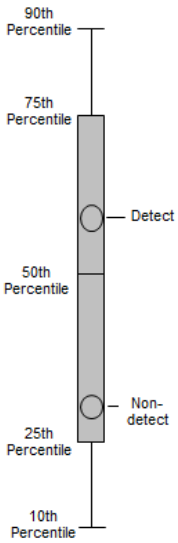
Iron



Lead



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

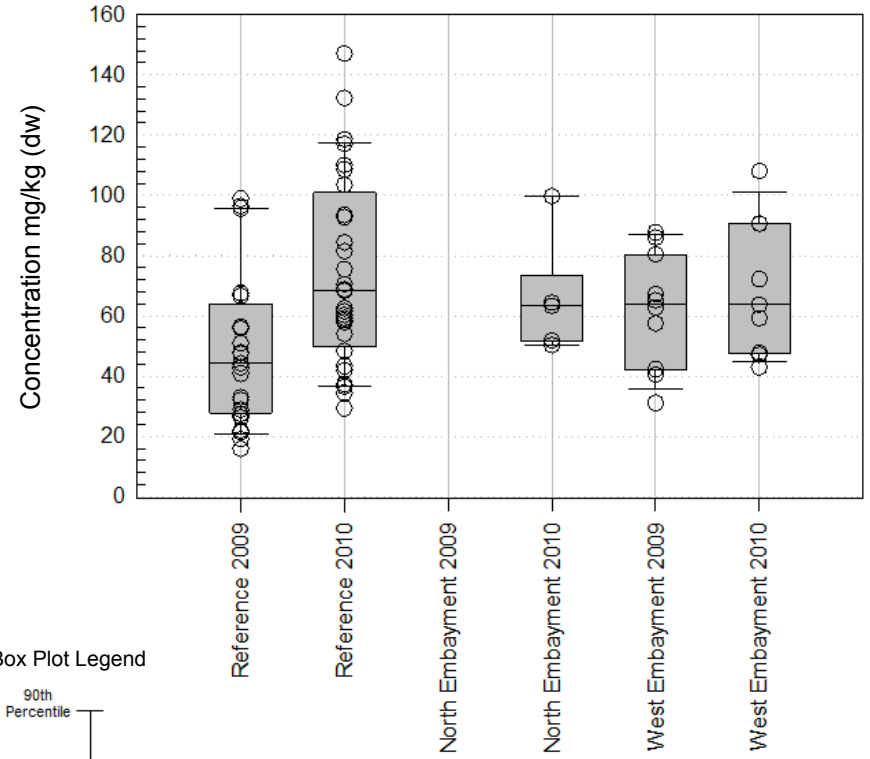
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – IRON AND LEAD

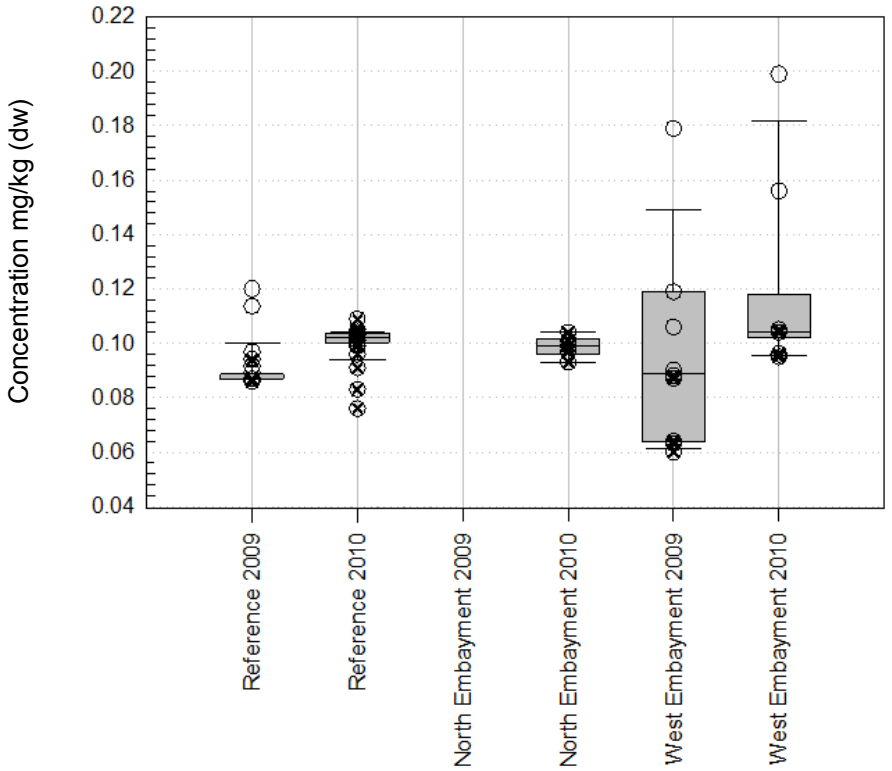
ARCADIS

FIGURE 13

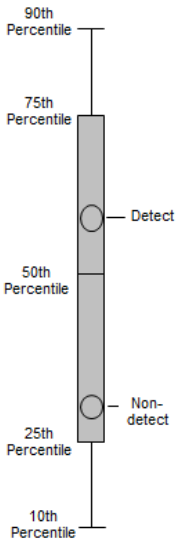
Manganese



Mercury



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

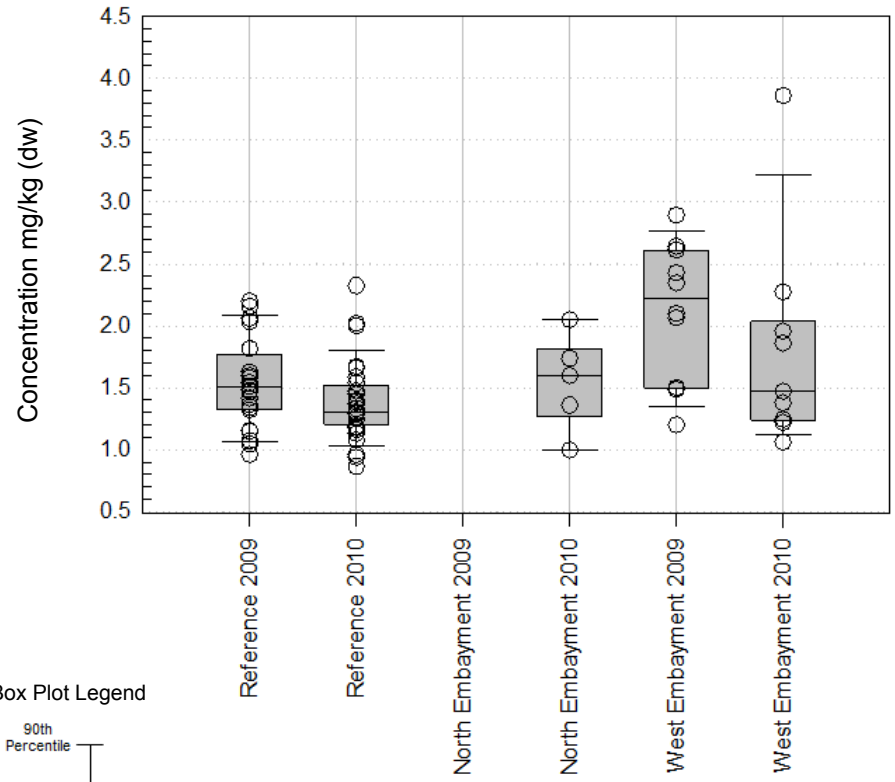
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – MANGANESE AND MERCURY

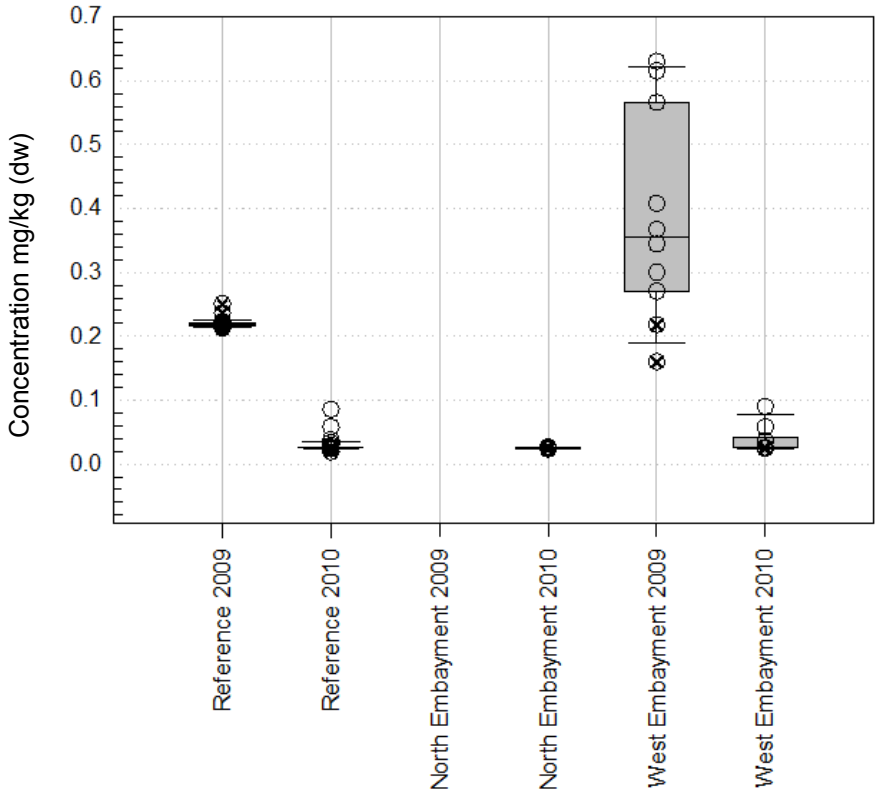
ARCADIS

FIGURE 14

Selenium



Silver



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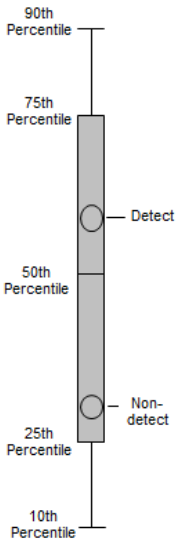


Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

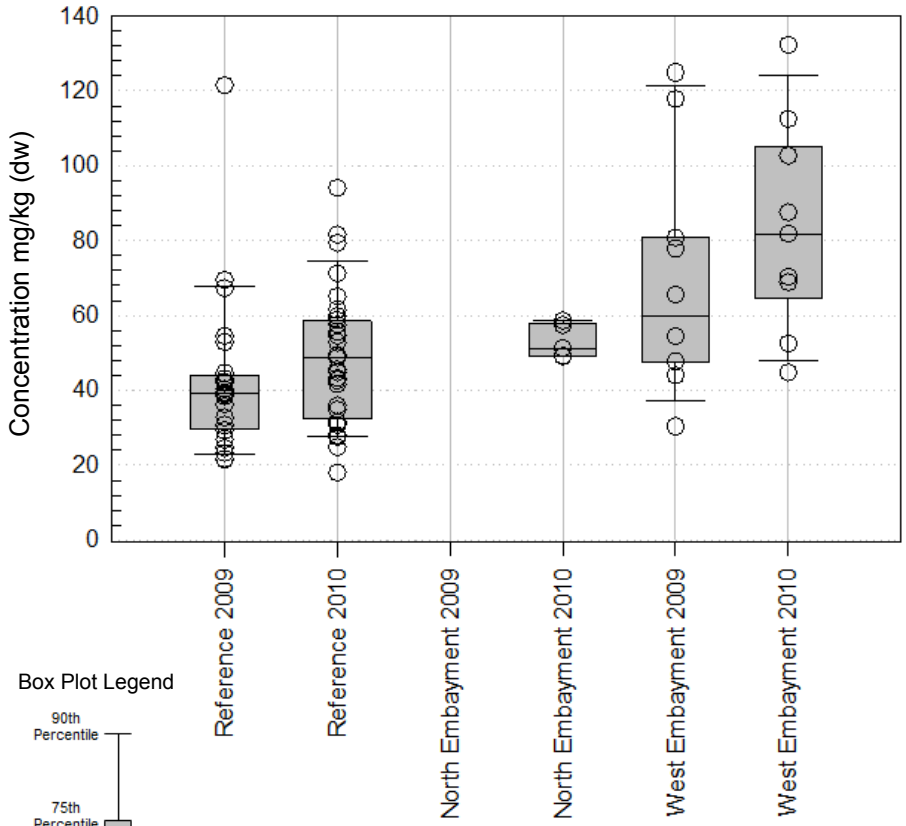
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – SELENIUM AND SILVER

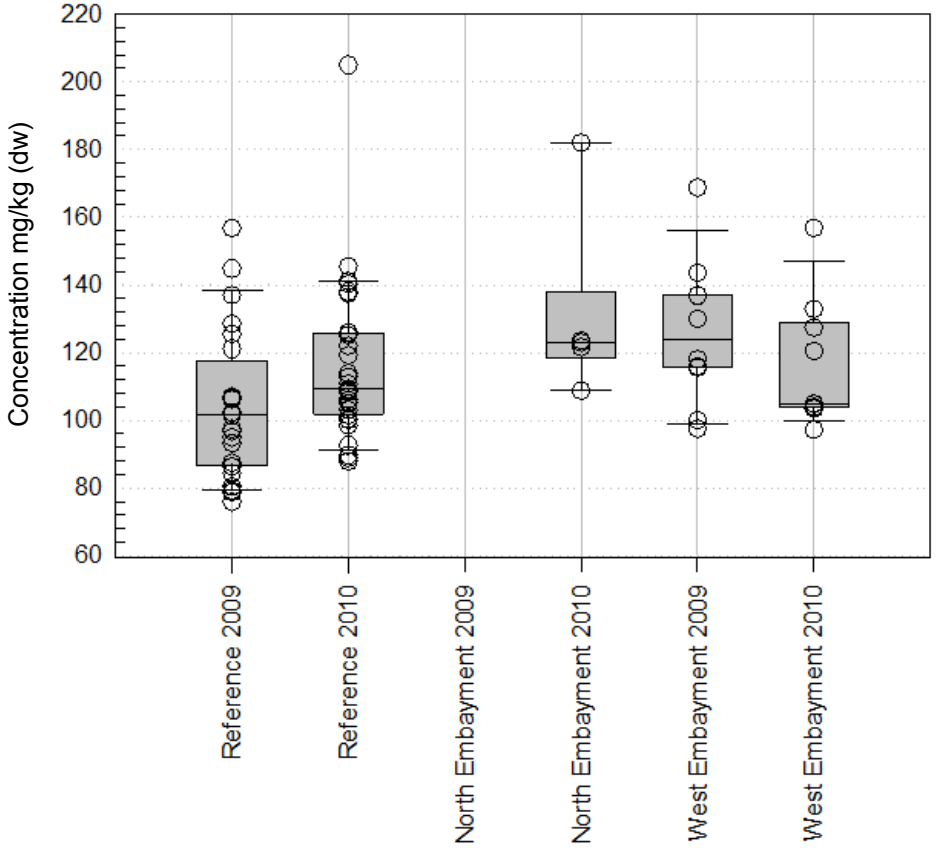
ARCADIS

FIGURE 15

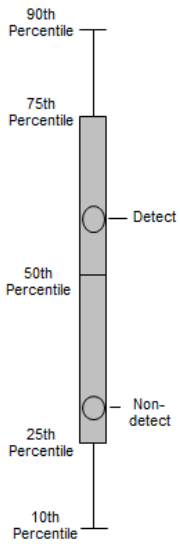
Strontium



Zinc



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No spring peepers were found during the 2009 North Embayment collections

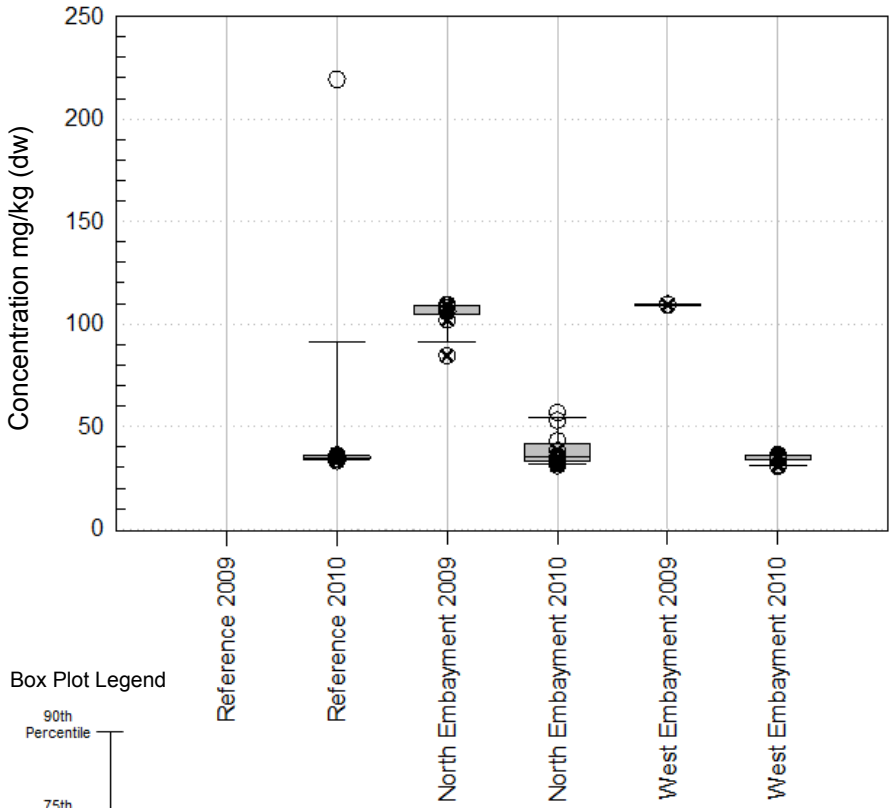
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN SPRING PEEPERS – STRONTIUM AND ZINC

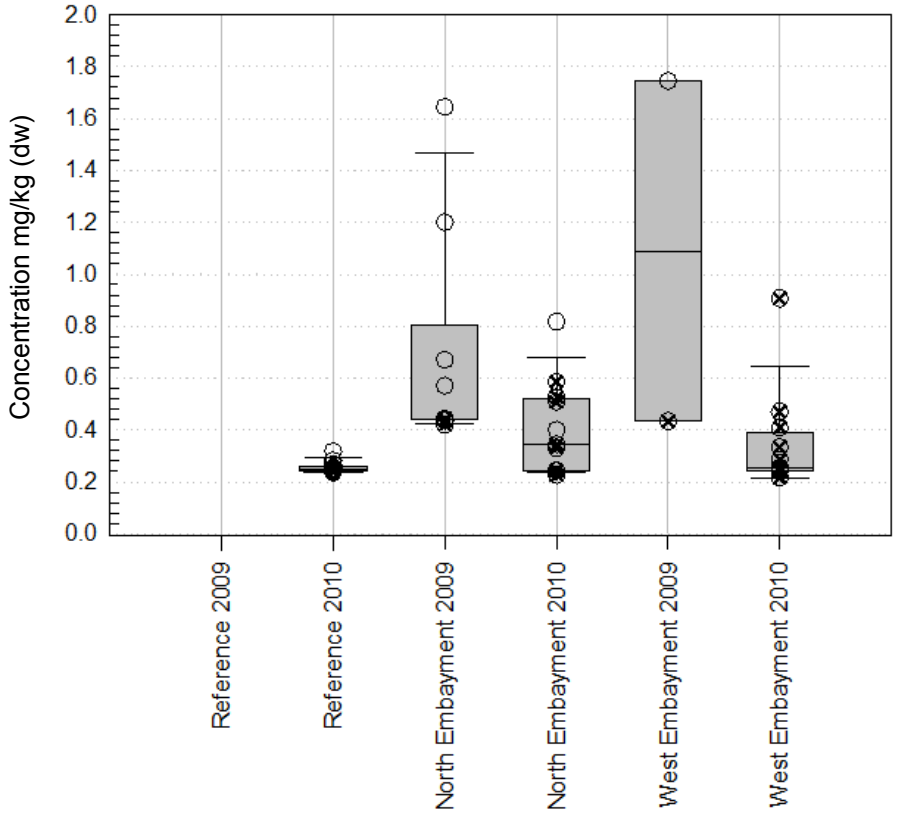
ARCADIS

FIGURE 16

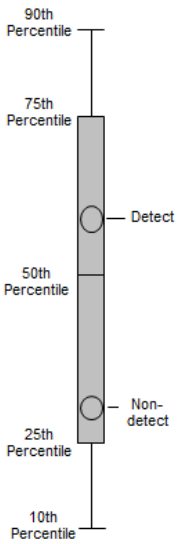
Aluminum



Arsenic



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

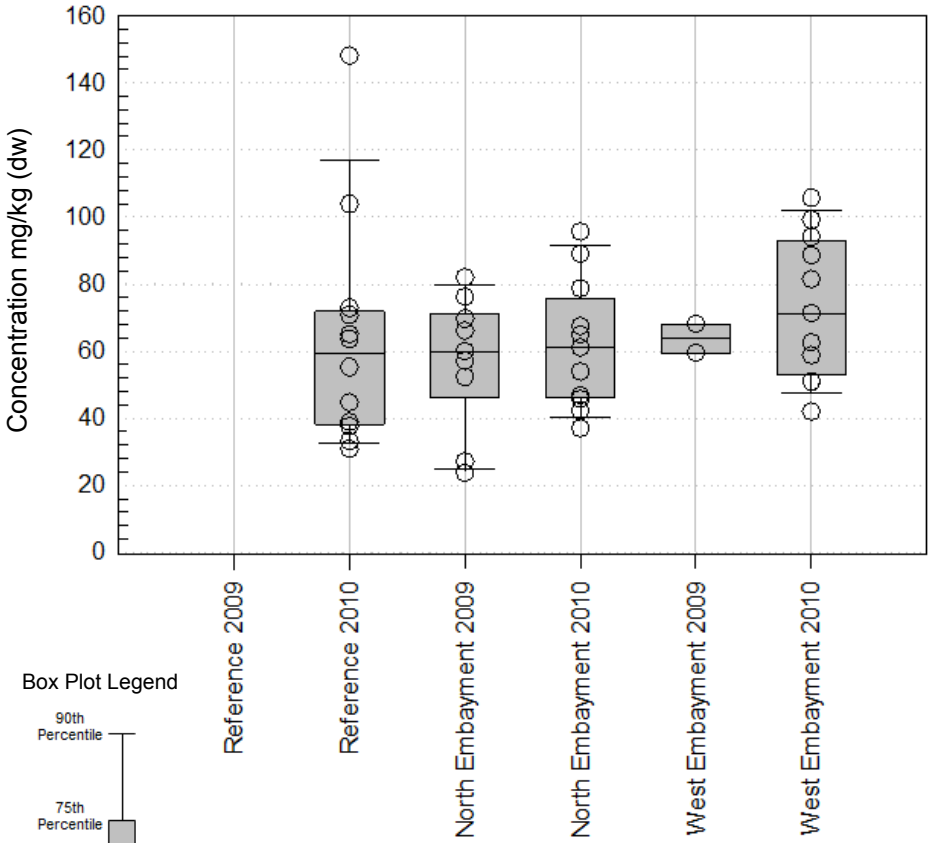
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – ALUMINUM AND ARSENIC

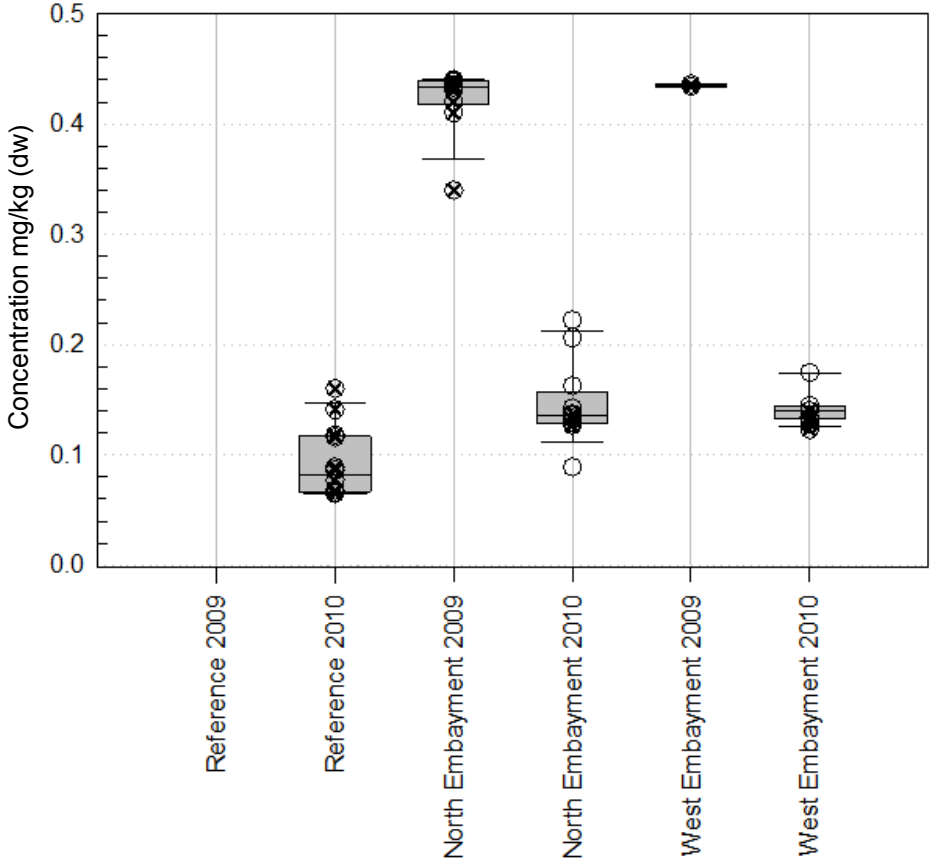
ARCADIS

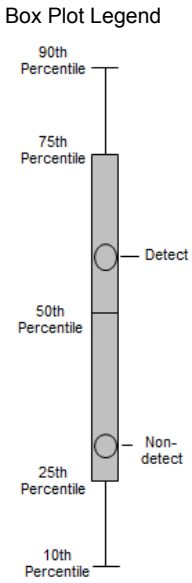
FIGURE 17

Barium



Cadmium





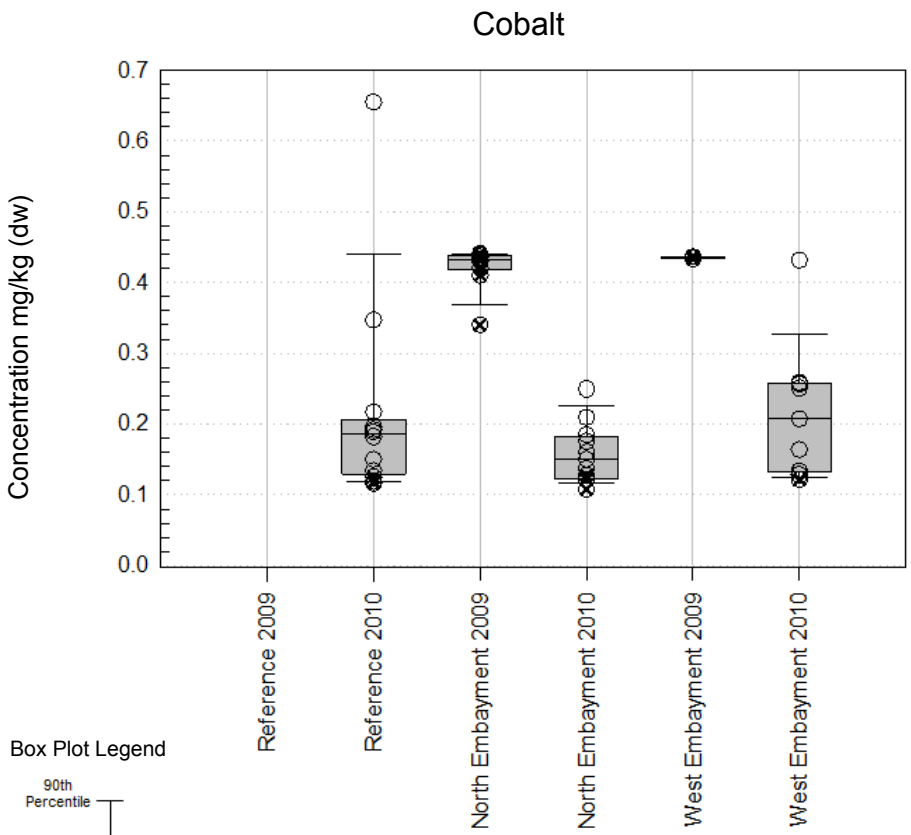
Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

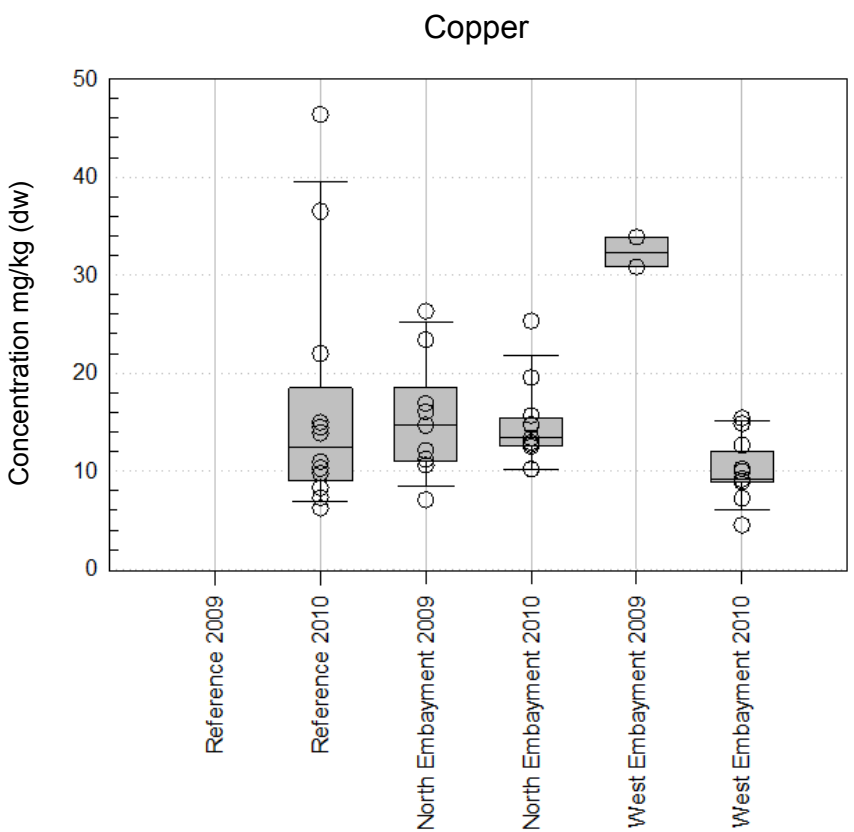
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

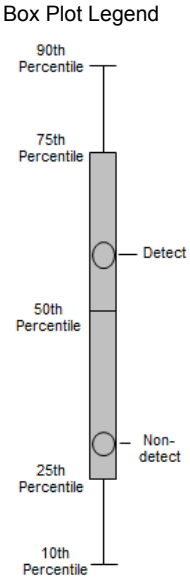
TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – BARIUM AND CADMIUM

ARCADIS

FIGURE 18







Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

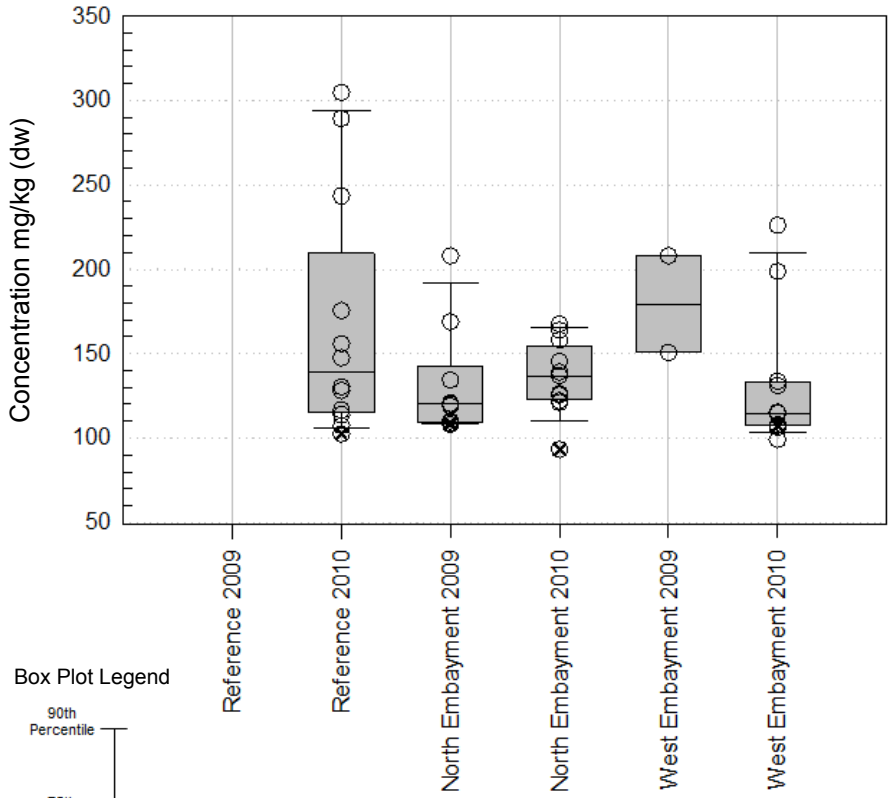
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – COBALT AND COPPER

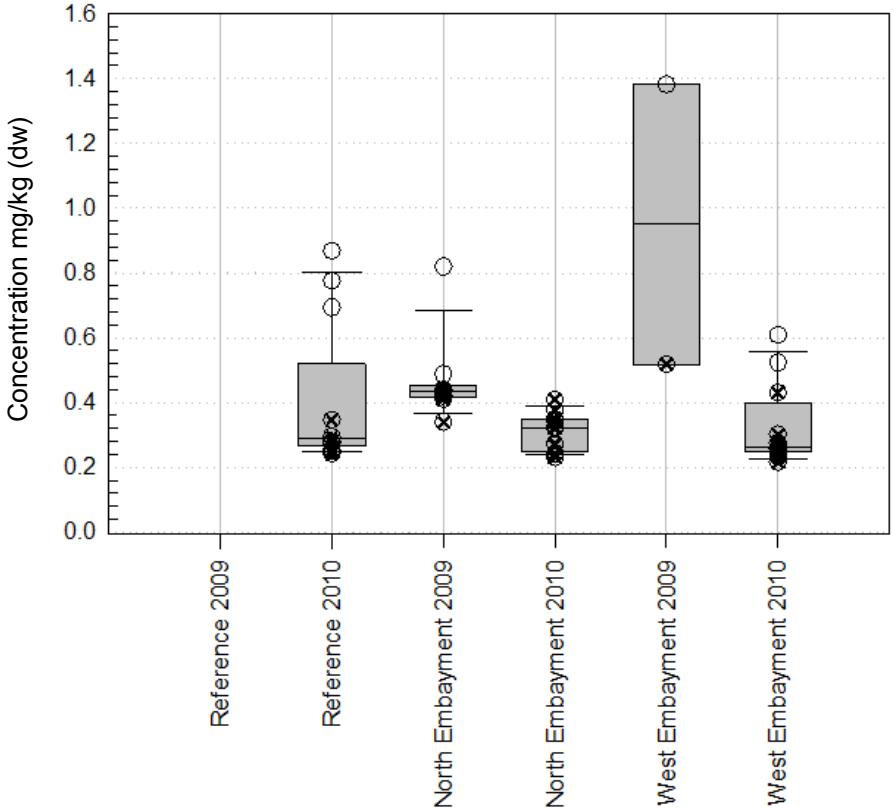
ARCADIS

FIGURE 19

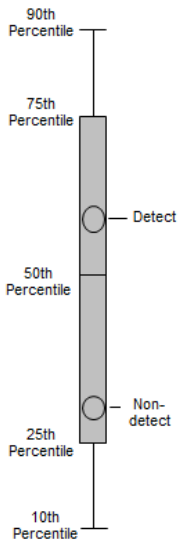
Iron



Lead



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

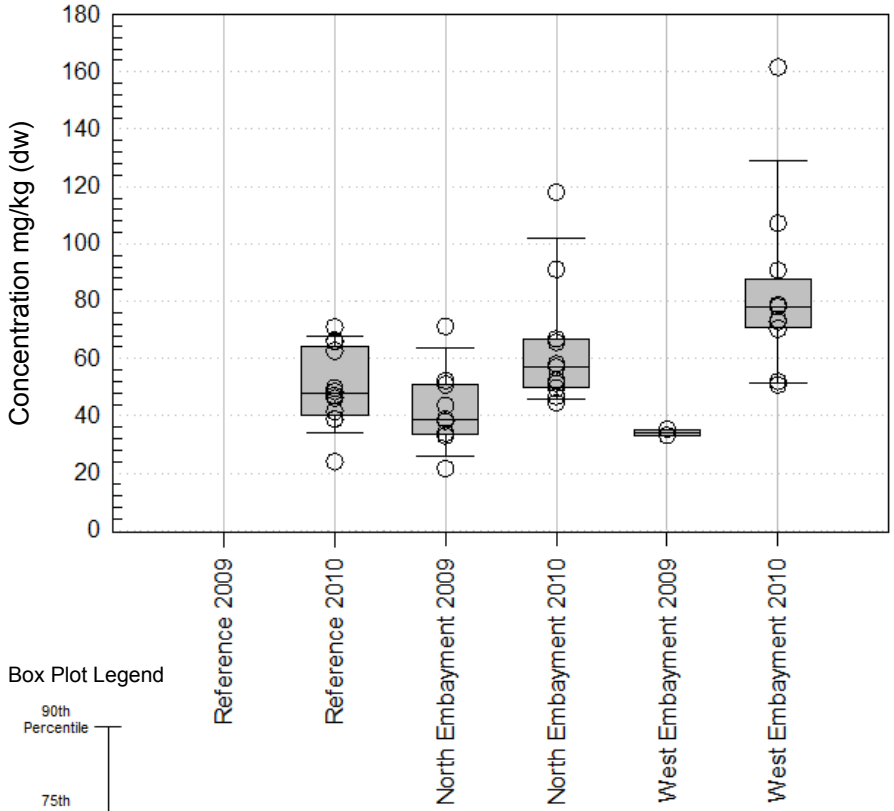
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – IRON AND LEAD

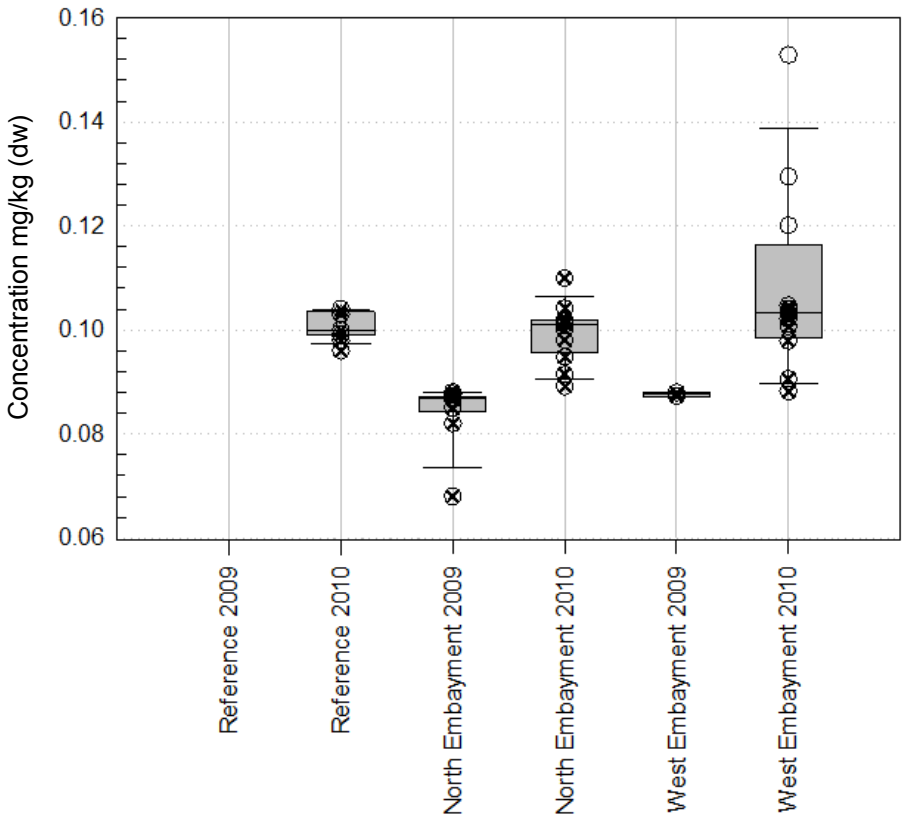
ARCADIS

FIGURE 20

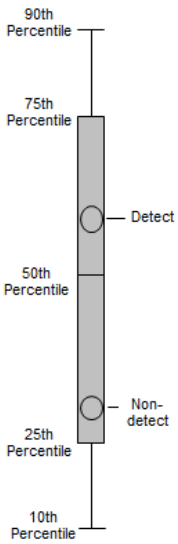
Manganese



Mercury



Box Plot Legend



Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

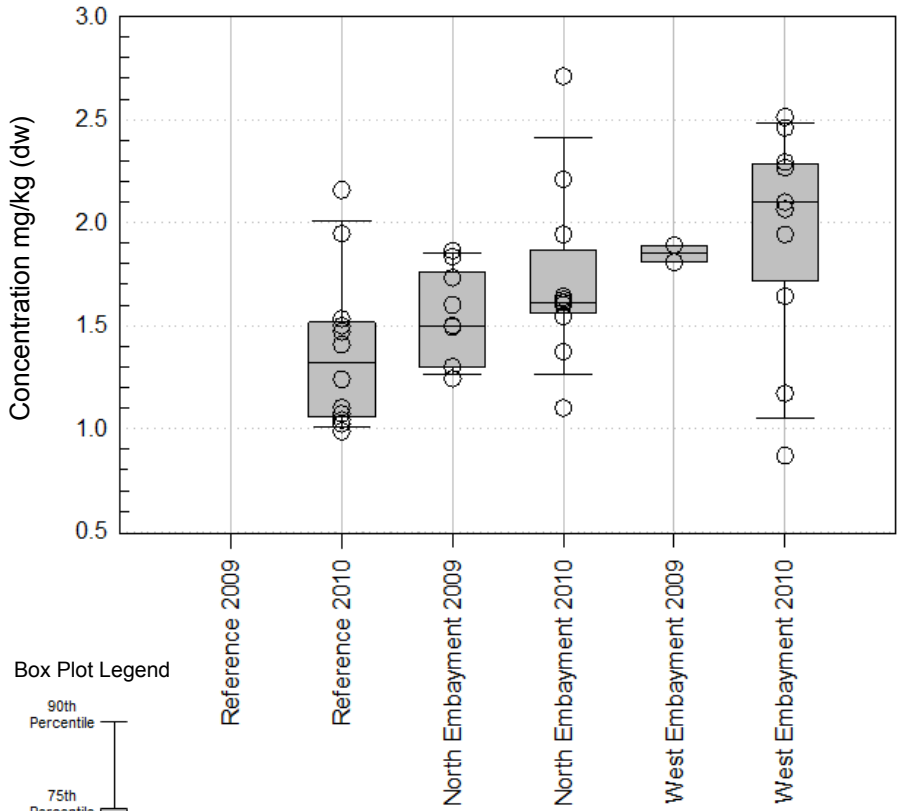
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – MANGANESE AND MERCURY

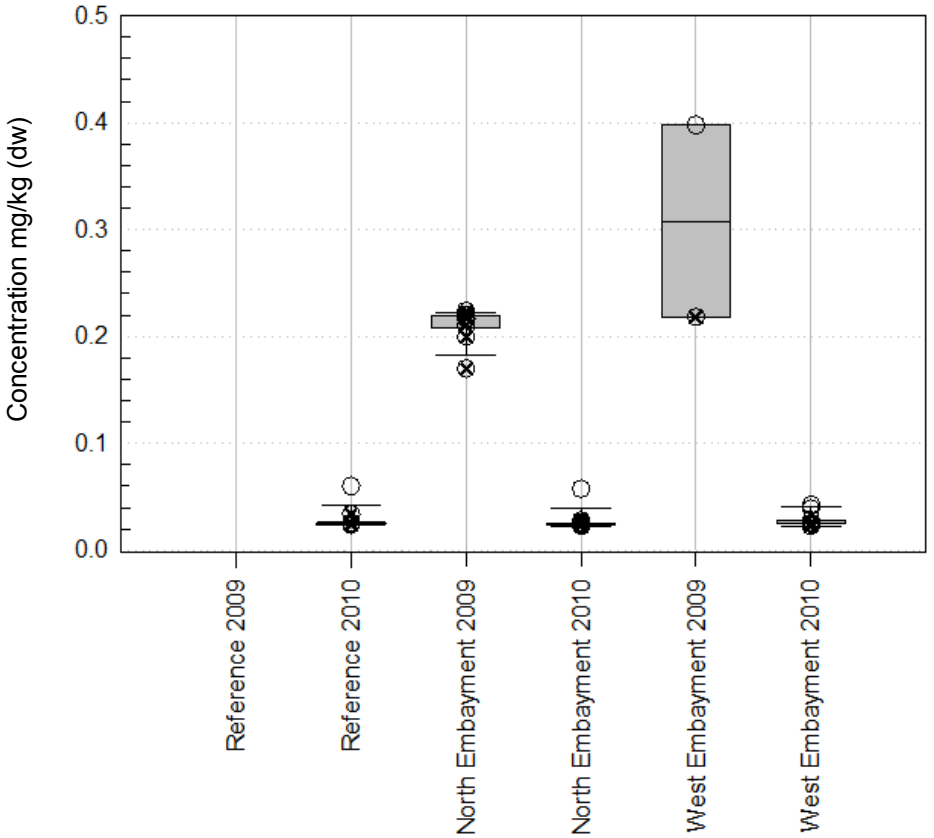
ARCADIS

FIGURE 21

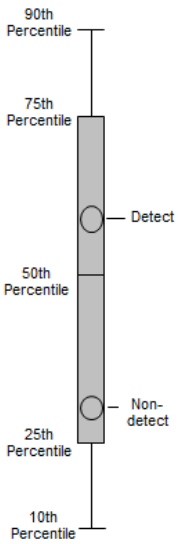
Selenium



Silver



Box Plot Legend



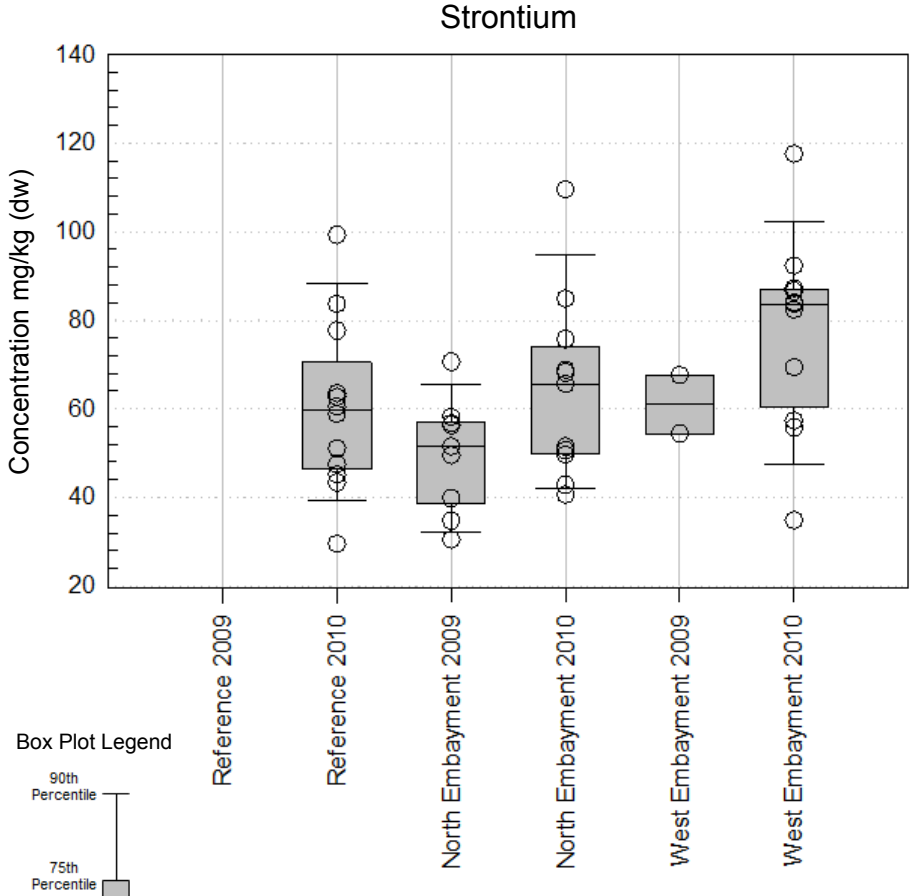
Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

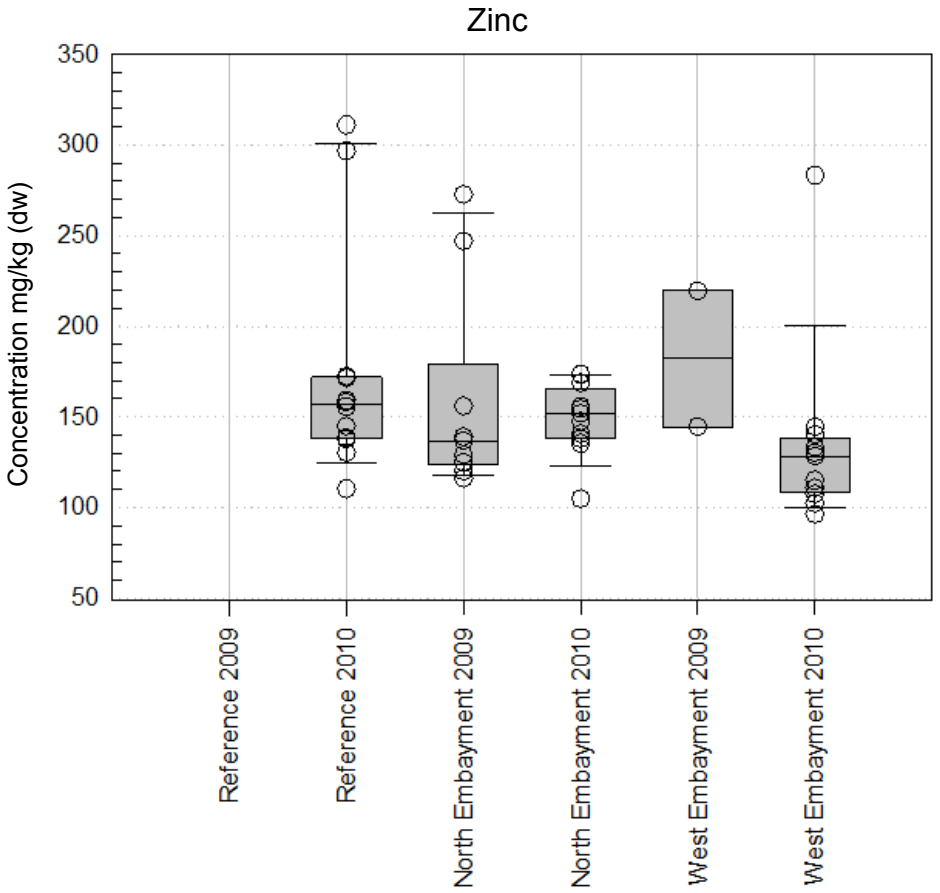
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

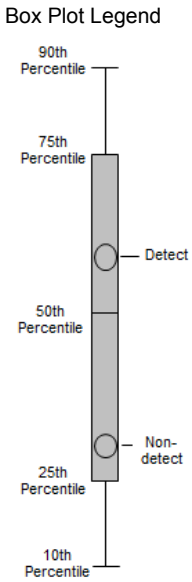
TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – SELENIUM AND SILVER

ARCADIS

FIGURE 22







Note: Whole body concentrations in mg/kg (dw) = milligram per kilogram (dry weight)
No chorus frogs were found during the 2009 Reference collections.

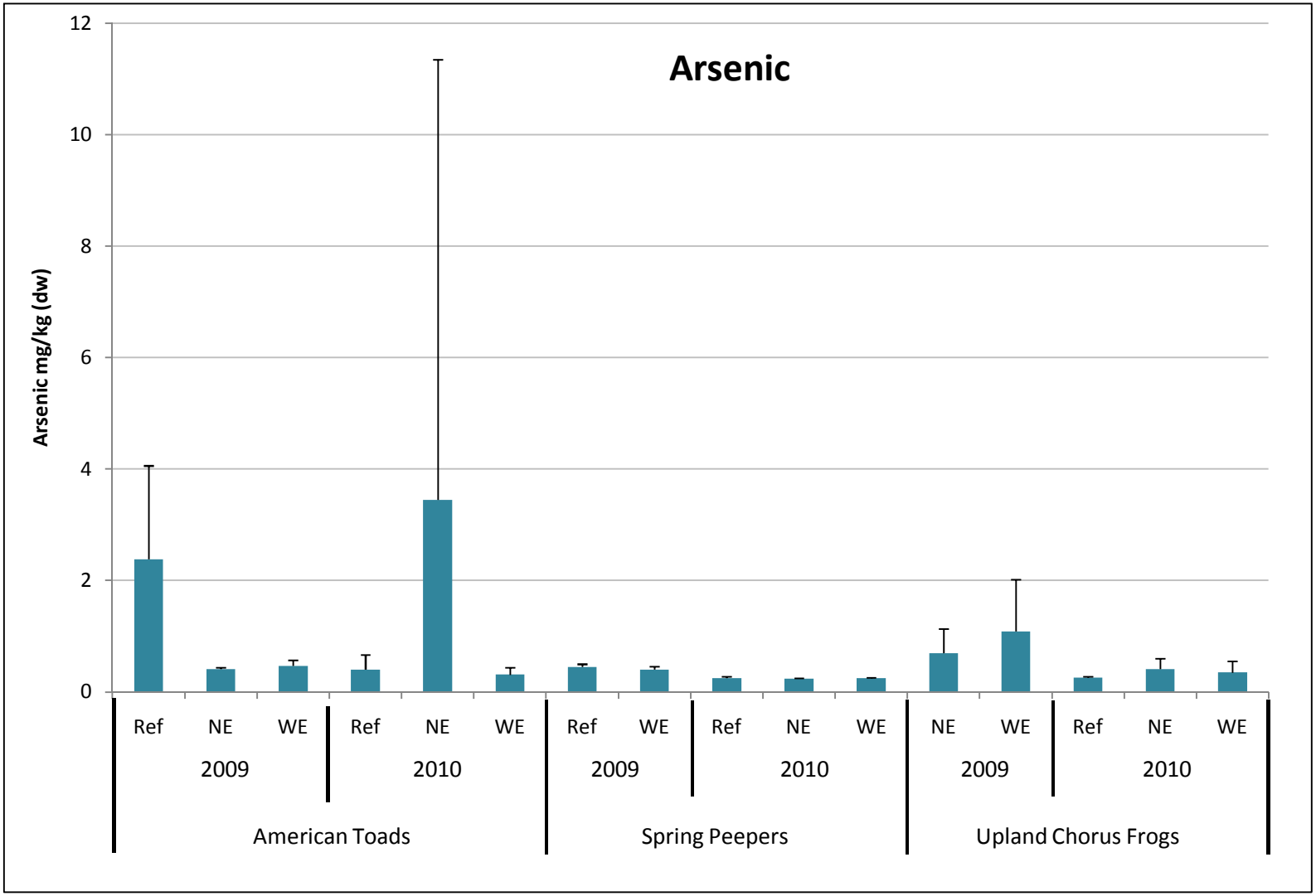
TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

TRACE ELEMENT CONCENTRATIONS IN CHORUS FROGS – STRONTIUM AND ZINC

ARCADIS

FIGURE 23

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F24_ArsenicBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

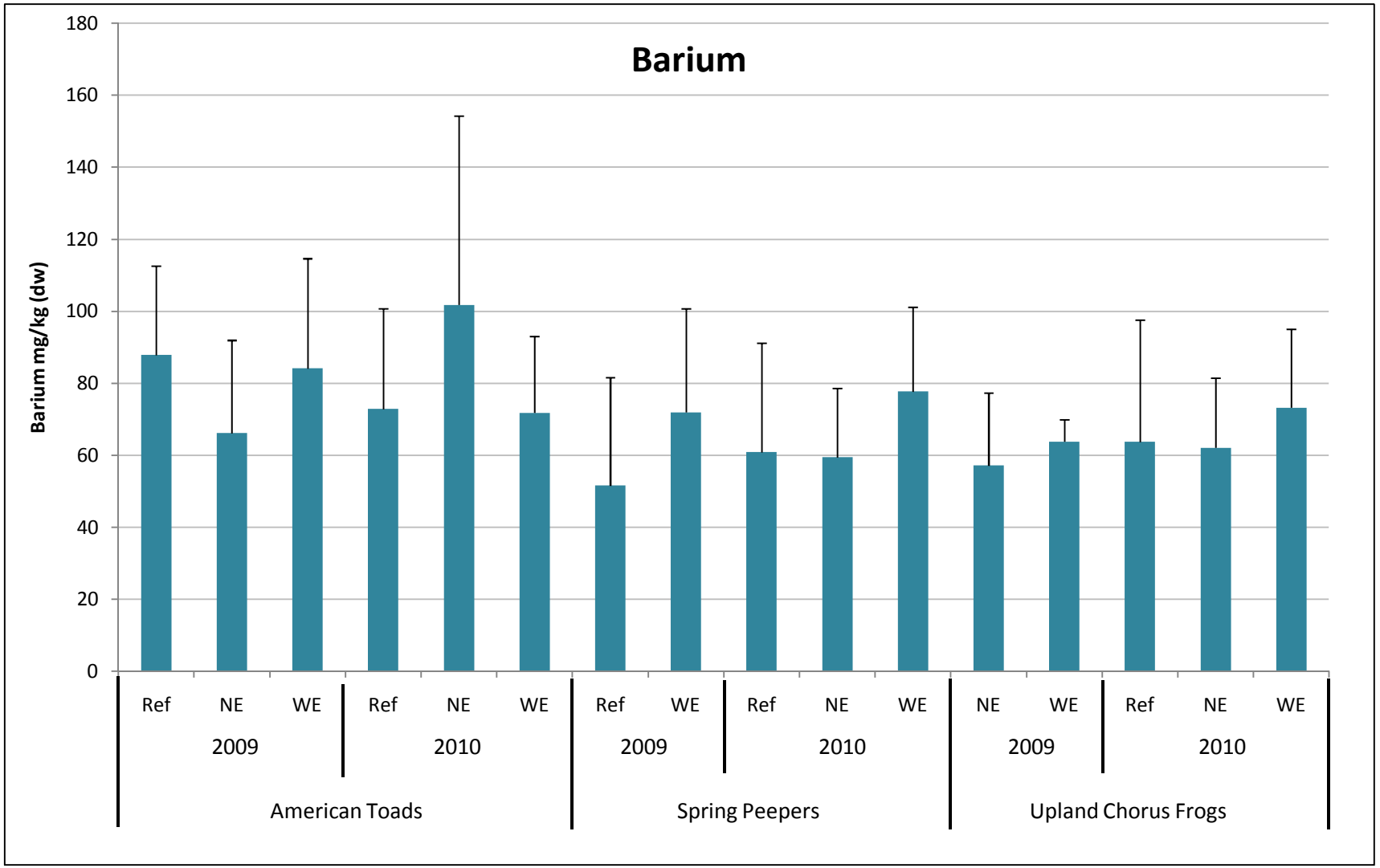
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF ARSENIC

ARCADIS

FIGURE
24

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F25_BariumBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

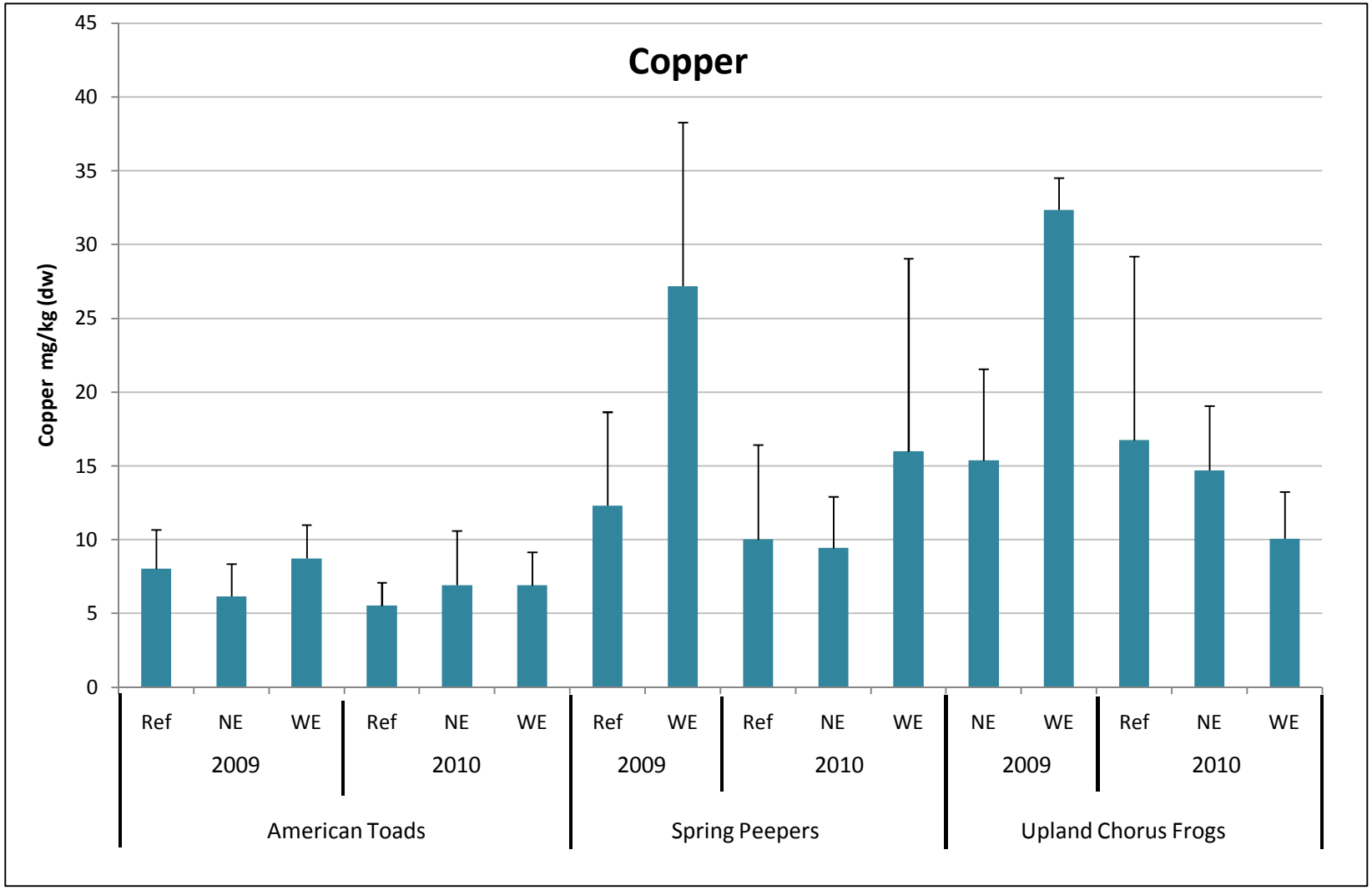
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF BARIUM

ARCADIS

FIGURE
25

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F26_CopperBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

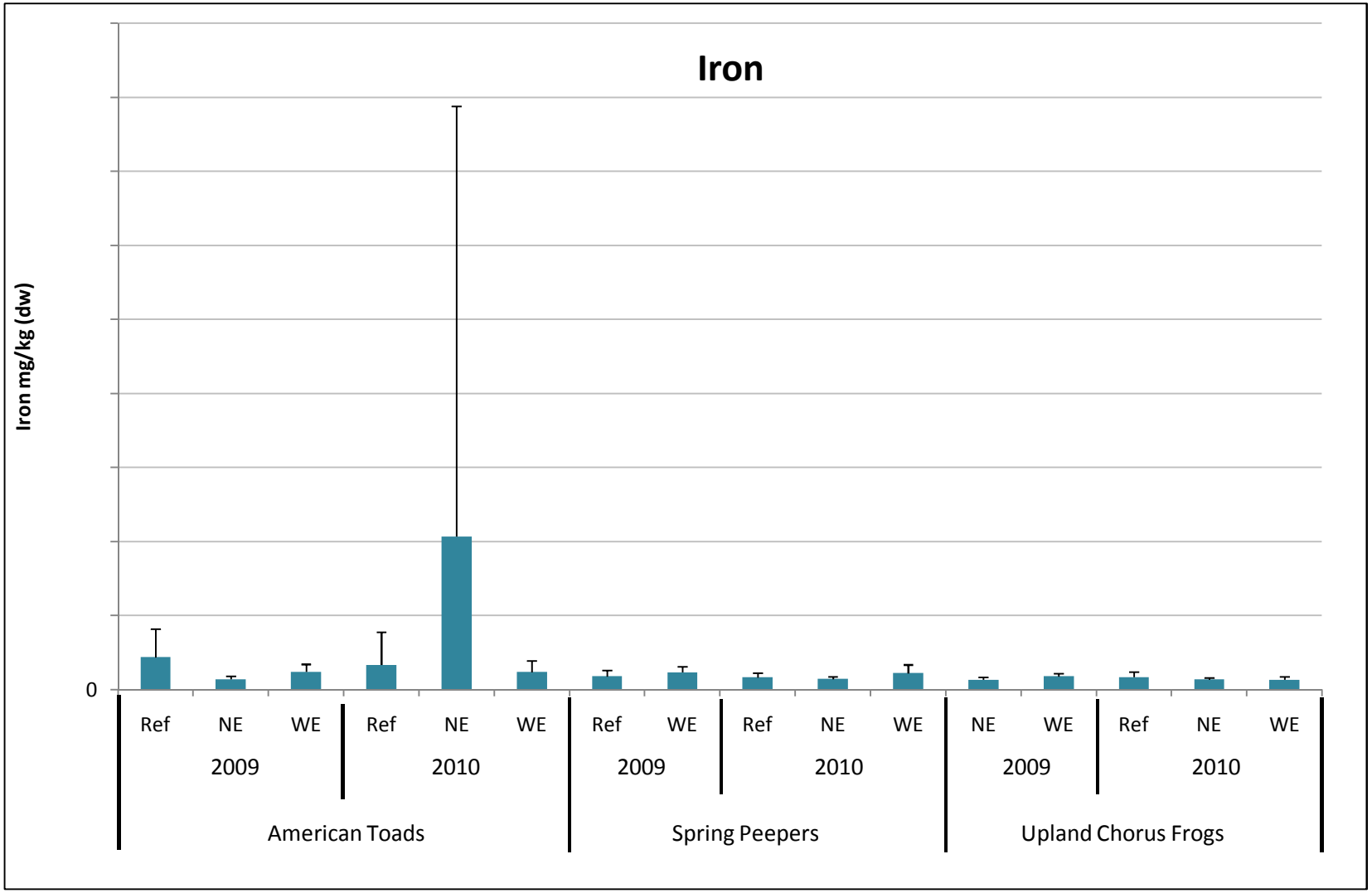
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF COPPER

ARCADIS

FIGURE
26

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F27_IronBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

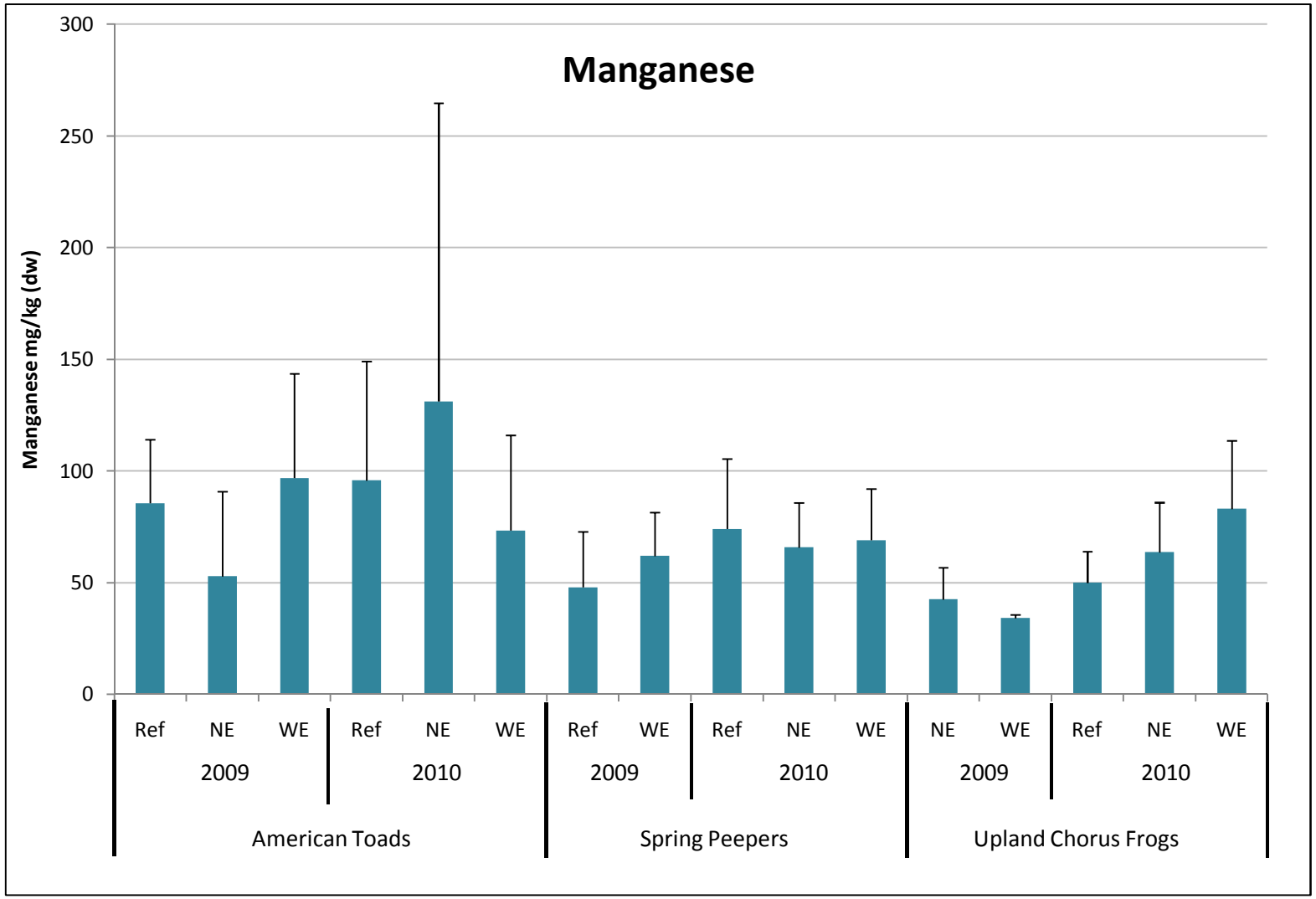
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF IRON

ARCADIS

FIGURE
27

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F28_ManganeseBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

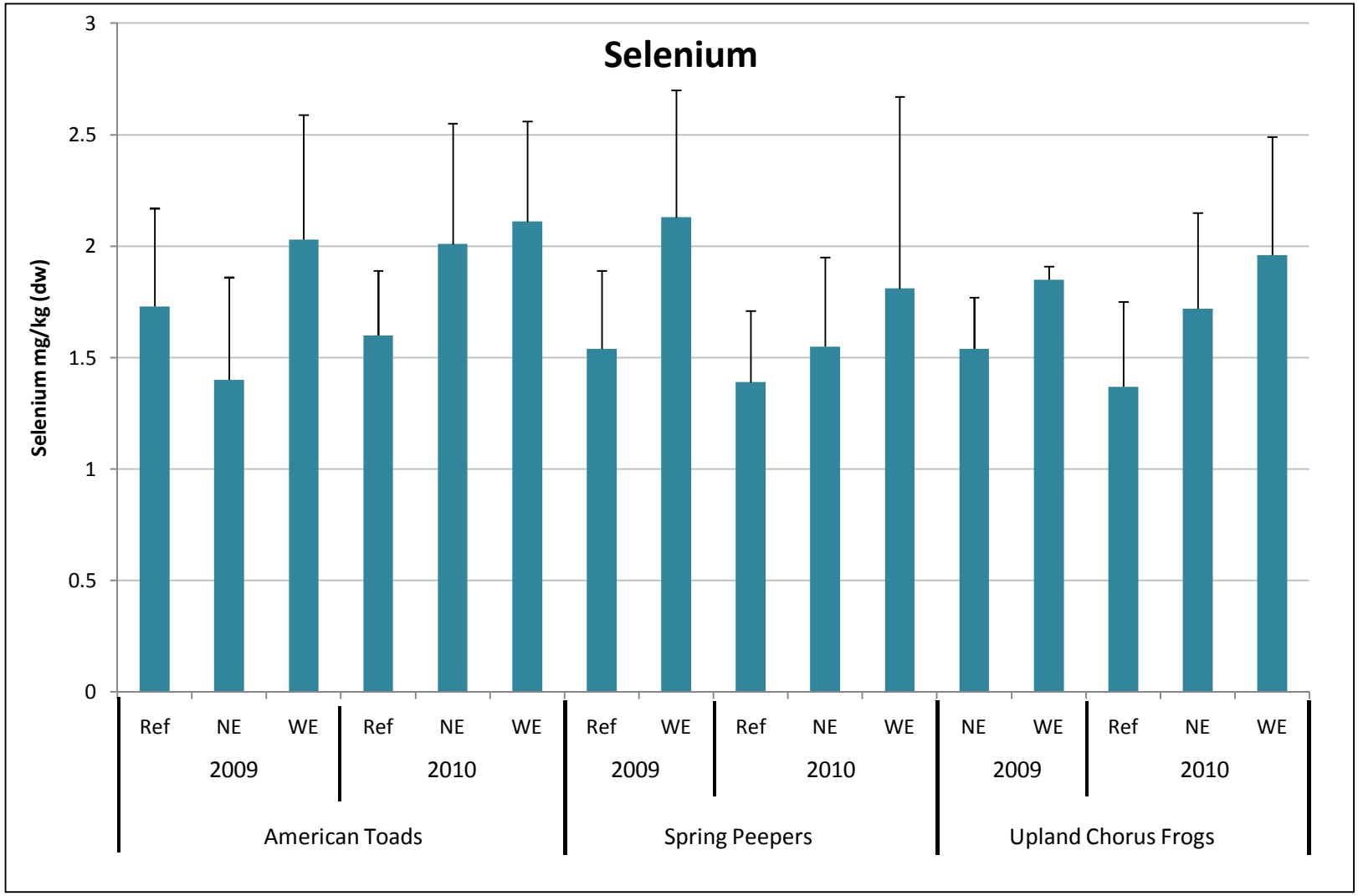
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF MANGANESE

ARCADIS

FIGURE
28

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F29_SeleniumBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

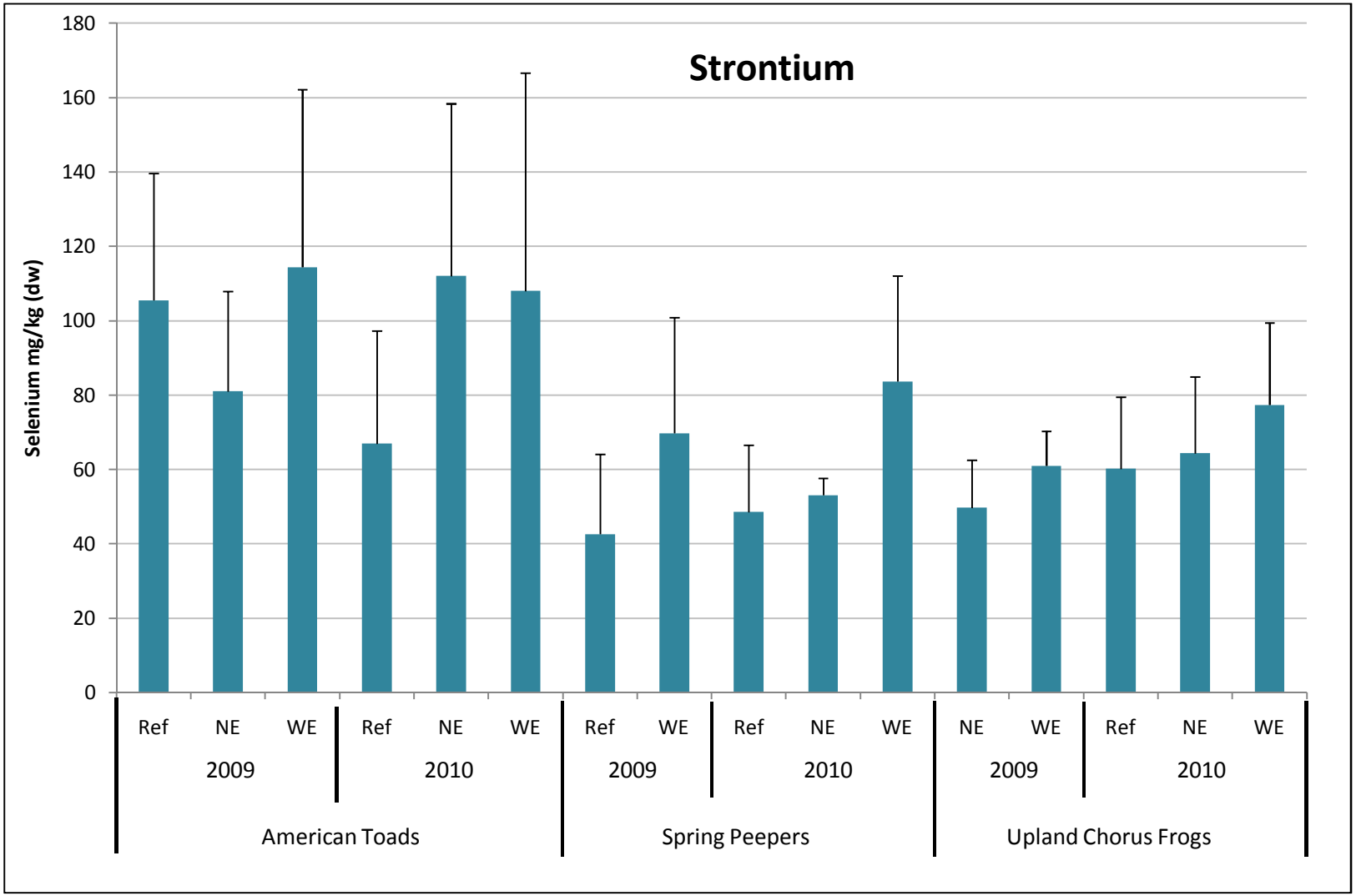
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF SELENIUM

ARCADIS

FIGURE
29

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F30_StrontiumBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

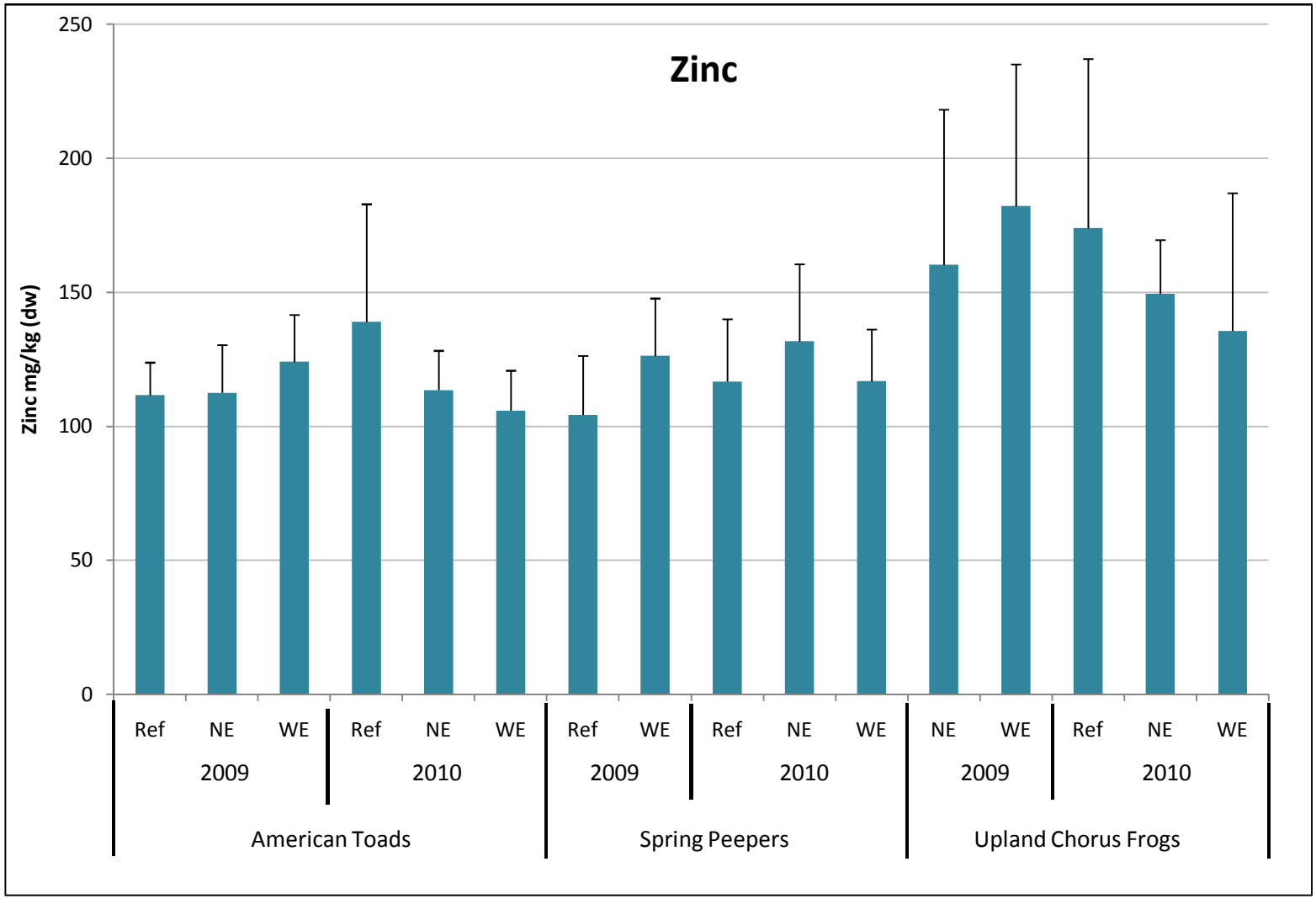
TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF STRONTIUM

ARCADIS

FIGURE
30

CITY: KNX DIV/GROUP: ENV/GIS DB: C.SMITH PIC: B.ILGNER PM: D.JONES TM: S.YOUNG
PROJECT: TNTVAKIP.ECA1.00007 PATH: G:\GIS\TVA\KIF\Amphibians data\Trace element conc. 2009-2010\F31_ZincBarGraph.pdf



Note:
Data are presented as mean ± standard deviation for whole body American toads, spring peepers and upland chorus frogs.
Where mg/kg (dw) = milligram per kilogram (dry weight) and Ref= Reference, NE= North Embayment and WE= West Embayment.

TENNESSEE VALLEY AUTHORITY
KINGSTON, TENNESSEE

TRACE ELEMENT CONCENTRATIONS IN AMPHIBIANS: 2009-2010

MEAN CONCENTRATIONS OF ZINC

ARCADIS

FIGURE
31

ARCADIS

Appendix A

Occurrence Tables

American Toad Dataset 2009
Reference Site
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	6 - 10	60	118.6 - 1430	108.1 - 109.5
Antimony	0 - 10	0	– - –	0.39 - 0.47
Arsenic	10 - 10	100	0.71 - 6.48	– - –
Barium	10 - 10	100	53 - 126.8	– - –
Beryllium	0 - 10	0	– - –	0.39 - 0.47
Boron	0 - 10	0	– - –	7.9 - 9.4
Cadmium	1 - 10	10	0.4469 - 0.4469	0.39 - 0.47
Calcium	10 - 10	100	36600 - 91859	– - –
Chromium	1 - 10	10	18.4 - 18.4	0.4346 - 1.247
Cobalt	2 - 10	20	0.61 - 0.634	0.39 - 0.47
Copper	6 - 10	60	8 - 12.1	4.528 - 6.931
Iron	10 - 10	100	171.5 - 1470	– - –
Lead	9 - 10	90	0.5638 - 2.1	0.4339 - 0.4339
Magnesium	10 - 10	100	1651 - 2390	– - –
Manganese	10 - 10	100	48.55 - 126.5	– - –
Mercury	1 - 10	10	0.1191 - 0.1191	0.079 - 0.094
Molybdenum	0 - 10	0	– - –	3.9 - 4.7
Nickel	3 - 10	30	0.9463 - 8.7	0.4346 - 0.7452
Potassium	10 - 10	100	8170 - 9747	– - –
Selenium	10 - 10	100	0.8928 - 2.3	– - –
Silver	0 - 10	0	– - –	0.2 - 0.24
Sodium	10 - 10	100	4580 - 6700	– - –
Strontium	10 - 10	100	67 - 172.5	– - –
Thallium	0 - 10	0	– - –	0.39 - 0.47
Vanadium	3 - 10	30	1.032 - 1.4	0.79 - 0.94
Zinc	10 - 10	100	90 - 134.1	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

American Toad Dataset 2010
Reference Site
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	5 - 13	38.5	75.7 - 2340	31.1 - 41
Antimony	0 - 13	0	– - –	0.11 - 0.15
Arsenic	6 - 13	46.2	0.29 - 1.1	0.22 - 0.29
Barium	13 - 13	100	43.9 - 123	– - –
Beryllium	0 - 13	0	– - –	0.2623 - 0.61
Boron	0 - 13	0	– - –	3.1 - 4.2
Cadmium	4 - 13	30.8	0.14 - 0.28	0.07743 - 0.127
Calcium	13 - 13	100	34800 - 85200	– - –
Chromium	1 - 13	7.69	5.2 - 5.2	0.96 - 1.3
Cobalt	11 - 13	84.6	0.13 - 1.3	0.12 - 0.14
Copper	11 - 13	84.6	4.1 - 8.5	3.411 - 3.6
Iron	13 - 13	100	127 - 1770	– - –
Lead	7 - 13	53.8	0.57 - 3.1	0.379 - 2.2
Magnesium	13 - 13	100	1280 - 2398	– - –
Manganese	13 - 13	100	37.2 - 227	– - –
Mercury	1 - 13	7.69	0.12 - 0.12	0.09 - 0.12
Molybdenum	0 - 13	0	– - –	0.27 - 0.36
Nickel	1 - 13	7.69	2.4 - 2.4	0.74 - 1
Potassium	13 - 13	100	8000 - 10700	– - –
Selenium	13 - 13	100	1.1 - 2.248	– - –
Silver	2 - 13	15.4	0.025 - 0.029	0.022 - 0.03
Sodium	13 - 13	100	3520 - 6368	– - –
Strontium	13 - 13	100	34.2 - 121	– - –
Thallium	0 - 13	0	– - –	0.1 - 0.14
Vanadium	1 - 13	7.69	3.8 - 3.8	0.34 - 0.48
Zinc	13 - 13	100	102.3 - 254.8	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

American Toad Dataset 2009
North Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	0 - 10	0	– - –	89.6 - 117
Antimony	0 - 10	0	– - –	0.36 - 0.47
Arsenic	0 - 10	0	– - –	0.36 - 0.47
Barium	10 - 10	100	31.5 - 126	– - –
Beryllium	0 - 10	0	– - –	0.36 - 0.47
Boron	0 - 10	0	– - –	7.2 - 9.4
Cadmium	0 - 10	0	– - –	0.36 - 0.47
Calcium	10 - 10	100	36200 - 111000	– - –
Chromium	0 - 10	0	– - –	0.39 - 0.73
Cobalt	0 - 10	0	– - –	0.36 - 0.47
Copper	3 - 10	30	6.8 - 10.4	3.9 - 6.5
Iron	7 - 10	70	121 - 260	105 - 117
Lead	4 - 10	40	0.43 - 1.1	0.36 - 0.43
Magnesium	10 - 10	100	990 - 2600	– - –
Manganese	10 - 10	100	15.4 - 128	– - –
Mercury	5 - 10	50	0.085 - 0.11	0.072 - 0.085
Molybdenum	0 - 10	0	– - –	3.6 - 4.7
Nickel	0 - 10	0	– - –	0.39 - 0.47
Potassium	10 - 10	100	6320 - 8810	– - –
Selenium	10 - 10	100	0.93 - 2.3	– - –
Silver	0 - 10	0	– - –	0.18 - 0.23
Sodium	8 - 10	80	4080 - 6670	3960 - 4200
Strontium	10 - 10	100	42.9 - 133	– - –
Thallium	0 - 10	0	– - –	0.36 - 0.47
Vanadium	0 - 10	0	– - –	0.72 - 0.94
Zinc	10 - 10	100	80 - 140	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

American Toad Dataset 2010
North Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples			FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	5	-	10	50	38.8 - 1980	33 - 43.3
Antimony	1	-	10	10	0.59 - 0.59	0.11 - 0.16
Arsenic	10	-	10	100	0.27 - 25.9	– - –
Barium	10	-	10	100	32.8 - 199	– - –
Beryllium	0	-	10	0	– - –	0.44 - 0.65
Boron	0	-	10	0	– - –	3.1 - 4.5
Cadmium	5	-	10	50	0.21 - 0.29	0.068 - 0.15
Calcium	10	-	10	100	30100 - 104000	– - –
Chromium	2	-	10	20	1 - 23.6	1 - 1.4
Cobalt	10	-	10	100	0.14 - 2.2	– - –
Copper	9	-	10	90	4.4 - 15.4	4.3 - 4.3
Iron	10	-	10	100	111 - 18600	– - –
Lead	8	-	10	80	0.61 - 9.9	0.27 - 0.44
Magnesium	10	-	10	100	1260 - 2640	– - –
Manganese	10	-	10	100	28.8 - 489	– - –
Mercury	1	-	10	10	0.1 - 0.1	0.085 - 0.13
Molybdenum	1	-	10	10	1 - 1	0.26 - 0.38
Nickel	1	-	10	10	1.3 - 1.3	0.72 - 1.1
Potassium	10	-	10	100	8170 - 11400	– - –
Selenium	10	-	10	100	0.92 - 2.9	– - –
Silver	2	-	10	20	0.031 - 0.049	0.021 - 0.028
Sodium	10	-	10	100	4850 - 7520	– - –
Strontium	10	-	10	100	61.7 - 186	– - –
Thallium	0	-	10	0	– - –	0.1 - 0.15
Vanadium	3	-	10	30	0.88 - 36.4	0.38 - 0.49
Zinc	10	-	10	100	96 - 141	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

American Toad Dataset 2009
West Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples			FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	6	-	11	54.5	121 - 378	101 - 184
Antimony	0	-	11	0	– - –	0.39 - 0.74
Arsenic	0	-	11	0	– - –	0.39 - 0.74
Barium	11	-	11	100	23.6 - 126	– - –
Beryllium	0	-	11	0	– - –	0.39 - 0.74
Boron	0	-	11	0	– - –	7.9 - 14.8
Cadmium	0	-	11	0	– - –	0.39 - 0.74
Calcium	11	-	11	100	24600 - 121000	– - –
Chromium	4	-	11	36.4	0.64 - 8.6	0.41 - 0.74
Cobalt	1	-	11	9.09	0.51 - 0.51	0.39 - 0.74
Copper	10	-	11	90.9	7 - 13.1	5.1 - 5.1
Iron	9	-	11	81.8	103 - 400	109 - 184
Lead	6	-	11	54.5	0.51 - 2.1	0.41 - 0.74
Magnesium	11	-	11	100	1180 - 6710	– - –
Manganese	11	-	11	100	44.2 - 174	– - –
Mercury	6	-	11	54.5	0.083 - 0.18	0.081 - 0.15
Molybdenum	0	-	11	0	– - –	3.9 - 7.4
Nickel	6	-	11	54.5	0.46 - 13.1	0.41 - 0.74
Potassium	11	-	11	100	6560 - 9840	– - –
Selenium	11	-	11	100	1.176 - 3.3	– - –
Silver	0	-	11	0	– - –	0.2 - 0.37
Sodium	9	-	11	81.8	4330 - 7280	3991 - 4810
Strontium	11	-	11	100	47 - 206	– - –
Thallium	0	-	11	0	– - –	0.39 - 0.74
Vanadium	0	-	11	0	– - –	0.79 - 1.5
Zinc	11	-	11	100	106 - 161	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

American Toad Dataset 2010
West Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	7 - 10	70	36.4 - 180	34.4 - 41.2
Antimony	0 - 10	0	– - –	0.11 - 0.15
Arsenic	6 - 10	60	0.24 - 0.65	0.22 - 0.29
Barium	10 - 10	100	45.1 - 111	– - –
Beryllium	0 - 10	0	– - –	0.23 - 0.3
Boron	0 - 10	0	– - –	3.3 - 4.3
Cadmium	5 - 10	50	0.15 - 0.27	0.065 - 0.12
Calcium	10 - 10	100	35800 - 113000	– - –
Chromium	0 - 10	0	– - –	1 - 1.3
Cobalt	10 - 10	100	0.16 - 0.45	– - –
Copper	9 - 10	90	5.5 - 11.1	3.3 - 3.3
Iron	1 - 10	10	634 - 634	104 - 265
Lead	7 - 10	70	0.41 - 1.5	0.25 - 0.29
Magnesium	10 - 10	100	1280 - 2510	– - –
Manganese	10 - 10	100	19.3 - 173	– - –
Mercury	2 - 10	20	0.13 - 0.14	0.091 - 0.12
Molybdenum	0 - 10	0	– - –	0.28 - 0.36
Nickel	0 - 10	0	– - –	0.77 - 1
Potassium	10 - 10	100	7970 - 9480	– - –
Selenium	10 - 10	100	1.4 - 3	– - –
Silver	4 - 10	40	0.035 - 0.047	0.025 - 0.03
Sodium	10 - 10	100	4540 - 6810	– - –
Strontium	10 - 10	100	42.1 - 241	– - –
Thallium	0 - 10	0	– - –	0.11 - 0.14
Vanadium	0 - 10	0	– - –	0.36 - 0.47
Zinc	10 - 10	100	84.9 - 131	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Spring Peeper Dataset 2009
Reference Site
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	0 - 23	0	– - –	108.1 - 123.2
Antimony	0 - 23	0	– - –	0.4303 - 0.4906
Arsenic	1 - 23	4.35	0.6629 - 0.6629	0.4303 - 0.4906
Barium	23 - 23	100	11.18 - 119.3	– - –
Beryllium	0 - 23	0	– - –	0.4303 - 0.4906
Boron	0 - 23	0	– - –	8.631 - 9.931
Cadmium	0 - 23	0	– - –	0.4303 - 0.4906
Calcium	23 - 23	100	31972 - 69401	– - –
Chromium	1 - 23	4.35	2.959 - 2.959	0.4303 - 0.6581
Cobalt	0 - 23	0	– - –	0.4303 - 0.4906
Copper	21 - 23	91.3	7.301 - 31.1	5.967 - 6.267
Iron	23 - 23	100	111.9 - 424	– - –
Lead	4 - 23	17.4	0.4795 - 0.721	0.4303 - 0.4906
Magnesium	23 - 23	100	1381 - 2056	– - –
Manganese	23 - 23	100	15.79 - 98.77	– - –
Mercury	5 - 23	21.7	0.08929 - 0.12	0.08631 - 0.09441
Molybdenum	0 - 23	0	– - –	4.303 - 4.906
Nickel	0 - 23	0	– - –	0.4303 - 0.5504
Potassium	23 - 23	100	7770 - 10135	– - –
Selenium	23 - 23	100	0.9607 - 2.2	– - –
Silver	0 - 23	0	– - –	0.2131 - 0.2513
Sodium	14 - 23	60.9	4424 - 5140	3825 - 4812
Strontium	23 - 23	100	21.53 - 121.5	– - –
Thallium	0 - 23	0	– - –	0.4303 - 0.4906
Vanadium	0 - 23	0	– - –	0.8631 - 0.9931
Zinc	23 - 23	100	75.84 - 156.7	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Spring Peeper Dataset 2010
Reference Site
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	6 - 31	19.4	38.09 - 69.78	26.1 - 36.22
Antimony	0 - 31	0	– - –	0.094 - 0.1341
Arsenic	2 - 31	6.45	0.2592 - 0.3904	0.18 - 0.2571
Barium	31 - 31	100	24 - 132.4	– - –
Beryllium	0 - 31	0	– - –	0.2279 - 0.541
Boron	0 - 31	0	– - –	2.7 - 3.801
Cadmium	5 - 31	16.1	0.07885 - 0.1824	0.06481 - 0.1166
Calcium	31 - 31	100	35135 - 63500	– - –
Chromium	1 - 31	3.23	29.74 - 29.74	0.83 - 1.19
Cobalt	26 - 31	83.9	0.1289 - 0.6248	0.092 - 0.1268
Copper	31 - 31	100	4.638 - 32.77	– - –
Iron	29 - 31	93.5	113.9 - 417	103.7 - 108.6
Lead	4 - 31	12.9	0.579 - 3.177	0.18 - 0.4973
Magnesium	31 - 31	100	1180 - 2114	– - –
Manganese	31 - 31	100	29.28 - 147	– - –
Mercury	0 - 31	0	– - –	0.076 - 0.109
Molybdenum	1 - 31	3.23	0.42 - 0.42	0.23 - 0.3228
Nickel	0 - 31	0	– - –	0.64 - 0.8831
Potassium	31 - 31	100	5950 - 11291	– - –
Selenium	31 - 31	100	0.8646 - 2.323	– - –
Silver	5 - 31	16.1	0.02963 - 0.08543	0.019 - 0.02652
Sodium	31 - 31	100	2840 - 5129	– - –
Strontium	31 - 31	100	18 - 94.07	– - –
Thallium	0 - 31	0	– - –	0.09 - 0.1292
Vanadium	1 - 31	3.23	1.677 - 1.677	0.3 - 0.4164
Zinc	31 - 31	100	87.8 - 204.9	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Spring Peeper Dataset 2010
North Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) (mg/kg dw)	(mg/kg dw)
Aluminum	0 - 5	0	– - –	32.06	35.92
Antimony	0 - 5	0	– - –	0.1191	0.1326
Arsenic	0 - 5	0	– - –	0.2274	0.2531
Barium	5 - 5	100	39.14 - 83.28	–	–
Beryllium	0 - 5	0	– - –	0.2383	0.5114
Boron	0 - 5	0	– - –	3.357	3.736
Cadmium	0 - 5	0	– - –	0.09057	0.1446
Calcium	5 - 5	100	38662 - 64143	–	–
Chromium	0 - 5	0	– - –	1.018	1.145
Cobalt	4 - 5	80	0.1124 - 0.1705	0.1236	0.1236
Copper	4 - 5	80	7.868 - 12.29	4.049	4.049
Iron	4 - 5	80	120.4 - 175.4	100.5	100.5
Lead	0 - 5	0	– - –	0.2274	0.2983
Magnesium	5 - 5	100	1615 - 2174	–	–
Manganese	5 - 5	100	50.26 - 99.62	–	–
Mercury	0 - 5	0	– - –	0.09314	0.1037
Molybdenum	0 - 5	0	– - –	0.2816	0.3134
Nickel	0 - 5	0	– - –	0.7797	0.8798
Potassium	5 - 5	100	8339 - 10314	–	–
Selenium	5 - 5	100	0.9963 - 2.049	–	–
Silver	0 - 5	0	– - –	0.02274	0.02652
Sodium	5 - 5	100	4060 - 4640	–	–
Strontium	5 - 5	100	49.06 - 58.55	–	–
Thallium	0 - 5	0	– - –	0.1083	0.1211
Vanadium	0 - 5	0	– - –	0.3942	0.8196
Zinc	5 - 5	100	108.7 - 182	–	–

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Spring Peeper Dataset 2009
West Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples			FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) (mg/kg dw)	
Aluminum	0	-	10	0	– - –	75.5	109.5
Antimony	0	-	10	0	– - –	0.3	0.441
Arsenic	0	-	10	0	– - –	0.3	0.441
Barium	10	-	10	100	39.6 - 123.5	–	–
Beryllium	0	-	10	0	– - –	0.3	0.441
Boron	0	-	10	0	– - –	6	8.803
Cadmium	0	-	10	0	– - –	0.3	0.441
Calcium	10	-	10	100	32300 - 63738	–	–
Chromium	1	-	10	10	2.285 - 2.285	0.35	3.588
Cobalt	2	-	10	20	0.5658 - 0.6026	0.3	0.441
Copper	10	-	10	100	8.525 - 46.87	–	–
Iron	10	-	10	100	147 - 359.3	–	–
Lead	4	-	10	40	0.48 - 0.9472	0.39	3.588
Magnesium	10	-	10	100	1330 - 2254	–	–
Manganese	10	-	10	100	31.1 - 87.7	–	–
Mercury	5	-	10	50	0.09021 - 0.1794	0.06	0.08803
Molybdenum	0	-	10	0	– - –	3	4.41
Nickel	0	-	10	0	– - –	0.3	0.441
Potassium	10	-	10	100	6580 - 12629	–	–
Selenium	10	-	10	100	1.2 - 2.893	–	–
Silver	8	-	10	80	0.27 - 0.63	0.16	0.2181
Sodium	9	-	10	90	4200 - 6228	2940	2940
Strontium	10	-	10	100	30.4 - 124.9	–	–
Thallium	0	-	10	0	– - –	0.3	0.441
Vanadium	0	-	10	0	– - –	0.6	0.8803
Zinc	10	-	10	100	97.5 - 168.7	–	–

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Spring Peeper Dataset 2010
West Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	0 - 9	0	– - –	33.03 - 36.25
Antimony	0 - 9	0	– - –	0.1167 - 0.1364
Arsenic	0 - 9	0	– - –	0.2262 - 0.2568
Barium	9 - 9	100	42.75 - 113.7	– - –
Beryllium	0 - 9	0	– - –	0.2441 - 0.5457
Boron	0 - 9	0	– - –	3.393 - 3.734
Cadmium	2 - 9	22.2	0.1795 - 0.2738	0.06261 - 0.1431
Calcium	9 - 9	100	40294 - 66760	– - –
Chromium	0 - 9	0	– - –	1.051 - 1.196
Cobalt	9 - 9	100	0.124 - 0.6098	– - –
Copper	9 - 9	100	7.125 - 43.31	– - –
Iron	6 - 9	66.7	129.9 - 470.4	124.2 - 268
Lead	1 - 9	11.1	0.5624 - 0.5624	0.2262 - 0.4108
Magnesium	9 - 9	100	1761 - 2477	– - –
Manganese	9 - 9	100	42.98 - 108	– - –
Mercury	2 - 9	22.2	0.1555 - 0.1991	0.095 - 0.1053
Molybdenum	1 - 9	11.1	0.448 - 0.448	0.2865 - 0.3231
Nickel	0 - 9	0	– - –	0.803 - 0.8859
Potassium	9 - 9	100	8284 - 10609	– - –
Selenium	9 - 9	100	1.061 - 3.858	– - –
Silver	3 - 9	33.3	0.0359 - 0.08961	0.02375 - 0.02623
Sodium	9 - 9	100	3931 - 6011	– - –
Strontium	9 - 9	100	44.79 - 132.2	– - –
Thallium	0 - 9	0	– - –	0.1131 - 0.1245
Vanadium	0 - 9	0	– - –	0.3732 - 0.4188
Zinc	9 - 9	100	97.21 - 156.8	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Upland Chorus Frog Dataset 2010
Reference Site
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples			FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	1	-	13	7.69	219.1 - 219.1	27.5 - 36.11
Antimony	0	-	13	0	– - –	0.099 - 0.1336
Arsenic	5	-	13	38.5	0.2366 - 0.3179	0.19 - 0.2536
Barium	13	-	13	100	26 - 148.1	– - –
Beryllium	0	-	13	0	– - –	0.2476 - 0.5345
Boron	0	-	13	0	– - –	2.9 - 3.757
Cadmium	0	-	13	0	– - –	0.06456 - 0.1602
Calcium	13	-	13	100	40044 - 66812	– - –
Chromium	0	-	13	0	– - –	0.87 - 1.149
Cobalt	10	-	13	76.9	0.1336 - 0.6548	0.1158 - 0.1252
Copper	13	-	13	100	6.225 - 46.37	– - –
Iron	12	-	13	92.3	107.2 - 304.7	102.4 - 102.4
Lead	3	-	13	23.1	0.6931 - 0.8675	0.22 - 0.3459
Magnesium	13	-	13	100	1570 - 2165	– - –
Manganese	13	-	13	100	23.89 - 70.93	– - –
Mercury	0	-	13	0	– - –	0.08 - 0.1044
Molybdenum	0	-	13	0	– - –	0.24 - 0.3207
Nickel	0	-	13	0	– - –	0.67 - 0.8819
Potassium	13	-	13	100	7920 - 11014	– - –
Selenium	13	-	13	100	0.96 - 2.157	– - –
Silver	1	-	13	7.69	0.06013 - 0.06013	0.02 - 0.03357
Sodium	13	-	13	100	4130 - 6041	– - –
Strontium	13	-	13	100	26 - 99.28	– - –
Thallium	0	-	13	0	– - –	0.095 - 0.1268
Vanadium	0	-	13	0	– - –	0.31 - 0.4142
Zinc	13	-	13	100	110.4 - 311	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Upland Chorus Frog Dataset 2009
North Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	0 - 9	0	– - –	84.5 - 109.4
Antimony	0 - 9	0	– - –	0.34 - 0.4402
Arsenic	5 - 9	55.6	0.444 - 1.644	0.42 - 0.4402
Barium	9 - 9	100	23.68 - 82	– - –
Beryllium	0 - 9	0	– - –	0.34 - 0.4402
Boron	0 - 9	0	– - –	6.8 - 8.803
Cadmium	0 - 9	0	– - –	0.34 - 0.4402
Calcium	9 - 9	100	42200 - 113712	– - –
Chromium	0 - 9	0	– - –	0.34 - 0.4402
Cobalt	0 - 9	0	– - –	0.34 - 0.4402
Copper	9 - 9	100	7.077 - 26.31	– - –
Iron	7 - 9	77.8	110 - 207.9	108 - 109
Lead	2 - 9	22.2	0.4873 - 0.8192	0.34 - 0.4399
Magnesium	9 - 9	100	1348 - 2079	– - –
Manganese	9 - 9	100	21.53 - 71.16	– - –
Mercury	0 - 9	0	– - –	0.068 - 0.08803
Molybdenum	0 - 9	0	– - –	3.4 - 4.402
Nickel	1 - 9	11.1	0.61 - 0.61	0.34 - 0.4402
Potassium	9 - 9	100	6857 - 8655	– - –
Selenium	9 - 9	100	1.243 - 1.863	– - –
Silver	0 - 9	0	– - –	0.17 - 0.224
Sodium	7 - 9	77.8	4120 - 4960	3895 - 4010
Strontium	9 - 9	100	30.47 - 70.61	– - –
Thallium	0 - 9	0	– - –	0.34 - 0.4402
Vanadium	0 - 9	0	– - –	0.68 - 0.8803
Zinc	9 - 9	100	116.2 - 272.7	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Upland Chorus Frog Dataset 2010
North Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples			FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	3	-	11	27.3	43.07 - 56.68	30.94 - 38.2
Antimony	0	-	11	0	– - –	0.1074 - 0.14
Arsenic	2	-	11	18.2	0.4 - 0.8164	0.2257 - 0.5852
Barium	11	-	11	100	37 - 95.66	– - –
Beryllium	0	-	11	0	– - –	0.1373 - 0.57
Boron	0	-	11	0	– - –	3.223 - 4
Cadmium	8	-	11	72.7	0.089 - 0.2224	0.1268 - 0.1373
Calcium	11	-	11	100	37121 - 71222	– - –
Chromium	0	-	11	0	– - –	0.9776 - 1.2
Cobalt	7	-	11	63.6	0.1373 - 0.2494	0.1074 - 0.1278
Copper	11	-	11	100	10.2 - 25.3	– - –
Iron	10	-	11	90.9	121 - 167.5	93.24 - 93.24
Lead	0	-	11	0	– - –	0.2306 - 0.4096
Magnesium	11	-	11	100	1499 - 2417	– - –
Manganese	11	-	11	100	44.41 - 118	– - –
Mercury	0	-	11	0	– - –	0.08916 - 0.11
Molybdenum	3	-	11	27.3	0.29 - 0.4	0.2851 - 0.316
Nickel	0	-	11	0	– - –	0.752 - 0.93
Potassium	11	-	11	100	7680 - 11100	– - –
Selenium	11	-	11	100	1.1 - 2.709	– - –
Silver	1	-	11	9.09	0.05734 - 0.05734	0.02256 - 0.028
Sodium	11	-	11	100	4199 - 5887	– - –
Strontium	11	-	11	100	40.58 - 109.6	– - –
Thallium	1	-	11	9.09	0.34 - 0.34	0.1093 - 0.64
Vanadium	0	-	11	0	– - –	0.44 - 0.81
Zinc	11	-	11	100	104.8 - 173.6	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Upland Chorus Frog Dataset 2009
West Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	0 - 2	0	– - –	109.4 - 109.6
Antimony	0 - 2	0	– - –	0.4339 - 0.4362
Arsenic	1 - 2	50	1.745 - 1.745	0.4339 - 0.4339
Barium	2 - 2	100	59.47 - 68.1	– - –
Beryllium	0 - 2	0	– - –	0.4339 - 0.4362
Boron	0 - 2	0	– - –	8.725 - 8.798
Cadmium	0 - 2	0	– - –	0.4339 - 0.4362
Calcium	2 - 2	100	56285 - 67182	– - –
Chromium	0 - 2	0	– - –	0.4362 - 0.5183
Cobalt	0 - 2	0	– - –	0.4339 - 0.4362
Copper	2 - 2	100	30.83 - 33.87	– - –
Iron	2 - 2	100	150.7 - 207.9	– - –
Lead	1 - 2	50	1.381 - 1.381	0.5183 - 0.5183
Magnesium	2 - 2	100	1555 - 2094	– - –
Manganese	2 - 2	100	33.15 - 35.31	– - –
Mercury	0 - 2	0	– - –	0.08725 - 0.08798
Molybdenum	0 - 2	0	– - –	4.339 - 4.362
Nickel	0 - 2	0	– - –	0.4339 - 0.4362
Potassium	2 - 2	100	10269 - 12288	– - –
Selenium	2 - 2	100	1.808 - 1.89	– - –
Silver	1 - 2	50	0.3977 - 0.3977	0.2181 - 0.2181
Sodium	2 - 2	100	5689 - 6209	– - –
Strontium	2 - 2	100	54.39 - 67.61	– - –
Thallium	0 - 2	0	– - –	0.4339 - 0.4362
Vanadium	0 - 2	0	– - –	0.8725 - 0.8798
Zinc	2 - 2	100	144.6 - 219.6	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

Upland Chorus Frog Dataset 2010
West Embayment
Tennessee Valley Authority (TVA)
Kingston Ash Recovery Project

Constituent	Frequency of Detection (FOD) [a] Number of Detects / Number of Samples	FOD %	Detected Concentrations (mg/kg dw) Min - Max	Detection Limits (mg/kg dw) Min - Max
Aluminum	0 - 11	0	– - –	30.68 - 36.19
Antimony	0 - 11	0	– - –	0.1079 - 0.1341
Arsenic	0 - 11	0	– - –	0.2155 - 0.9061
Barium	11 - 11	100	41.98 - 105.7	– - –
Beryllium	0 - 11	0	– - –	0.4618 - 0.5456
Boron	0 - 11	0	– - –	3.181 - 3.786
Cadmium	5 - 11	45.5	0.1402 - 0.1747	0.1231 - 0.1402
Calcium	11 - 11	100	39642 - 66590	– - –
Chromium	0 - 11	0	– - –	0.9749 - 1.186
Cobalt	10 - 11	90.9	0.1283 - 0.4314	0.1214 - 0.1214
Copper	11 - 11	100	4.496 - 15.39	– - –
Iron	10 - 11	90.9	99.13 - 226	107.3 - 107.3
Lead	2 - 11	18.2	0.524 - 0.6086	0.2157 - 0.431
Magnesium	11 - 11	100	1581 - 2282	– - –
Manganese	11 - 11	100	50.72 - 161.6	– - –
Mercury	3 - 11	27.3	0.1201 - 0.1528	0.08825 - 0.1047
Molybdenum	0 - 11	0	– - –	0.2668 - 0.3229
Nickel	0 - 11	0	– - –	0.7491 - 0.8831
Potassium	11 - 11	100	7607 - 9905	– - –
Selenium	11 - 11	100	0.8686 - 2.511	– - –
Silver	3 - 11	27.3	0.02838 - 0.04258	0.02258 - 0.02575
Sodium	11 - 11	100	4283 - 5975	– - –
Strontium	11 - 11	100	34.85 - 117.6	– - –
Thallium	0 - 11	0	– - –	0.1026 - 0.123
Vanadium	0 - 11	0	– - –	0.3489 - 0.4148
Zinc	11 - 11	100	96.36 - 283.2	– - –

– - Not detected/not analyzed/not applicable.
mg/kg dw - Milligram per kilogram dry weight.
[a] - Frequency of detection (FOD) = number of detects / total number of samples analyzed.

ARCADIS

Appendix B

Raw Data

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010
Aluminum	<33.7	<33.45	<34.9	385	<31.1	<33	<38.3	<41	354	2340
Antimony	<0.12	<0.1232	<0.13	<0.13	<0.11	<0.12	<0.14	<0.15	<0.14	<0.13
Arsenic	0.32 J	<0.2369	<0.24	<0.25	<0.22	0.87	0.51 J	<0.29	<0.27	1.1
Barium	59.8	53.63	52.3	50	68.2	115	43.9	86.7	50.1	47
Beryllium	<0.5	<0.5022	<0.52	<0.53	<0.46	<0.48	<0.57	<0.61	<0.57	<0.53
Boron	<3.5	<3.506	<3.6	<3.7	<3.2	<3.4	<4	<4.2	<3.9	<3.7
Cadmium	0.14 J	<0.1137	<0.11	<0.097	<0.095	<0.127	0.23 J	<0.081	<0.097	<0.11
Calcium	85200	48801	47000	35200	57500	50500	39900	59600	39500	34800
Chromium	<1.1	<1.042	<1.1	<1.1	<0.98	<1	<1.2	<1.3	<1.2	5.2 J
Cobalt	0.13 J	0.2464 J	0.21 J	0.32 J	0.16 J	<0.12	0.29 J	<0.14	0.28 J	1.3
Copper	4.1	<3.411	4.7	5.3	8.5	6.1	7.4	5.1	<3.6	6.9
Iron	247	127 J	143 J	356	192	156 J	169 J	151 J	323	1770
Lead	1.7	<0.379	<0.5	0.75 J	<0.4	0.63 J	0.57 J	0.86 J	0.61 J	3.1
Magnesium	2330	1526	1400	1280	1660	1570	1660	1780	1510	1480
Manganese	123 J	70.03 J	69 J	51.1 J	75.9 J	68.2 J	37.2 J	58.7 J	71.3 J	227 J
Mercury	<0.097	<0.09476	<0.1	<0.1	<0.09	<0.095	<0.11	<0.12	<0.11	<0.1
Molybdenum	<0.3	<0.2938	<0.31	<0.31	<0.27	<0.29	<0.34	<0.36	<0.33	<0.31
Nickel	<0.82	<0.8149	<0.85	<0.86	<0.76	<0.81	<0.94	<1	<0.93	2.4 J
Potassium	10000	9760	8050	9410	8430	8000	10000	10700	9370	9660
Selenium	1.9	1.611	1.6 J	1.2 J	1.4 J	1.1 J	1.6 J	1.6 J	1.5 J	1.7
Silver	<0.024	<0.02464	<0.025	<0.025	<0.022	<0.024	<0.028	<0.03	<0.027	<0.026
Sodium	5930	6368	3880	4980	3520	3760	5600	6360	5640	5180
Strontium	121 J	41.41 J	66.1 J	37.5 J	52.8 J	68 J	39.3 J	81.8 J	36.8 J	34.2 J
Thallium	<0.12	<0.1137	<0.12	<0.12	<0.11	<0.11	<0.13	<0.14	<0.13	<0.12
Vanadium	<0.38	<0.379	<0.4	<0.4	<0.35	<0.38	<0.44	<0.47	<0.48	3.8
Zinc	130 J	102.3 J	107 J	125 J	111 J	107 J	142 J	135 J	107 J	180 J

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Rocky Top Farm 3/31/2010	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009
Aluminum	<35.84	<108.3	<108.1	409.5 J	118.6 J	1430 J	254 J	<109.5	142 J	<109.4	287.3 J
Antimony	<0.1249	<0.4332	<0.4365	<0.4365	<0.429	<0.39	<0.47	<0.4346	<0.39	<0.4339	<0.4387
Arsenic	0.3497 J	2.491	0.9042	3.638	6.48	0.71	1.6	1.997	2.2	1.321	2.495
Barium	102.7	106.3	126.8	74.31	108.6	87.1	53	60.5	113	80.74	68.13
Beryllium	<0.2623	<0.4332	<0.4365	<0.4365	<0.429	<0.39	<0.47	<0.4346	<0.39	<0.4339	<0.4387
Boron	<3.747	<8.664	<8.626	<8.73	<8.67	<7.9	<9.4	<8.81	<7.9	<8.772	<8.775
Cadmium	<0.07743	<0.4332	0.4469	<0.4365	<0.429	<0.39	<0.47	<0.4346	<0.39	<0.4339	<0.4387
Calcium	58574	66819	91770	77428	64160	36600	64600	91859	74100	63385	56175
Chromium	<1.137	<1.083	<0.4365	<1.247	<0.6297	18.4 J	<0.78	<0.4346	<0.8	<0.5659	<1.204
Cobalt	0.1998 J	<0.4332	<0.4365	0.634 J	<0.429	0.61 J	<0.47	<0.4346	<0.39	<0.4339	<0.4387
Copper	4.746	8.555	<4.885	9.25	9.766	<5	12.1	<6.931	11.2	<4.528	8
Iron	147.4 J	274 J	171.5 J	497.8 J	358.7 J	1470 J	355 J	223.2 J	277 J	255.6 J	515.3 J
Lead	<0.4121	0.8447	0.5924	1.559	0.6662	1.2	2.1	0.5638	0.96	<0.4339	1.376
Magnesium	2398	1754 J	2141 J	1975 J	1771 J	2390 J	1710 J	1856 J	1740 J	1651 J	1807 J
Manganese	93.92	72.13 J	106 J	115.4 J	48.55 J	52.6 J	108 J	60.97 J	67.6 J	99.04 J	126.5 J
Mercury	<0.1037	0.1191 J	<0.08626	<0.0873	<0.0867	<0.079	<0.094	<0.0881	<0.079	<0.08772	<0.08603
Molybdenum	<0.3122	<4.332	<4.365	<4.365	<4.29	<3.9	<4.7	<4.346	<3.9	<4.339	<4.387
Nickel	<0.8742	<0.6498	<0.4365	0.9562 J	<0.5293	8.7 J	<0.6	<0.4346	<0.63	<0.7452	0.9463 J
Potassium	8193	9747	9260	9666	9054	8170	9360	9409	9090	8508	8947
Selenium	2.248	2.274	1.663	1.975	1.734	1.2	2.3	0.8928 J	1.9	1.603	1.807
Silver	<0.02623	<0.2166	<0.2183	<0.2183	<0.219	<0.2	<0.24	<0.2232	<0.2	<0.2169	<0.2151
Sodium	5433	5675	5810	5654	5084	4580	6700	5744	5060	6527	5901
Strontium	86.3 J	149.4 J	172.5 J	124.7 J	72.28 J	67 J	107 J	81.64 J	97.5 J	96.21 J	86.89 J
Thallium	<0.1236	<0.4332	<0.4365	<0.4365	<0.429	<0.39	<0.47	<0.4346	<0.39	<0.4339	<0.4387
Vanadium	<0.4121	<0.8664	<0.8626	1.247	<0.867	1.4	<0.94	<0.881	<0.79	<0.8772	1.032
Zinc	254.8	123.5	134.1	114.3	119.6	90	105	110.2	110	101.9	107.5

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Timberlake 4/6/2010	Timberlake 4/6/2010	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009
Aluminum	75.7 J	236	<106	<104	<96.8	<117	<96.6	<89.6	<107
Antimony	<0.13	<0.11	<0.42	<0.41	<0.39	<0.47	<0.39	<0.36	<0.43
Arsenic	<0.24	0.29 J	<0.42	<0.41	<0.39	<0.47	<0.39	<0.36	<0.43
Barium	94.5	123	61.5	74.4	46.4	50.7	58.4	31.5	66.9
Beryllium	<0.52	<0.45	<0.42	<0.41	<0.39	<0.47	<0.39	<0.36	<0.43
Boron	<3.6	<3.1	<8.5	<8.3	<7.7	<9.4	<7.7	<7.2	<8.6
Cadmium	0.28 J	0.21 J	<0.42	<0.41	<0.39	<0.47	<0.39	<0.36	<0.43
Calcium	64900	83500	64800	90300	48500	80100	57800	36200	70900
Chromium	<1.1	<0.96	<0.42	<0.66	<0.39	<0.47	<0.39	<0.73	<0.43
Cobalt	0.48 J	0.48 J	<0.42	<0.41	<0.39	<0.47	<0.39	<0.36	<0.43
Copper	4.9	7.2	<4.2	<4.7	<4.8	<6.5	9.4	<5.2	10.4
Iron	243	342	121	260	125	<117	145	137	149
Lead	<0.5	<2.2	0.67	1.1	0.43	1	<0.39	<0.36	<0.43
Magnesium	1570	2380	1350	1940	1190	1930	1590	990	1890
Manganese	138	162	22.2 J	105 J	24.6 J	128 J	19.4 J	15.4 J	56 J
Mercury	<0.1	0.12 J	<0.085	<0.083	0.085 J	0.097 J	<0.077	<0.072	0.11 J
Molybdenum	<0.31	<0.27	<4.2	<4.1	<3.9	<4.7	<3.9	<3.6	<4.3
Nickel	<0.85	<0.74	<0.42	<0.41	<0.39	<0.47	<0.39	<0.44	<0.43
Potassium	9310	8810	7480	8810	6710	8600	7870	6320	8240
Selenium	1.5 J	1.8	0.96	1.7	1.1	2.3	0.94	0.93	1.9
Silver	0.025 J	0.029 J	<0.21	<0.21	<0.19	<0.23	<0.19	<0.18	<0.21
Sodium	4980	5580	<4200	5680	<3960	5290	4780	4080	5750
Strontium	86.2	119	57.7	93.7	42.9	133	63.8	54.9	79.5
Thallium	<0.12	<0.1	<0.42	<0.41	<0.39	<0.47	<0.39	<0.36	<0.43
Vanadium	<0.4	<0.34	<0.85	<0.83	<0.77	<0.94	<0.77	<0.72	<0.86
Zinc	119	186	108	140	96.7	127	102	80	125

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/24/2010	North Embayment 3/24/2010	North Embayment 3/24/2010	North Embayment 3/24/2010	North Embayment 3/24/2010	North Embayment 3/24/2010
Aluminum	<108	<103	<105	312	<33.4	<43.3	<38.2	<36.3	54.5 J
Antimony	<0.43	<0.41	<0.42	<0.11	<0.12	<0.16	<0.14	<0.13	<0.12
Arsenic	<0.43	<0.41	<0.42	1.8	0.27 J	0.88 J	1.1	0.64 J	0.97
Barium	59.4	86	126	145 J	98.9 J	199 J	96.1 J	45.1 J	60.2 J
Beryllium	<0.43	<0.41	<0.42	<0.44	<0.5	<0.65	<0.57	<0.54	<0.51
Boron	<8.6	<8.2	<8.4	<3.1	<3.5	<4.5	<4	<3.8	<3.5
Cadmium	<0.43	<0.41	<0.42	0.29 J	<0.098	<0.15	0.21 J	0.23 J	0.25 J
Calcium	111000	67500	78000	53000	54700	88200	54300	47400	67100
Chromium	<0.43	<0.41	<0.67	1 J	<1.1	<1.4	<1.2	<1.2	<1.1
Cobalt	<0.43	<0.41	<0.42	0.39 J	0.56 J	0.31 J	0.21 J	0.18 J	0.24 J
Copper	<3.9	6.8	<5.8	4.6	4.4	11.3	<4.3	5.1	15.4
Iron	<108	130	<105	379	138 J	205 J	144 J	137 J	189 J
Lead	<0.43	<0.41	<0.42	1.1	1.1	0.88 J	0.61 J	<0.44	0.92
Magnesium	2600	1720	1770	1570	1460	2420	1640	1600	1730
Manganese	65.9 J	52.4 J	39.8 J	99.6 J	69.7 J	122 J	180 J	43.9 J	28.8 J
Mercury	0.095 J	0.088 J	<0.084	<0.085	<0.097	<0.13	<0.11	<0.11	<0.099
Molybdenum	<4.3	<4.1	<4.2	<0.26	<0.29	<0.38	<0.34	<0.32	<0.3
Nickel	<0.43	<0.41	<0.42	<0.72	<0.82	<1.1	<0.93	<0.89	<0.84
Potassium	8560	7870	8350	9320	9340	10500	10100	9450	8170
Selenium	1.6	1.4	1.2	2.9	0.92 J	2.1	2.3	2.1	1.4 J
Silver	<0.22	<0.21	<0.21	<0.021	<0.024	0.031 J	<0.028	0.049 J	<0.025
Sodium	6670	4760	6010	4850	5570	6660	5820	5140	5870
Strontium	101	93.6	90.1	106 J	82.7 J	161 J	147 J	95.6 J	64.6 J
Thallium	<0.43	<0.41	<0.42	<0.1	<0.12	<0.15	<0.13	<0.13	<0.12
Vanadium	<0.86	<0.82	<0.84	0.88 J	<0.38	<0.49	<0.44	<0.41	<0.39
Zinc	129	106	111	110	98.8	128	107	96	141

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	North Embayment 3/24/2010	North Embayment 3/24/2010	North Embayment 3/24/2010	North Embayment 3/24/2010	West Embayment 3/20/2009	West Embayment 3/20/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009
Aluminum	435	<33	1980	38.8 J	<109	<117	<184	253	378
Antimony	<0.14	<0.12	0.59 J	<0.13	<0.4395	<0.47	<0.74	<0.44	<0.4
Arsenic	0.96	0.93	25.9	1	<0.4395	<0.47	<0.74	<0.44	<0.4
Barium	75.2 J	108 J	157 J	32.8 J	98.47	46.7	23.6	105	59.6
Beryllium	<0.57	<0.49	<0.57	<0.55	<0.4395	<0.47	<0.74	<0.44	<0.4
Boron	<3.9	<3.4	<4	<3.8	<8.671	<9.4	<14.8	<8.7	<8
Cadmium	0.27 J	<0.068	<0.073	<0.09	<0.4395	<0.47	<0.74	<0.44	<0.4
Calcium	30100	69700	104000	64100	45254	59400	24600	121000	33200
Chromium	<1.2	<1	23.6 J	<1.2	<0.4395	<0.7	<0.74	1.6 J	0.64 J
Cobalt	0.45 J	0.14 J	2.2	0.14 J	<0.4395	<0.47	<0.74	<0.44	0.51 J
Copper	6.5	4.9	4.7	8	8.196	8.1	13.1	8.9	8.7
Iron	620	111 J	18600	183 J	<109	201 J	<184	236 J	400 J
Lead	1.8	<0.27	9.9	0.96	<0.4395	<0.47	<0.74	2.1	0.77
Magnesium	1260	1930	2640	1930	1699	1640	1180	2270	1230
Manganese	96.3 J	126 J	489 J	56.5 J	55.11 J	44.2 J	50.4 J	121 J	62.8 J
Mercury	<0.11	0.1 J	<0.11	<0.11	<0.08671	0.18 J	<0.15	0.14 J	0.1 J
Molybdenum	<0.33	<0.29	1 J	<0.33	<4.395	<4.7	<7.4	<4.4	<4
Nickel	<0.92	<0.81	1.3 J	<0.9	<0.4395	<0.47	<0.74	1.3 J	0.88 J
Potassium	9990	9050	11400	10100	9443	8060	6560	7020	8300
Selenium	1.8	2.3	2.2	2.1	1.176	3.3	2.3	2.5	1.7
Silver	<0.027	<0.024	<0.028	<0.027	<0.2138	<0.23	<0.37	<0.22	<0.2
Sodium	5250	5140	7520	6840	<3991	5830	<4810	6100	4840
Strontium	61.7 J	154 J	186 J	62 J	66.75	84.7	47 J	178 J	86.8 J
Thallium	<0.13	<0.11	<0.13	<0.13	<0.4395	<0.47	<0.74	<0.44	<0.4
Vanadium	0.92 J	<0.38	36.4	<0.42	<0.8671	<0.94	<1.5	<0.87	<0.8
Zinc	102	112	130	110	112.5 J	121 J	161 J	139 J	117 J

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010
Aluminum	182	192	289	121	<118	<101	72.9 J	36.4 J	47.8 J
Antimony	<0.39	<0.4	<0.54	<0.42	<0.47	<0.41	<0.11	<0.13	<0.13
Arsenic	<0.39	<0.4	<0.54	<0.42	<0.47	<0.41	<0.22	<0.24	<0.24
Barium	74.3	102	91.1	126	86.8	112	58 J	57.4 J	111 J
Beryllium	<0.39	<0.4	<0.54	<0.42	<0.47	<0.41	<0.23	<0.26	<0.26
Boron	<7.9	<8	<10.7	<8.3	<9.4	<8.1	<3.3	<3.6	<3.6
Cadmium	<0.39	<0.4	<0.54	<0.42	<0.47	<0.41	<0.095	0.27 J	0.15 J
Calcium	49600	58500	69300	61500	55200	77700	36800 J	74600 J	66300 J
Chromium	<0.7	<0.53	1.3 J	8.6 J	<0.47	<0.41	<1	<1.1	<1.1
Cobalt	<0.39	<0.4	<0.54	<0.42	<0.47	<0.41	0.45 J	0.25 J	0.29 J
Copper	9.6	7	12.1	7.2	8	<5.1	11.1	6.8	5.8
Iron	296 J	306 J	328 J	350 J	126 J	103	634	<146	<161
Lead	0.66	0.58	1	0.51	<0.47	<0.41	<0.26	0.69 J	0.82 J
Magnesium	1210	1660	1920	6710	1660	1630	1280	1860	1810
Manganese	170 J	174 J	137 J	79.7 J	81.5 J	89.5 J	50.5 J	97.1 J	98.5 J
Mercury	0.083 J	0.098 J	0.12 J	<0.083	<0.094	<0.081	<0.091	<0.1	0.13 J
Molybdenum	<3.9	<4	<5.4	<4.2	<4.7	<4.1	<0.28	<0.3	<0.31
Nickel	0.46 J	0.53 J	0.7 J	13.1 J	<0.47	<0.41	<0.77	<0.85	<0.85
Potassium	6910	7510	8740	7290	9840	7740	7970	8080	8530
Selenium	1.6	2	2	1.9	2.2	1.7	1.9	1.7	2.4
Silver	<0.2	<0.2	<0.27	<0.21	<0.24	<0.2	0.04 J	<0.025	<0.025
Sodium	4920	5850	7280	4330	6190	4680	4540	5360	5880
Strontium	94.5 J	150 J	111 J	107 J	127 J	206	96.5 J	129 J	121 J
Thallium	<0.39	<0.4	<0.54	<0.42	<0.47	<0.41	<0.11	<0.12	<0.12
Vanadium	<0.79	<0.8	<1.1	<0.83	<0.94	<0.81	<0.36	<0.4	<0.4
Zinc	106 J	126 J	146 J	111 J	109 J	116	101	111	119

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-1. American Toad 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010
Aluminum	169 J	<34.4	102 J	180 J	<35.9	<41.2	136 J
Antimony	<0.13	<0.12	<0.11	<0.13	<0.13	<0.15	<0.12
Arsenic	0.36 J	0.24 J	0.31 J	0.65 J	0.25 J	<0.29	0.29 J
Barium	45.1 J	94.5 J	81.8 J	68.7 J	50.5 J	63.2 J	87.9 J
Beryllium	<0.27	<0.25	<0.23	<0.27	<0.26	<0.3	<0.25
Boron	<3.8	<3.6	<3.3	<3.8	<3.7	<4.3	<3.6
Cadmium	<0.12	<0.065	0.17 J	0.23 J	<0.085	<0.11	0.17 J
Calcium	47700 J	113000 J	62400 J	42800 J	35800 J	38200 J	38200 J
Chromium	<1.2	<1.1	<1	<1.2	<1.1	<1.3	<1.1
Cobalt	0.23 J	0.32 J	0.27 J	0.23 J	0.16 J	0.24 J	0.31 J
Copper	5.6	<3.3	8	6.1	9.8	7	5.5
Iron	<241	<104	<265	<262	<172	<157	<240
Lead	0.74 J	1.5	0.64 J	0.69 J	<0.25	<0.29	0.41 J
Magnesium	1410	2510	1710	1450	1280	1510	1310
Manganese	38.7 J	173 J	54.2 J	61.5 J	19.3 J	65.5 J	76.2 J
Mercury	<0.11	<0.099	0.14 J	<0.11	<0.1	<0.12	<0.099
Molybdenum	<0.32	<0.3	<0.28	<0.32	<0.32	<0.36	<0.3
Nickel	<0.89	<0.84	<0.77	<0.9	<0.88	<1	<0.84
Potassium	9390	8880	8030	8610	9350	9480	8770
Selenium	1.4 J	1.9	2.3	1.9	3	2.4	2.2
Silver	<0.026	<0.025	0.047 J	0.035 J	0.035 J	<0.03	<0.025
Sodium	5480	6630	4790	6000	5010	6810	4980
Strontium	42.1 J	241 J	153 J	54.9 J	53 J	95.1 J	94.5 J
Thallium	<0.13	<0.12	<0.11	<0.13	<0.12	<0.14	<0.12
Vanadium	<0.42	<0.39	<0.36	<0.42	<0.41	<0.47	<0.39
Zinc	96.4	120	131	106	84.9	85.3	104

Note:
Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake
mg/kg dw = milligrams per kilogram dry weight
J = estimated value
< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/26/2010	Dawson Farm 3/30/2010	Dawson Farm 3/30/2010
Aluminum	44.62 J	<35.92	<30.75	38.97 J	<35.48	<34.68	<34.85	<35.34	<35.16	<34.56	<35.59	<35.72
Antimony	<0.1259	<0.1293	<0.11	<0.128	<0.1279	<0.1234	<0.1225	<0.1223	<0.1268	<0.1307	<0.1294	<0.1268
Arsenic	<0.2487	0.3735 J	<0.2144	<0.2472	<0.2451	<0.2469	<0.245	<0.2445	<0.2421	<0.2376	<0.2481	<0.2536
Barium	43.68	44.39	30.47	25.59	38.57	56.11	31.4	28.12	44.15	87.9	92.44	25.36
Beryllium	<0.2643	<0.2586	<0.2257	<0.2617	<0.2664	<0.2581	<0.2561	<0.2568	<0.2652	<0.2494	<0.2589	<0.2642
Boron	<3.576	<3.735	<3.103	<3.635	<3.623	<3.591	<3.563	<3.668	<3.689	<3.563	<3.667	<3.699
Cadmium	<0.1119	0.2155 J	<0.1382	<0.07707	0.07885 J	<0.06621	<0.09242	<0.06725	<0.06686	<0.06533	<0.06795	<0.1004
Calcium	65137	64794	89142	69508	53701	50951	48884	46952	56720	51193	48429	56009
Chromium	<1.104	<1.135	<0.9873	<1.12	<1.172	<1.1	<1.102	<1.125	<1.118	<1.093	<1.079	<1.162
Cobalt	0.3731 J	0.158 J	0.3103 J	0.2908 J	0.1705 J	0.1796 J	0.1448 J	<0.1223	<0.1268	0.1307 J	0.1834 J	0.2853 J
Copper	14.15	12.79	15.52	20.07	8.311	9.315	7.906	9.17	7.493	12.95	4.638	7.609
Iron	419.7	195.4 J	349.8	382.4	149.2 J	180.7 J	125.8 J	138.2 J	138.3 J	131.8 J	186.6 J	167 J
Lead	<0.2487	<0.3592	<0.3667	<0.349	<0.2451	<0.2469	0.579 J	<0.2934	<0.2421	<0.4751	<0.2481	<0.2748
Magnesium	2721	2615	3554	2690	1811	1773	1815	1773	1741	1948	1693	2114
Manganese	189.7	148	115.1	154.1	68.72	37.15	59.24	58.57	103.4	84.33	110	41.85
Mercury	<0.101	<0.1034	0.09309 J	<0.1018	<0.1023	<0.09988	<0.1002	<0.1027	<0.1014	<0.09977	<0.1025	<0.1036
Molybdenum	<0.3109	<0.3161	0.2793 J	0.4217 J	<0.309	<0.303	<0.3118	<0.3057	<0.3113	<0.3088	<0.3128	<0.317
Nickel	<0.855	<0.8764	<0.7617	<0.8725	<0.8631	<0.8417	<0.8463	<0.8681	<0.8646	<0.8433	<0.8629	<0.8771
Potassium	11784	13936	19803	11371	9888	9618	9821	9268	9257	9775	8596	10885
Selenium	1.71	2.011	3.103	1.6 J	1.385 J	2.02	1.67	2.323	0.8646 J	1.307 J	0.9384 J	1.585 J
Silver	<0.02487	0.04454 J	0.02454 J	0.03781 J	<0.02557	<0.02469	<0.02561	0.0379 J	<0.02536	<0.02494	<0.02589	<0.02536
Sodium	4819	4784	9450	4886	4273	5129	4053	3937	3113	3932	4606	4766
Strontium	45.39	47.99	44.29	39.99	35.91	59.82	45.54	24.82	49.23	79.34	43.25	31.28
Thallium	<0.1197	<0.1236	<0.1072	<0.1221	<0.1172	<0.1234	<0.1225	<0.1223	<0.1268	<0.1188	<0.1186	<0.1268
Vanadium	<0.4042	<0.4023	<0.3385	<0.4072	<0.4049	<0.3928	<0.4009	<0.4035	<0.4035	<0.392	<0.4099	<0.4121
Zinc	155.5	137.9	194.6	123.2	100.1	105.9	98.44	92.56	113.8	125.9	204.9	125.8

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Dawson Farm 3/30/2010	Dawson Farm 4/1/2010	Dawson Farm 4/1/2010	Dawson Farm 4/8/2009	Dawson Farm 4/8/2009	Dawson Farm 4/8/2009	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010
Aluminum	<35.41	<26.1	64.1 J	<109	<108.9	<109	<35.98	<35.22	38.09 J	<34.18	54.58 J	69.78 J
Antimony	<0.1225	<0.094	<0.1	<0.4402	<0.4314	<0.436	<0.1289	<0.1253	<0.1326	<0.1233	<0.1249	<0.1326
Arsenic	<0.245	<0.18	<0.2	<0.4402	<0.4314	<0.436	<0.2478	<0.2507	<0.241	<0.2414	<0.2498	<0.2531
Barium	29.29	33.2	24	23.16	25.24	26.25	36.18	73.44	47.37	38.5	51.46	65.81
Beryllium	<0.2561	<0.39	<0.43	<0.4402	<0.4314	<0.436	<0.2676	<0.2632	<0.2531	<0.2541	<0.2623	<0.2652
Boron	<3.675	<2.7	<3	<8.699	<8.737	<8.72	<3.767	<3.634	<3.616	<3.558	<3.622	<3.736
Cadmium	<0.09799	<0.074	0.17 J	<0.4402	<0.4314	<0.436	<0.109	<0.07269	<0.08557	<0.06481	<0.07244	<0.0687
Calcium	58015	35800	39700	41502	35162	31972	52339	47499	38929	56929	47334	52910
Chromium	<1.114	<0.83	<0.9	<0.4402	<0.4314	<0.436	<1.19	<1.115	<1.109	<1.08	<1.124	<1.145
Cobalt	<0.1225	<0.092	0.18 J	<0.4402	<0.4314	<0.436	0.1289 J	0.1755 J	0.5183 J	0.1652 J	<0.1249	0.2531 J
Copper	9.131	7.3	31.4	10.79	9.6	<6.267	8.921	6.266	7.472	7.879	7.743	6.508
Iron	165.9 J	142 J	216	169.8	179	119.9	137.8 J	136.6 J	148.2 J	113.9 J	168.6 J	192.8 J
Lead	<0.245	<0.18	<0.35	<0.4402	<0.4314	<0.436	<0.2478	<0.2507	<0.241	3.177	<0.3122	<0.4459
Magnesium	1938	1180	1390	1698	1478	1381	1814	1880	1651	1944	1848	1784
Manganese	37.19	62.5 J	147 J	28.82	55.87	47.5	43.32	117.1	57.85	60.23	53.95	93.41
Mercury	<0.1024	<0.076	<0.083	<0.08699	<0.08737	<0.0872	<0.109	<0.1015	<0.1012	<0.09912	<0.1024	<0.1037
Molybdenum	<0.3118	<0.23	0.42 J	<4.402	<4.314	<4.36	<0.3172	<0.3133	<0.3134	<0.305	<0.3122	<0.3134
Nickel	<0.8686	<0.64	<0.7	<0.4402	<0.4314	<0.436	<0.8822	<0.8648	<0.8557	<0.8387	<0.8617	<0.8798
Potassium	9732	5950	7780	9118	9330	8656	8525	8811	8955	9022	8855	8111
Selenium	1.67	1.3	2	1.467	2.157	1.817	1.289 J	1.078 J	1.446 J	1.398 J	1.249 J	1.446 J
Silver	<0.02561	<0.019	0.058 J	<0.2201	<0.2157	<0.218	<0.02577	<0.02507	<0.02531	<0.02414	<0.02623	<0.02652
Sodium	4966	2840	3610	<3825	4789	<4214	4124	4186	4447	4257	4271	3652
Strontium	31.51	27.8 J	18 J	30.71	21.68	21.53	44.81	54.64	65.08	57.56	42.71	58.82
Thallium	<0.1225	<0.09	<0.098	<0.4402	<0.4314	<0.436	<0.1289	<0.1216	<0.1205	<0.1182	<0.1224	<0.1205
Vanadium	<0.4009	<0.3	<0.33	<0.8699	<0.8737	<0.872	<0.4064	<0.401	<0.3977	<0.3939	<0.3997	<0.4098
Zinc	119.1	87.8 J	106 J	96.73	78.74	75.84	105.1	145.4	88.83	141.1	137.4	100.3

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2010	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009
Aluminum	<34.53	67.02 J	<36.08	57.56 J	<108.7	<109.3	<109.8	<118	<108.7	<108.6	<108.6	<108.8
Antimony	<0.1203	<0.114	<0.1268	<0.1292	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.4333
Arsenic	0.2592 J	<0.2166	<0.2536	<0.2467	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.4333
Barium	132.4	77.16	102.4	75.53	11.18	59.75	49.2	110.8	119.3	39.68	43.94	36.25
Beryllium	<0.25	<0.2279	<0.2652	<0.2702	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.4333
Boron	<3.61	<3.305	<3.689	<3.759	<8.646	<8.693	<8.743	<9.441	<8.737	<8.631	<8.675	<8.666
Cadmium	<0.08887	0.1824 J	<0.06917	<0.0787	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.4333
Calcium	58971	38523	48073	45695	45422	38295	44460	36738	64676	46376	69401	46498
Chromium	<1.111	<1.003	<1.141	<1.139	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4507	2.959 J
Cobalt	0.2407 J	0.2621 J	0.1729 J	0.2114 J	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.4333
Copper	5.184	12.99	8.531	9.397	10.03	10.45	9.952	17.75	<5.967	9.533	7.323	7.82
Iron	<103.7	251.9	<108.6	156.2 J	156.8 J	132.1 J	116.3 J	162.1 J	111.9 J	193.2 J	142 J	127.9 J
Lead	0.648 J	0.6724 J	<0.2536	<0.3054	<0.4381	<0.4402	<0.4372	<0.4721	0.4795	<0.438	0.721	<0.4333
Magnesium	1963	1596	1706	1621	1752 J	1596 J	1702 J	1385 J	2056 J	1507 J	2039 J	1649 J
Manganese	70.45	132.2	81.39	108.5	15.79 J	32.02 J	42.88 J	44.23 J	98.77 J	19.07 J	67.49 J	21.88 J
Mercury	<0.1018	<0.09118	<0.1038	<0.1045	<0.08646	<0.08693	0.08929 J	<0.09441	<0.08737	<0.08631	<0.08675	<0.08666
Molybdenum	<0.3055	<0.2735	<0.3228	<0.3172	<4.381	<4.402	<4.372	<4.721	<4.369	<4.38	<4.394	<4.333
Nickel	<0.8424	<0.775	<0.8762	<0.881	<0.5188	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.5072
Potassium	7212	7978	8462	8340	9707	10135	9162	8877	9941	9430	9272	8972
Selenium	1.296 J	1.368 J	1.13 J	1.175 J	1.153 J	1.321 J	1.581	1.539	1.598	1.417	1.07 J	1.479
Silver	<0.025	0.02963 J	<0.02652	<0.02584	<0.219	<0.2201	<0.2232	<0.236	<0.2131	<0.219	<0.2141	<0.2219
Sodium	4666	4103	3654	3982	4542	4424	<4288	<4413	<4347	4869	4890	4903
Strontium	81.56	61.55	94.07	41.7	26.86 J	36.2 J	42.97 J	67.32 J	121.5 J	23.32 J	69.51 J	38.36 J
Thallium	<0.1203	<0.1094	<0.1268	<0.1292	<0.4381	<0.4402	<0.4372	<0.4721	<0.4369	<0.438	<0.4394	<0.4333
Vanadium	<0.3981	<0.3647	<0.415	<0.4111	<0.8646	<0.8693	<0.8743	<0.9441	<0.8737	<0.8631	<0.8675	<0.8666
Zinc	137.9	122	89.69	141	97.41	79.34	94.87	106.7	106.3	106.9	128.4	101.6

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Rocky Top Farm 3/26/2009	Rocky Top Farm 3/26/2009	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake 3/28/2010
Aluminum	<109.5	<109.8	<35.55	<35.46	<35.92	<35.72	<36.22	<34.91	<35.28	<35.32
Antimony	<0.4355	<0.4427	<0.1288	<0.1227	<0.1301	<0.1249	<0.1341	<0.1302	<0.1307	<0.1275
Arsenic	<0.4355	<0.4427	<0.2448	<0.2454	0.3904 J	<0.2498	<0.2571	<0.2485	<0.2494	<0.2423
Barium	35.44	23.81	106.1	91.79	34.74	47.08	69.2	47.22	61.41	95.76
Beryllium	<0.4355	<0.4427	<0.541	<0.5276	<0.5335	<0.5245	<0.5366	<0.5207	<0.5345	<0.5355
Boron	<8.709	<8.734	<3.736	<3.681	<3.774	<3.747	<3.801	<3.669	<3.682	<3.698
Cadmium	<0.4355	<0.4427	<0.07729	<0.1166	<0.07808	<0.06744	<0.07714	<0.06627	<0.0974	0.1275 J
Calcium	44151	49894	49983	49328	35135	44461	46617	41774	52856	63500
Chromium	<0.4355	<0.6581	<1.121	<1.129	<1.145	<1.137	29.74 J	<1.101	<1.117	<1.122
Cobalt	<0.4355	<0.4427	0.2834 J	0.6013 J	0.2472 J	0.2748 J	0.1789 J	0.2367 J	0.5701 J	0.6248 J
Copper	13.43	8.136	7.729	11.9	10.02	6.619	7.266	6.272	5.82	32.77
Iron	194.7 J	183.1 J	201 J	175.5 J	213.4 J	161.1 J	127.4 J	124.3 J	123.5 J	417
Lead	<0.4355	<0.4427	<0.3478	<0.2454	<0.2472	<0.3497	<0.2571	<0.2603	<0.487	<0.4973
Magnesium	1476 J	1639 J	1894	1706	1510	1699	1968	1550	1770	1900
Manganese	27.34 J	21.42 J	61.45	48.35	29.28	36.47	118.5	103.4	68.3	92.7
Mercury	<0.08709	<0.08734	<0.1031	<0.1018	<0.1041	<0.1037	<0.1051	<0.1006	<0.1021	<0.102
Molybdenum	<4.355	<4.427	<0.3092	<0.3068	<0.3123	<0.3122	<0.313	<0.3077	<0.3088	<0.306
Nickel	<0.4355	<0.5504	<0.8631	<0.859	<0.8719	<0.8742	<0.8831	<0.8521	<0.8671	<0.8671
Potassium	9326	8699	9778	8835	9656	9454	11291	9077	9455	9372
Selenium	1.814	1.149 J	1.159 J	1.472 J	1.288 J	1.249 J	0.9614 J	1.538 J	1.188 J	1.658
Silver	<0.2177	<0.2154	<0.02576	<0.02577	<0.02603	<0.02623	<0.02571	<0.02485	<0.02494	0.08543 J
Sodium	4766	4690	3955	4577	4203	4484	4762	4414	3943	4374
Strontium	29.27 J	24.53 J	71.24	48.71	27.98	34.84	57.57	30.65	49.41	52.79
Thallium	<0.4355	<0.4427	<0.1224	<0.1215	<0.1236	<0.1224	<0.123	<0.1183	<0.1188	<0.1211
Vanadium	<0.8709	<0.8734	<0.3993	<0.4049	<0.4164	<0.4121	1.677 J	<0.4024	<0.4038	<0.408
Zinc	102.2	144.8	108.6	125.2	108.9	108.2	103.1	109.2	101.4	140.3

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Timberlake 3/28/2010	Timberlake 3/28/2010	Timberlake.01 4/9/2009	Timberlake.02 4/9/2009	Timberlake.03 4/9/2009	Timberlake.04 4/9/2009	Timberlake.05 4/9/2009	Timberlake.06 4/9/2009	Timberlake.07 4/9/2009
Aluminum	<33.26	<34.91	<109.2	<108.4	<108.2	<123.2	<108.6	<109	<108.1
Antimony	<0.1198	<0.1302	<0.4328	<0.4364	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Arsenic	<0.2298	<0.2485	<0.4328	<0.4364	<0.4328	<0.4906	0.6629	<0.4414	<0.4303
Barium	25.64	117.5	58.12	40.89	63.59	103	45.06	100.2	41.5
Beryllium	<0.4959	<0.5207	<0.4328	<0.4364	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Boron	<3.387	<3.669	<8.76	<8.728	<8.657	<9.931	<8.742	<8.712	<8.703
Cadmium	0.121 J	<0.06627	<0.4328	<0.4364	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Calcium	47175	54437	47818	46169	52147	41519	53415	61679	37966
Chromium	<1.052	<1.101	<0.4741	<0.4479	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Cobalt	0.1572 J	0.2012 J	<0.4328	<0.4364	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Copper	8.225	17.63	19.89 J	9.073 J	19.17 J	25.01 J	7.301 J	14.17 J	7.938 J
Iron	125.8 J	184.6 J	265.9	127.5	170	390.1	123	234.6	126.2
Lead	<0.2298	<0.4142	0.5462	<0.4364	<0.4328	<0.4906	<0.4323	0.5111	<0.4303
Magnesium	1851	1645	1731	1757	1731	1555	2008	1917	1731
Manganese	34.35	75.38	67.4	26.3	50.91	47.86	66.58	96.41	32.99
Mercury	<0.09556	<0.1006	0.09687 J	<0.08728	0.09172 J	0.1137 J	<0.08742	<0.08712	<0.08703
Molybdenum	<0.2903	<0.3077	<4.328	<4.364	<4.328	<4.906	<4.323	<4.414	<4.303
Nickel	<0.8104	<0.8521	<0.4328	<0.4364	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Potassium	10378	9065	7770	9119	8616	8507	9703	9966	9659
Selenium	1.331 J	1.302 J	2.061	1.045	1.34	2.034	0.9607	1.626	1.626
Silver	<0.02419	0.03314 J	<0.2164	<0.2182	<0.2164	<0.2513	<0.221	<0.2207	<0.22
Sodium	4270	4379	5132	<4812	<4040	5025	4727	5018	<4313
Strontium	27.46	55.62	40.3	39.39	41.94	32.78	42.27	54.48	38.83
Thallium	<0.1149	<0.1183	<0.4328	<0.4364	<0.4328	<0.4906	<0.4323	<0.4414	<0.4303
Vanadium	<0.375	<0.4024	<0.876	<0.8728	<0.8657	<0.9931	<0.8742	<0.8712	<0.8703
Zinc	110.8	112.8	106.1 J	86.37 J	87.39 J	156.7 J	121 J	125.4 J	80.43 J

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Timberlake.08 4/9/2009	Timberlake.09 4/9/2009	Timberlake.10 4/9/2009	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 4/5/2010	North Embayment 4/5/2010
Aluminum	<109.1	<108.9	<109	<32.06	<35.92	<35.22	<33.41	116.9 J	187.1 J
Antimony	<0.4382	<0.4314	<0.44	<0.1191	<0.1326	<0.1236	<0.1226	<0.1234	<0.1293
Arsenic	<0.4382	<0.4314	<0.44	<0.2274	<0.2531	<0.2472	<0.235	0.734 J	0.7841 J
Barium	28.82	35.59	65.3	83.28	56.16	43.75	39.14	118.1	64.93
Beryllium	<0.4382	<0.4314	<0.44	<0.2383	<0.2652	<0.2595	<0.2452	<0.5004	<0.5365
Boron	<8.667	<8.737	<8.7	<3.357	<3.736	<3.707	<3.474	<3.503	<3.714
Cadmium	<0.4382	<0.4314	<0.44	<0.1191	<0.1446	<0.1236	<0.1431	0.1234 J	<0.09354
Calcium	50248	42497	51400	38662	42424	40658	57631	61554	52821
Chromium	<0.4382	<0.5069	<0.44	<1.018	<1.145	<1.112	<1.022	<1.084	<1.142
Cobalt	<0.4382	<0.4314	<0.44	0.1191 J	0.1446 J	<0.1236	0.1124 J	0.3503 J	0.3026 J
Copper	10.61 J	11.97 J	31.1 J	11.37	12.29	11.62	7.868	13.18	12.93
Iron	132.4	207.1	424	175.4 J	169.9 J	155.7 J	<100.5	335.3	320.5
Lead	<0.4382	<0.4314	<0.44	<0.2274	<0.2531	<0.2472	<0.2963	<0.417	<0.4264
Magnesium	1879	1683	1790	1657	1615	1817	2136	2486	1940
Manganese	40.8	56.3	95.6	51.87	50.26	63.27	64.38	218.5	155.4
Mercury	<0.08667	<0.08737	0.12 J	<0.09314	<0.1037	<0.1013	<0.09707	<0.09842	<0.1032
Molybdenum	<4.382	<4.314	<4.4	<0.2816	<0.3134	<0.309	<0.2963	0.4003 J	0.4814 J
Nickel	<0.4382	<0.4314	<0.44	<0.7797	<0.8798	<0.8651	<0.8175	<0.8341	<0.8803
Potassium	9514	9222	8150	8339	8702	9899	9820	15347	12132
Selenium	1.363	1.51	2.2	0.9963 J	2.049	1.359 J	1.737	1.835	1.926
Silver	<0.2142	<0.2157	<0.22	<0.02274	<0.02652	<0.02595	<0.02452	<0.02502	<0.02614
Sodium	<4178	4757	5140	4180	4640	4424	4629	7006	5310
Strontium	52.88	39.15	44.6	49.06	49.17	51.29	58.55	86.41	53.78
Thallium	<0.4382	<0.4314	<0.44	<0.1083	<0.1205	<0.1211	<0.1124	<0.1168	<0.2338
Vanadium	<0.8667	<0.8737	<0.87	<0.7581	<0.8196	<0.7909	<0.7562	<0.3837	<0.4127
Zinc	93.19 J	84.35 J	137 J	123.5	182	123	121.6	158.3	147.2

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte	Location: / Sample Date:	North Embayment 4/5/2010	West Embayment 3/22/2010	West Embayment 3/22/2010	West Embayment 3/22/2010	West Embayment 3/22/2010	West Embayment 3/22/2010	West Embayment 3/22/2010	West Embayment 3/22/2010	West Embayment 3/22/2010
Aluminum		<34.42	<36.27	<36.24	<36.09	<36.25	<36.2	<36.21	<36.12	<36.09
Antimony		<0.1279	<0.1303	<0.1308	<0.1364	<0.1316	<0.1284	<0.1305	<0.1311	<0.1245
Arsenic		<0.2451	<0.2517	<0.2589	<0.248	<0.2513	<0.2568	<0.2501	<0.2503	<0.2489
Barium		74.8	111.6	122.3	88.42	113.7	97.06	45.56	87.38	85.87
Beryllium		<0.5114	<0.5329	<0.545	<0.5457	<0.5384	<0.5392	<0.5437	<0.5365	<0.5227
Boron		<3.516	<3.701	<3.815	<3.721	<3.709	<3.723	<3.697	<3.696	<3.734
Cadmium		<0.09057	<0.1392	0.3406 J	<0.07317	0.1795 J	<0.1412	<0.1392	<0.1431	0.2738 J
Calcium		64143	52848	54498	46507	62218	66760	48930	40294	61854
Chromium		<1.066	<1.155	<1.144	<1.141	<1.149	<1.143	<1.196	<1.144	<1.145
Cobalt		0.1705 J	0.2221 J	0.2725 J	0.124 J	0.3231 J	0.1669 J	0.1305 J	0.1788 J	0.6098 J
Copper		<4.049	11.1	27.11	33.24	14	11.55	9.677	7.987	43.31
Iron		120.4 J	216.1 J	532.7	302.6	169.9 J	164.3 J	153.3 J	129.9 J	470.4
Lead		<0.2983	<0.2517	0.7493 J	<0.2976	0.5624 J	<0.4108	<0.2501	<0.2503	<0.4107
Magnesium		2174	2280	2139	1761	2477	2285	1783	1955	2128
Manganese		99.62	36.12	159.4	47.62	72.15	108	59.15	90.48	90.6
Mercury		<0.09909	0.1243 J	0.1635 J	<0.1042	0.1555 J	<0.1053	<0.1044	<0.1037	0.1991
Molybdenum		<0.2983	<0.3257	0.3815 J	<0.3224	<0.3231	<0.321	<0.3153	<0.3219	0.448 J
Nickel		<0.8417	<0.8882	<0.8856	<0.8805	<0.8854	<0.8859	<0.8807	<0.8822	<0.8836
Potassium		10314	13160	11022	8284	9799	8974	9362	9907	10006
Selenium		1.598 J	3.849	3.134	1.86	2.273	1.22 J	1.957	1.061 J	3.858
Silver		<0.02451	<0.02665	0.09265 J	0.05829 J	0.0359 J	<0.02568	<0.0261	<0.02623	0.08961 J
Sodium		4060	6736	5586	3931	4248	4481	4969	4339	6011
Strontium		57.43	78.9	73.3	87.56	102.7	132.2	52.52	81.78	70.32
Thallium		<0.1172	<0.1243	<0.1253	<0.124	<0.1197	<0.1245	<0.1196	<0.1192	<0.1245
Vanadium		<0.3942	<0.4145	<0.4087	<0.4093	<0.4188	<0.4108	<0.4132	<0.4172	<0.4107
Zinc		108.7	121.4	179.8	104.9	132.8	127.4	97.21	120.4	156.8

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/20/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009
Aluminum	<36.19	<33.11	<33.03	<108	<109.5	<76.3	<108.4	<108.6	<108.2
Antimony	<0.1357	<0.1167	<0.1244	<0.4362	<0.4402	<0.31	<0.4301	<0.441	<0.4278
Arsenic	<0.2488	<0.2334	<0.2262	<0.4362	<0.4402	<0.31	<0.4301	<0.441	<0.4278
Barium	64.24 J	74.07 J	42.75 J	94.86	123.5	47.1	64.52	46.55	110
Beryllium	<0.2714	<0.2441	<0.2488	<0.4362	<0.4402	<0.31	<0.4301	<0.441	<0.4278
Boron	<3.732	<3.396	<3.393	<8.624	<8.803	<6.1	<8.603	<8.656	<8.693
Cadmium	<0.1086	<0.06261	<0.06334	<0.4362	<0.4402	<0.31	<0.4301	<0.441	<0.4278
Calcium	55985 J	55391 J	47276 J	63738	52821	41300	61079	36093	62648
Chromium	<1.131	<1.051	<1.052	<0.4362	<0.763	<7.7	<0.499	<0.441	<3.588
Cobalt	0.2036 J	0.1592 J	0.147 J	<0.4362	<0.4402	<0.31	<0.4301	<0.441	0.5658 J
Copper	7.125	9.02	8.03	8.525	37.56	22.1	31.49	46.87	33.95
Iron	<268	<124.2	<237.5	174.5 J	338.9 J	247 J	258.1 J	359.3 J	302.2 J
Lead	<0.2488	<0.2441	<0.2262	0.7434	<0.763	<7.7	<0.499	0.9472	<3.588
Magnesium	2183	2112	1798	1695	2142	1430	2254	1491	1849
Manganese	47.05 J	63.67 J	42.98 J	85.94 J	67.2 J	40.8 J	57.47 J	62.71 J	80.31 J
Mercury	<0.1052	<0.0955	<0.095	0.09021 J	<0.08803	<0.061	0.1187 J	0.1192 J	0.1794 J
Molybdenum	<0.3167	<0.2865	<0.2941	<4.362	<4.402	<3.1	<4.301	<4.41	<4.278
Nickel	<0.8822	<0.8065	<0.803	<0.4362	<0.4402	<0.31	<0.4301	<0.441	<0.4278
Potassium	10609	9953	9093	9149	12354	8090	12629	10942	10805
Selenium	1.47 J	1.379 J	1.244 J	1.487	2.641	1.7	2.065	2.613	2.346
Silver	<0.02601	<0.02441	<0.02375	<0.2181	0.3668	0.36	0.3441	0.4083	0.5658
Sodium	5112	4605	4897	4946	5854	4350	6228	6141	6072
Strontium	68.88 J	112.5 J	44.79 J	124.9	117.8 J	51.9 J	77.94 J	47.69 J	80.72 J
Thallium	<0.1244	<0.1167	<0.1131	<0.4362	<0.4402	<0.31	<0.4301	<0.441	<0.4278
Vanadium	<0.4185	<0.382	<0.3732	<0.8624	<0.8803	<0.61	<0.8603	<0.8656	<0.8693
Zinc	103.9	103.5	104.7	136.8 J	136.9 J	106 J	129.9 J	115.8 J	143.5 J

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-2. Spring Peeper 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009	West Embayment 3/26/2009
Aluminum	<109.1	<80.1	<75.5	<78.1	<108.4
Antimony	<0.4339	<0.32	<0.3	<0.31	<0.4284
Arsenic	<0.4339	<0.32	<0.3	<0.31	<0.4284
Barium	72.31	41.5	39.6	61.7	64.54
Beryllium	<0.4339	<0.32	<0.3	<0.31	<0.4284
Boron	<8.678	<6.4	<6	<6.3	<8.71
Cadmium	<0.4339	<0.32	<0.3	<0.31	<0.4284
Calcium	35072	32300	42300	54300	49978
Chromium	<0.4339	<0.39	<1.1	<0.35	2.285 J
Cobalt	0.6026 J	<0.32	<0.3	<0.31	<0.4284
Copper	23.38	25.4	24.7	14.1	25.85
Iron	174.8 J	189 J	179 J	147 J	212.8 J
Lead	<0.4339	<0.39	<1.1	0.48	0.5712
Magnesium	1989	1390	1330	1820	1899
Manganese	31.1 J	40.4 J	42.3 J	87.7 J	65.11 J
Mercury	<0.08678	<0.064	<0.06	<0.063	0.1057 J
Molybdenum	<4.339	<3.2	<3	<3.1	<4.284
Nickel	<0.4339	<0.32	<0.3	<0.31	<0.4284
Potassium	10136	7510	6580	8630	12395
Selenium	2.893	2.1	1.2	1.5	2.428
Silver	0.6147	0.63	0.27	<0.16	0.2999
Sodium	5255	4200	<2940	5350	5198
Strontium	65.57 J	54.4 J	30.4 J	54.5 J	43.98 J
Thallium	<0.4339	<0.32	<0.3	<0.31	<0.4284
Vanadium	<0.8678	<0.64	<0.6	<0.63	<0.871
Zinc	168.7 J	97.5 J	100 J	118 J	115.5 J

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-3. Upland Chorus Frog 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Dawson Farm 3/30/2010	Dawson Farm 3/30/2010	Dawson Farm 3/30/2010	Dawson Farm 4/1/2010	Rocky Tap Farm 3/30/2010	Rocky Tap Farm 3/31/2010	Rocky Tap Farm 3/31/2010	Rocky Tap Farm 3/31/2010	Rocky Tap Farm 3/31/2010	Rocky Tap Farm 3/31/2010	Rocky Tap Farm 3/31/2010	Rocky Tap Farm 3/31/2010
Aluminum	<34.1	<34.11	<36.11	<27.5	<35.74	<34.01	<34.48	<35.52	<33.13	<34.52	<34.44	<35.74
Antimony	<0.1263	<0.1218	<0.1252	<0.099	<0.1268	<0.1268	<0.1239	<0.13	<0.1179	<0.1249	<0.1259	<0.1336
Arsenic	0.2526 J	<0.2437	<0.2505	<0.19	<0.2536	<0.2421	0.2366 J	<0.2491	<0.2358	0.3179 J	<0.2403	0.2672 J
Barium	33.15	63.6	30.89	26	65.02	55.22	70.75	103.9	44.69	72.89	37.64	148.1
Beryllium	<0.2526	<0.2559	<0.2609	<0.41	<0.2652	<0.2536	<0.2591	<0.2599	<0.2476	<0.2498	<0.2517	<0.2672
Boron	<3.578	<3.533	<3.757	<2.9	<3.689	<3.574	<3.605	<3.682	<3.419	<3.52	<3.547	<3.675
Cadmium	<0.06525	<0.08894	<0.07723	<0.106	<0.06802	<0.06456	<0.08562	<0.1408	<0.1179	<0.06585	<0.1602	<0.06793
Calcium	64302	49830	53749	49400	51301	61792	60951	47976	56830	57336	40044	55231
Chromium	<1.052	<1.084	<1.148	<0.87	<1.13	<1.072	<1.093	<1.083	<1.049	<1.09	<1.087	<1.114
Cobalt	<0.1158	<0.1194	<0.1252	0.15 J	0.1499 J	0.196 J	0.1915 J	0.3466 J	0.1886 J	0.1817 J	0.2174 J	0.1336 J
Copper	7.262	8.285	13.88	10.6	10.95	6.225	36.5	21.98	14.97	9.764	10.3	14.48
Iron	155.8 J	175.4 J	113.8 J	128 J	116.4 J	<102.4	243.4	289.2	147.4 J	107.2 J	128.1 J	130.3 J
Lead	<0.2421	<0.2802	<0.2505	<0.22	<0.2536	<0.3459	0.8675	0.6931 J	<0.2948	<0.2952	<0.2746	<0.2784
Magnesium	2021	1803	1920	1570	1868	2006	1927	1668	1910	1817	1590	1837
Manganese	23.89	65.91	46.13	36.3 J	38.74	47.04	38.87	70.93	62.61	66.19	41.53	48.44
Mercury	<0.09893	<0.09869	<0.1044	<0.08	<0.1026	<0.09799	<0.1003	<0.1029	<0.0955	<0.09991	<0.09954	<0.1036
Molybdenum	<0.3052	<0.3046	<0.3131	<0.24	<0.3113	<0.2997	<0.3042	<0.3141	<0.2948	<0.3066	<0.2975	<0.3118
Nickel	<0.8314	<0.8285	<0.8767	<0.67	<0.8762	<0.83	<0.845	<0.8664	<0.8135	<0.8402	<0.8352	<0.8686
Potassium	10734	11014	10645	7920	10445	9995	9700	9389	10222	9401	9748	9432
Selenium	1.042 J	0.9869 J	1.023 J	0.96 J	1.499 J	1.072 J	1.239 J	1.408 J	1.533 J	2.157	1.945	1.102 J
Silver	<0.02421	<0.02437	<0.02609	<0.02	<0.02536	<0.02421	<0.02479	<0.03357	<0.02358	<0.02498	<0.02517	<0.02561
Sodium	5862	5787	5229	4130	5707	6041	5385	5166	5789	5779	5297	5857
Strontium	45.15	43.37	58.86	26 J	63.52	47.5 J	51.04 J	77.65 J	99.28 J	83.68 J	60.52 J	62.69 J
Thallium	<0.1158	<0.117	<0.1252	<0.095	<0.1268	<0.1153	<0.1239	<0.1191	<0.1144	<0.1135	<0.1144	<0.1225
Vanadium	<0.3894	<0.3899	<0.407	<0.31	<0.4035	<0.392	<0.3943	<0.4007	<0.3773	<0.3974	<0.389	<0.412
Zinc	171.5	145	137.8	163 J	130.3	159.1	311	296.7	155.6	138.5	110.4	158.1

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-3. Upland Chorus Frog 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	Timberlake 3/28/2010	North Embayment 3/24/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010
Aluminum	219.1	<38.2	43.07 J	<35.3	<33.78	<35.21	<34.85	52.97 J	<30.94
Antimony	<0.131	<0.14	<0.1287	<0.13	<0.1268	<0.1214	<0.1278	<0.1259	<0.1074
Arsenic	0.2806 J	0.4 J	<0.5852	<0.33	<0.2421	<0.2428	<0.2439	<0.5263	0.8164 J
Barium	38.88	37 J	67.41	89	42.31	95.66	45.77	64.87	61.12
Beryllium	<0.5345	<0.57	<0.2692	<0.26	<0.2536	<0.2549	<0.2555	<0.1373	<0.2256
Boron	<3.741	<4	<3.745	<3.7	<3.459	<3.642	<3.601	<3.661	<3.223
Cadmium	<0.1163	0.089 J	0.2224 J	0.13 J	<0.1268	0.2064 J	0.1626 J	<0.1373	0.1289 J
Calcium	66812	57100	51259	58000	38044	59728	52735	49769	71222
Chromium	<1.149	<1.2	<1.135	<1.1	<1.072	<1.117	<1.103	<1.11	<0.9776
Cobalt	0.6548 J	0.16 J	0.1755 J	0.15 J	0.1845 J	<0.1214	<0.1278	0.1373 J	<0.1074
Copper	46.37	12.5	19.54	10.2	13.37	15.66	14.75	12.93	10.21
Iron	304.7	139 J	158 J	122 J	121 J	126.3 J	125.4 J	145.3 J	<93.24
Lead	0.775 J	<0.27	<0.4096	<0.35	<0.2306	<0.2428	<0.3252	<0.3432	<0.376
Magnesium	2165	1940	1732	1640	1499	2149	1638	1819	2417
Manganese	49.57	118 J	91.05	51.3	46.69	58.03	56.92	66.82	65.64
Mercury	<0.1042	<0.11	<0.1042	<0.1	<0.09799	<0.102	<0.1011	<0.1018	<0.08916
Molybdenum	<0.3207	0.4 J	<0.316	<0.31	<0.2997	<0.3035	0.3252 J	<0.3089	0.29 J
Nickel	<0.8819	<0.93	<0.8777	<0.86	<0.8185	<0.8619	<0.8479	<0.8581	<0.752
Potassium	9514	11100	9667	7680	9834	9906	9978	9542	9958
Selenium	1.47 J	1.6 J	1.638 J	1.1 J	1.614	1.942	1.626	1.373 J	1.611
Silver	0.06013 J	<0.028	0.05734 J	<0.026	<0.02421	<0.02549	<0.02555	<0.02517	<0.02256
Sodium	5318	5110	5887	4970	5292	5439	5204	5400	4318
Strontium	29.53	42.8 J	49.62	65.6	40.58	84.86	68.77	68.19	109.6
Thallium	<0.1243	0.34 J	<0.2458	<0.64	<0.1153	<0.1214	<0.1162	<0.1259	<0.2256
Vanadium	<0.4142	<0.44	<0.8075	<0.81	<0.7609	<0.8012	<0.7899	<0.7894	<0.6983
Zinc	172.4	138	173.2	152	140.6	168.7	154.5	147.6	155.8

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-3. Upland Chorus Frog 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/29/2010	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009
Aluminum	<31.83	56.68 J	<33	<109.1	<109.3	<109.4	<84.5	<108
Antimony	<0.1152	<0.1326	<0.1194	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Arsenic	<0.2257	<0.5082	<0.3448	<0.4356	<0.4402	0.444 J	0.57	0.67
Barium	53.92	46.84	78.69	57.12	69.69	52.31	60	76.2
Beryllium	<0.2376	<0.2652	<0.2463	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Boron	<3.326	<3.646	<3.448	<8.712	<8.803	<8.664	<6.8	<8.7
Cadmium	0.1425 J	<0.1326	0.1355 J	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Calcium	41216	37121	53445	48786	57956	113712	47900	45800
Chromium	<1.01	<1.105	<1.047	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Cobalt	0.2494 J	<0.1215	0.2093 J	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Copper	25.3	12.71	14.65	16.05	14.67	16.89	12.1	23.4
Iron	163.9 J	137 J	167.5 J	120.5	207.9	134.3	120	<108
Lead	<0.2732	<0.2431	<0.3202	<0.4356	0.8192	0.4873	<0.34	<0.43
Magnesium	1556	1690	1699	1444	1883	2079	1470	1470
Manganese	52.38	44.41	49.63	21.53 J	71.16 J	38.12 J	33.9 J	43.5 J
Mercury	<0.09146	<0.1016	<0.09482	<0.08712	<0.08803	<0.08664	<0.068	<0.087
Molybdenum	<0.2851	<0.3093	<0.2955	<4.356	<4.402	<4.332	<3.4	<4.3
Nickel	<0.7721	<0.8617	<0.8004	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Potassium	9965	10451	9347	6857	8143	7516	7540	8480
Selenium	1.544	2.21	2.709	1.493	1.834	1.733	1.6	1.5
Silver	<0.02257	<0.02541	<0.0234	<0.224	<0.2201	<0.2166	<0.17	<0.22
Sodium	4787	4276	4199	<3895	<4010	4960	4370	4730
Strontium	51.43	50.6	75.73	34.72	56.73	70.61	49.5	51.5
Thallium	<0.1093	<0.1215	<0.3448	<0.4356	<0.4402	<0.4332	<0.34	<0.43
Vanadium	<0.7245	<0.7955	<0.7512	<0.8712	<0.8803	<0.8664	<0.68	<0.87
Zinc	135.4	104.8	173.6	136.9	272.7	246.9	120	156

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-3. Upland Chorus Frog 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	North Embayment 3/26/2009	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010
Aluminum	<102	<109	<109.4	<106	<34.05	<34.28	<31.28	<35.81	<36.11
Antimony	<0.41	<0.4399	<0.4384	<0.42	<0.1283	<0.1201	<0.1079	<0.1294	<0.1341
Arsenic	1.2	<0.4399	1.644	<0.42	<0.4081	<0.2402	<0.2157	<0.3344	<0.4695
Barium	27.1	66.08	23.68	82	58.76	50.98	50.91	105.7	99.16
Beryllium	<0.41	<0.4399	<0.4384	<0.42	<0.513	<0.5131	<0.4638	<0.5393	<0.5366
Boron	<8.2	<8.703	<8.769	<8.5	<3.498	<3.603	<3.236	<3.667	<3.689
Cadmium	<0.41	<0.4399	<0.4384	<0.42	<0.1283	0.1747 J	0.1402 J	<0.1402	<0.1341
Calcium	42200	52598	44281	65600	56431	43886	43252	59862	57460
Chromium	<0.41	<0.4399	<0.4384	<0.42	<1.084	<1.092	<0.9923	<1.186	<1.118
Cobalt	<0.41	<0.4399	<0.4384	<0.42	0.1283 J	0.2074 J	0.4314 J	0.2589 J	0.2571 J
Copper	10.6	7.077	26.31	11.2	7.229	15.39	9.168	10.25	8.943
Iron	110	<109	168.8	119	114.8 J	226	106.2 J	107.9 J	115.1 J
Lead	<0.41	<0.4399	<0.4384	<0.42	<0.2332	<0.262	<0.2157	<0.302	<0.2459
Magnesium	1450	1521	1348	1780	2005	1692	1812	2092	1811
Manganese	38.8 J	52.22 J	32.88 J	50.8 J	50.72	73.47	78.09	72.81	78.59
Mercury	<0.082	<0.08703	<0.08769	<0.085	<0.09794	0.1201 J	<0.0906	0.1294 J	<0.104
Molybdenum	<4.1	<4.399	<4.384	<4.2	<0.3031	<0.3057	<0.2804	<0.3128	<0.313
Nickel	0.61 J	<0.4399	<0.4384	<0.42	<0.8278	<0.8406	<0.7658	<0.8737	<0.8831
Potassium	7840	8655	8626	8370	8745	8537	8963	8812	9905
Selenium	1.3	1.243	1.863	1.3	2.099	2.293	2.265	2.265	2.459
Silver	<0.2	<0.22	<0.2192	<0.21	<0.02448	0.02838 J	<0.02265	0.03883 J	<0.02571
Sodium	4120	4839	4560	4960	4687	4705	4908	5975	5265
Strontium	39.8	58.14	30.47	56.3	69.37	57.31	83.7	117.6	87.2
Thallium	<0.41	<0.4399	<0.4384	<0.42	<0.1166	<0.1201	<0.1079	<0.1186	<0.123
Vanadium	<0.82	<0.8703	<0.8769	<0.85	<0.3848	<0.393	<0.3559	<0.4099	<0.4136
Zinc	125	129.1	116.2	139	102.4	107.5	128.4	140.2	115.1

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than

Table B-3. Upland Chorus Frog 2009 and 2010 Sample Results (mg/kg dw)

Analyte / Location: / Sample Date:	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/24/2010	West Embayment 3/26/2009	West Embayment 3/26/2009
Aluminum	<30.68	<36.03	<35.66	<34.88	<36.19	<35.81	<109.6	<109.4
Antimony	<0.1129	<0.131	<0.1328	<0.1287	<0.1336	<0.1335	<0.4339	<0.4362
Arsenic	<0.2155	<0.9061	<0.2861	<0.2458	<0.2561	<0.2549	<0.4339	1.745
Barium	71.32	62.55	88.59	94.09	41.98	81.46	68.1	59.47
Beryllium	<0.4618	<0.5349	<0.5314	<0.5149	<0.5456	<0.5341	<0.4339	<0.4362
Boron	<3.181	<3.712	<3.679	<3.628	<3.786	<3.763	<8.798	<8.725
Cadmium	<0.1231	0.1747 J	<0.1328	0.1404 J	0.1448 J	<0.1335	<0.4339	<0.4362
Calcium	52336	45197	51500	66590	39642	63612	56285	67182
Chromium	<0.9749	<1.092	<1.124	<1.112	<1.114	<1.141	<0.5183	<0.4362
Cobalt	0.2566 J	0.2511 J	0.1328 J	0.1638 J	0.1336 J	<0.1214	<0.4339	<0.4362
Copper	8.928	14.85	4.496	12.64	8.908	9.955	33.87	30.83
Iron	99.13 J	198.7 J	<107.3	131.1 J	133.6 J	114.5 J	150.7 J	207.9 J
Lead	<0.431	0.524 J	<0.2759	0.6086 J	<0.2561	<0.2549	<0.5183	1.381
Magnesium	1919	1758	1788	2001	1581	2282	1555	2094
Manganese	51.93	161.6	78.68	107.2	90.75	70.29	35.31 J	33.15 J
Mercury	<0.08825	0.1528 J	<0.1022	<0.1006	<0.1047	<0.1032	<0.08798	<0.08725
Molybdenum	<0.2668	<0.3166	<0.3168	<0.3043	<0.3229	<0.3156	<4.339	<4.362
Nickel	<0.7491	<0.8734	<0.8686	<0.8543	<0.8797	<0.8741	<0.4339	<0.4362
Potassium	9308	8985	8308	7607	7973	9457	10269	12288
Selenium	1.642	2.511	1.941	1.17 J	0.8686 J	2.064	1.808	1.89
Silver	<0.02258	0.04258 J	<0.02555	<0.02575	<0.02561	<0.02549	0.3977	<0.2181
Sodium	4495	4574	4731	4283	4499	5948	5689	6209
Strontium	82.4	55.79	83.99	92.34	34.85	86.56	67.61 J	54.39 J
Thallium	<0.1026	<0.1201	<0.1226	<0.117	<0.1225	<0.1214	<0.4339	<0.4362
Vanadium	<0.3489	<0.4148	<0.4087	<0.3979	<0.412	<0.4128	<0.8798	<0.8725
Zinc	110.8	133.2	96.36	283.2	130.3	144.5	144.6 J	219.6 J

Note:

Reference Locations = Dawson Farm, Rocky Top Farm, Timberlake

mg/kg dw = milligrams per kilogram dry weight

J = estimated value

< = less than