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Table 9-1. Summary of Amphibian Sample 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's	Unaffected Sites [1]		0	10	3	11	0	4
Rocky Top			10	1	10	10	0	8
North Embayment	Potentially Affected Sites	North Embayment	10	10	0	5	9	11
West Embayment		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 release.
[2] Reference = both unaffected sites and Timberlake were combined for statistical tests and collectively referred to as reference.

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Table 9-2. Representative Amphibian Species of Potential Occurrence in Roane County, Tennessee
Tennessee Valley Authority Kingston, Tennessee

Common Name	Scientific Name
Frogs and Toads	
Northern Cricket Frog	*Acris crepitans*
American Toad	*Bufo americanus*
Fowler's Toad	*Bufo woodhouseii*
Eastern Narrowmouth Toad	*Gastrophryne carolinensis*
Cope's Gray Treefrog	*Hyla chrysoscelis*
Spring Peeper	*Pseudacris crucifer*
Gray Treefrog	*Hyla versicolor*
Upland Chorus Frog	*Pseudacris triseriata*
Bullfrog	*Rana catesbeiana*
Green Frog	*Rana clamitans*
Pickerel Frog	*Rana palustris*
Southern Leopard Frog	*Rana sphenocephala*
Wood Frog	*Rana sylvatica*
Eastern Spadefoot Toad	*Scaphiopus holbrookii*
Salamanders	
Spotten Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Green Salamander [S3S4 G3G4]	*Aneides aeneus*
Hellbender [S3 G3G4 D]	*Cryptobranchus alleganiensis*
Dusky Salamander	*Desmognathus fuscus*
Two-lined Salamander	*Eurycea bislineata*
Southern Two-lined Salamander	*Eurycea cirrigera*
Long-tailed Salamander	*Eurycea longicauda*
Cave Salamander	*Eurycea lucifuga*
Blue Ridge Two-lined Salamander	*Eurycea wilderae*
Berry Cave Salamander [S1 G1Q T]	*Gyrinophilus gulolineatus*

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Table 9-2. Representative Amphibian Species of Potential Occurrence in Roane County, Tennessee
Tennessee Valley Authority Kingston, Tennessee

Common Name	Scientific Name
Salamanders (continued)	
Tennessee Cave Salamander	*Gyrinophilus palleucus*
Spring Salamander	*Gyrinophilus porphyriticus*
Four-toed Salamander [S3 G5 D]	*Hemidactylium scutatum*
Mudpuppy	*Necturus maculosus*
Eastern Newt	*Notophthalmus viridescens*
Red-back Salamander	*Plethodon cinereus*
White-Spotted Slimy Salamander	*Plethodon cylindraceus*
Northern Slimy Salamander	*Plethodon glutinosus*
Mississippi Slimy Salamander	*Plethodon mississippi*
Mud Salamander	*Pseudotrition montanus*
Red Salamander	*Pseudotriton ruber*

Notes:
Information compiled from Klein 1989 and Redmond and Scott 1996.
D = Deemed in Need of Management. Species of nongame wildlife which shoud be investigated in order to develop information relating to biological and ecological data to determine management measures necessary for their continued ability to sustain themselves successfully.
G = Global rank.
G1 = Extremely rare and critically imperiled in the world with five or fewer occurances, or very few remaining individuals, or because of some special condition where the species is particularly vulnerable to extinction.
G3 = Rare and uncommon in its range or found locally in a restricted range, generally from 21-100 occurances.
G4 = Widespread, abundant, and apparently secure globally, but with cause for long-term concern.
G5 = Demonstrably widespread and secure globally.
Q = Questionable taxonomy.
S = State rank.
S1 = Extremely rare and critically imperiled in the state with five or fewer occurances, or very few remaining individuals, or because of some special condition where the species is particularly vulnerable to extinction.
S3 = Rare and uncommon in the state, from 21-100 occurances.
S4 = Widespread, abundant, and apparently secure within the state, but with cause for long-term concern.
T = Subspecific taxon rank.

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Table 9-3. Data Used in Determining Appropriate Statistical Hypothesis Testing for Each COPEC
Tennessee Valley Authority Kingston, Tennessee

Analyte	n	n Detected 2009 & 2010	% Detected 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

Notes:

[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.

% = Percent.

COPEC = Constituent of potential ecological concern.

mg/kg (dw) = Milligrams per kilogram (dry weight).

n = Number of samples.

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Table 9-4. Summary of COPEC Concentrations in Amphibian Whole Body Tissue from the North Embayment (2009 Results) Compared to Effects Levels

Tennessee Valley Authority **Kingston, Tennessee**

Analyte Name	Type of Effect	Species	Critical Body Residue (NOEC)	Units	Amphibian Species											
					American Toad				Spring Peeper				Chorus Frog			
					Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum			--	mg/kg dw	117	ND	NA	NA	NC	NC	NA	NA	109	ND	NA	NA
Antimony			--	mg/kg dw	0.47	ND	NA	NA	NC	NC	NA	NA	0.44	ND	NA	NA
Arsenic			--	mg/kg dw	0.47	ND	NA	NA	NC	NC	NA	NA	1.64	0.70	NA	NA
Barium			--	mg/kg dw	126	66.10	NA	NA	NC	NC	NA	NA	82	57.10	NA	NA
Beryllium			--	mg/kg dw	0.47	ND	NA	NA	NC	NC	NA	NA	0.44	ND	NA	NA
Boron			--	mg/kg dw	9.4	ND	NA	NA	NC	NC	NA	NA	8.8	ND	NA	NA
Cadmium	Survival	*Rana*	47-100	mg/kg dw	0.47	ND	NA	<1	NC	NC	NA	NA	0.44	ND	NA	<1
		Bufo	200	mg/kg dw	0.47	ND	NA	<1	NC	NC	NA	NA	0.44	ND	NA	<1
	Growth*	*Rana*	47-100	mg/kg dw	0.47	ND	NA	<1	NC	NC	NA	NA	0.44	ND	NA	<1
		Bufo	28	mg/kg dw	0.47	ND	NA	<1	NC	NC	NA	NA	0.44	ND	NA	<1
Chromium			--	mg/kg dw	0.73	ND	NA	NA	NC	NC	NA	NA	0.44	ND	NA	NA
Cobalt			--	mg/kg dw	0.5	ND	NA	NA	NC	NC	NA	NA	0.44	ND	NA	NA
Copper	Survival and Growth	*Rana*	16-79	mg/kg dw	10.4	6.17	<1	<1	NC	NC	NA	NA	26.3	15.4	<1	2
		Bufo	93	mg/kg dw	10.4	6.17	<1	<1	NC	NC	NA	NA	26.3	15.4	<1	<1
Iron			--	mg/kg dw	260	140	NA	NA	NC	NC	NA	NA	208	133	NA	NA
Lead	Survival and Growth	*Rana*	700-870	mg/kg dw	1.1	0.56	<1	<1	NC	NC	NA	NA	0.82	0.47	<1	<1
		Bufo	620	mg/kg dw	1.1	0.56	<1	<1	NC	NC	NA	NA	0.82	0.47	<1	<1
Manganese			--	mg/kg dw	128	52.9	NA	NA	NC	NC	NA	NA	71.2	42.6	NA	NA
Mercury			--	mg/kg dw	0.11	0.09	NA	NA	NC	NC	NA	NA	0.09	ND	NA	NA
Molybdenum			--	mg/kg dw	4.7	ND	NA	NA	NC	NC	NA	NA	4.4	ND	NA	NA
Nickel			--	mg/kg dw	0.47	ND	NA	NA	NC	NC	NA	NA	0.61	0.44	NA	NA
Selenium			--	mg/kg dw	2.3	1.40	NA	NA	NC	NC	NA	NA	1.86	1.54	NA	NA
Silver			--	mg/kg dw	0.23	ND	NA	NA	NC	NC	NA	NA	0.22	ND	NA	NA
Strontium			--	mg/kg dw	133	81	NA	NA	NC	NC	NA	NA	70.6	49.8	NA	NA
Thallium			--	mg/kg dw	0.47	ND	NA	NA	NC	NC	NA	NA	0.44	ND	NA	NA
Vanadium			--	mg/kg dw	--	ND	NA	NA	NC	NC	NA	NA	0.88	ND	NA	NA
Zinc	Survival and Growth	*Rana*	240-300	mg/kg dw	140	112	<1	<1	NC	NC	NA	NA	273	160	<1	1
		Bufo	250	mg/kg dw	140	112	<1	<1	NC	NC	NA	NA	273	160	<1	1

Notes: Critical body residues were obtained from No Observed Effect Concentrations (NOEC) values for survival and growth taken from Table 4-1 of Naval Facilities Engineering Command (2004).

* = NOEC critical body residues were reported from the control treatment and are not considered reliable effect concentrations; therefore, Low Observed Effect Concentration values were used.

Bufo = American toad (*Bufo americanus*) and *Rana* = leopard frog (*Rana pipiens*).

Mean HQ = Mean with Full RL / Critical Body Residue.

Maximum HQ = Maximum Detection or Maximum RL / Critical Body Residue.

When a range was presented for critical body residues, the NOEC on the low end of the range was used as a basis of comparison.

Maximum detection or mean exceeds the limiting NOEC.

-- = No data available.

COPEC = Constituent of potential ecological concern.

HQ = Hazard quotient.

mg/kg dw = Milligram per kilogram dry weight.

NA = Not available.

NC = Data not collected.

ND = All samples were non-detects. The maximum RL is reported in the adjacent column instead of the maximum detection.

RL = Reporting limit.

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Table 9-5. Summary of COPEC Concentrations in Amphibian Whole Body Tissue from the West Embayment (2009 Results) Compared to Effects Levels

Tennessee Valley Authority **Kingston, Tennessee**

Analyte Name	Type of Effect	Species	Critical Body Residue (NOEC)	Units	Amphibian Species											
					American Toad				Spring Peeper				Chorus Frog			
					Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum			--	mg/kg dw	378	186	NA	NA	109.46	ND	NA	NA	110	ND	NA	NA
Antimony			--	mg/kg dw	0.74	ND	NA	NA	0.44	ND	NA	NA	0.44	ND	NA	NA
Arsenic			--	mg/kg dw	0.74	ND	NA	NA	0.44	ND	NA	NA	1.74	1.09	NA	NA
Barium			--	mg/kg dw	126	84.1	NA	NA	123.54	71.91	NA	NA	68.1	63.8	NA	NA
Beryllium			--	mg/kg dw	0.74	ND	NA	NA	0.44	ND	NA	NA	0.44	ND	NA	NA
Boron			--	mg/kg dw	14.8	ND	NA	NA	8.8	ND	NA	NA	8.8	ND	NA	NA
Cadmium	Survival	*Rana*	47-100	mg/kg dw	0.74	ND	NA	<1	0.44	ND	NA	<1	0.44	ND	NA	<1
		Bufo	200	mg/kg dw	0.74	ND	NA	<1	0.44	ND	NA	<1	0.44	ND	NA	<1
	Growth*	*Rana*	47-100	mg/kg dw	0.74	ND	NA	<1	0.44	ND	NA	<1	0.44	ND	NA	<1
		Bufo	28	mg/kg dw	0.74	ND	NA	<1	0.44	ND	NA	<1	0.44	ND	NA	<1
Chromium			--	mg/kg dw	8.6	1.47	NA	NA	3.59	1.03	NA	NA	0.52	ND	NA	NA
Cobalt			--	mg/kg dw	0.74	0.48	NA	NA	0.6	0.43	NA	NA	0.44	ND	NA	NA
Copper	Survival and Growth	*Rana*	16-79	mg/kg dw	13.1	8.73	<1	<1	46.87	27.18	2	3	33.9	32.4	2	2
		Bufo	93	mg/kg dw	13.1	8.73	<1	<1	46.87	27.18	<1	<1	33.9	32.4	<1	<1
Iron			--	mg/kg dw	400	240	NA	NA	359.3	233.55	NA	NA	208	179	NA	NA
Lead	Survival and Growth	*Rana*	700-870	mg/kg dw	2.1	0.74	<1	<1	3.59	0.95	<1	<1	1.38	0.95	<1	<1
		Bufo	620	mg/kg dw	2.1	0.74	<1	<1	3.59	0.95	<1	<1	1.38	0.95	<1	<1
Manganese			--	mg/kg dw	174	97	NA	NA	87.7	62.02	NA	NA	35.3	34.2	NA	NA
Mercury			--	mg/kg dw	0.18	0.11	NA	NA	0.18	0.10	NA	NA	0.09	ND	NA	NA
Molybdenum			--	mg/kg dw	7.4	ND	NA	NA	4.41	ND	NA	NA	4.36	ND	NA	NA
Nickel			--	mg/kg dw	13.1	1.77	NA	NA	0.44	ND	NA	NA	0.44	ND	NA	NA
Selenium			--	mg/kg dw	3.3	2.03	NA	NA	2.89	2.13	NA	NA	1.89	1.85	NA	NA
Silver			--	mg/kg dw	0.37	ND	NA	NA	0.63	0.39	NA	NA	0.4	0.31	NA	NA
Strontium			--	mg/kg dw	206	114	NA	NA	124.9	69.79	NA	NA	67.6	61	NA	NA
Thallium			--	mg/kg dw	0.74	ND	NA	NA	0.44	ND	NA	NA	0.44	ND	NA	NA
Vanadium			--	mg/kg dw	--	ND	NA	NA	0.88	ND	NA	NA	0.88	ND	NA	NA
Zinc	Survival and Growth	*Rana*	240-300	mg/kg dw	161	124	<1	<1	168.73	126.26	<1	<1	220	182	<1	<1
		Bufo	250	mg/kg dw	161	124	<1	<1	168.73	126.26	<1	<1	220	182	<1	<1

Notes: Critical body residues were obtained from NOEC (No Observed Effect Concentrations) values for survival and growth taken from Table 4-1 of Naval Facilities Engineering Command (2004).

* = NOEC critical body residues were reported from the control treatment and are not considered reliable effect concentrations; therefore, Low Observed Effect Concentration values were used.

Bufo = American toad (*Bufo americanus*) and *Rana* = leopard frog (*Rana pipiens*).

Mean HQ = Mean with Full RL / Critical Body Residue.

Maximum HQ = Maximum Detection or Maximum RL / Critical Body Residue.

When a range was presented for Critical Body Residues, the NOEC on the low end of the range was used as a basis of comparison.

Maximum detection or mean exceeds the limiting NOEC.

-- = No data available.

COPEC = Constituent of potential ecological concern.

HQ = Hazard quotient.

mg/kg dw = Milligram per kilogram dry weight.

NA = Not available.

ND = All samples were non-detects. The maximum RL is reported in the adjacent column instead of the maximum detection.

RL = Reporting limit.

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Table 9-6. Summary of COPEC Concentrations in Amphibian Whole Body Tissue from the North Embayment (2010 results) Compared to Effects Levels

Tennessee Valley Authority **Kingston, Tennessee**

Analyte Name	Type of Effect	Species	Critical Body Residue (NOEC)	Units	Amphibian Species											
					American Toad				Spring Peeper				Chorus Frog			
					Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum			--	mg/kg dw	1980	300	NA	NA	35.92	ND	NA	NA	56.7	38.7	NA	NA
Antimony			--	mg/kg dw	0.59	0.18	NA	NA	0.13	ND	NA	NA	0.14	ND	NA	NA
Arsenic			--	mg/kg dw	25.9	3.45	NA	NA	0.25	ND	NA	NA	0.82	0.41	NA	NA
Barium			--	mg/kg dw	199	102	NA	NA	83.28	59.43	NA	NA	95.7	62.10	NA	NA
Beryllium			--	mg/kg dw	0.65	ND	NA	NA	0.51	ND	NA	NA	0.57	ND	NA	NA
Boron			--	mg/kg dw	4.5	ND	NA	NA	3.74	ND	NA	NA	4	ND	NA	NA
Cadmium	Survival	*Rana*	47-100	mg/kg dw	0.29	0.17	<1	<1	0.15	ND	NA	<1	0.22	0.15	<1	<1
		Bufo	200	mg/kg dw	0.29	0.17	<1	<1	0.15	ND	NA	<1	0.22	0.15	<1	<1
	Growth*	*Rana*	47-100	mg/kg dw	0.29	0.17	<1	<1	0.15	ND	NA	<1	0.22	0.15	<1	<1
		Bufo	28	mg/kg dw	0.29	0.17	<1	<1	0.15	ND	NA	<1	0.22	0.15	<1	<1
Chromium			--	mg/kg dw	23.6	3.40	NA	NA	1.15	ND	NA	NA	1.2	ND	NA	NA
Cobalt			--	mg/kg dw	2.2	0.48	NA	NA	0.17	0.13	NA	NA	0.25	0.16	NA	NA
Copper	Survival and Growth	*Rana*	16-79	mg/kg dw	15.4	6.92	<1	<1	12.29	9.44	<1	<1	25.3	14.7	<1	2
		Bufo	93	mg/kg dw	15.4	6.92	<1	<1	12.29	9.44	<1	<1	25.3	14.7	<1	<1
Iron			--	mg/kg dw	18600	2070	NA	NA	175.44	144.41	NA	NA	167	136	NA	NA
Lead	Survival and Growth	*Rana*	700-870	mg/kg dw	9.9	1.8	<1	<1	0.3	ND	NA	<1	0.41	ND	NA	<1
		Bufo	620	mg/kg dw	9.9	1.8	<1	<1	0.3	ND	NA	<1	0.41	ND	NA	<1
Manganese			--	mg/kg dw	489	131	NA	NA	99.62	65.88	NA	NA	118	63.7	NA	NA
Mercury			--	mg/kg dw	0.13	0.11	NA	NA	0.1	ND	NA	NA	0.11	ND	NA	NA
Molybdenum			--	mg/kg dw	1	0.38	NA	NA	0.31	ND	NA	NA	0.4	0.31	NA	NA
Nickel			--	mg/kg dw	1.3	0.92	NA	NA	0.88	ND	NA	NA	0.93	ND	NA	NA
Selenium			--	mg/kg dw	2.9	2.01	NA	NA	2.05	1.55	NA	NA	2.71	1.72	NA	NA
Silver			--	mg/kg dw	0.05	0.03	NA	NA	0.03	ND	NA	NA	0.06	0.03	NA	NA
Strontium			--	mg/kg dw	186	112	NA	NA	58.55	53.1	NA	NA	110	64.3	NA	NA
Thallium			--	mg/kg dw	0.15	ND	NA	NA	0.12	ND	NA	NA	0.64	0.23	NA	NA
Vanadium			--	mg/kg dw	36.4	4.11	NA	NA	0.82	ND	NA	NA	0.81	ND	NA	NA
Zinc	Survival and Growth	*Rana*	240-300	mg/kg dw	141	113	<1	<1	181.99	131.74	<1	<1	174	149	<1	<1
		Bufo	250	mg/kg dw	141	113	<1	<1	181.99	131.74	<1	<1	174	149	<1	<1

Notes: Critical body residues were obtained from NOEC (No Observed Effect Concentrations) values for survival and growth taken from Table 4-1 of Naval Facilities Engineering Command (2004).

* = NOEC critical body residues were reported from the control treatment and are not considered reliable effect concentrations; therefore, Low Observed Effect Concentration values were used.

Bufo = American toad (*Bufo americanus*) and *Rana* = leopard frog (*Rana pipiens*).

Mean HQ = Mean with Full RL / Critical Body Residue.

Maximum HQ = Maximum Detection or Maximum RL / Critical Body Residue.

When a range was presented for Critical Body Residues, the NOEC on the low end of the range was used as a basis of comparison.

Maximum detection or mean exceeds the limiting NOEC.

-- = No data available.

COPEC = Constituent of potential ecological concern.

HQ = Hazard quotient.

mg/kg dw = Milligram per kilogram dry weight.

NA = Not available.

ND = All samples were non-detects. The maximum RL is reported in the adjacent column instead of the maximum detection.

RL = Reporting limit.

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Table 9-7. Summary of COPEC Concentrations in Amphibian Whole Body Tissue from the West Embayment (2010 Results) Compared to Effects Levels

Tennessee Valley Authority Kingston, Tennessee

					Amphibian Species											
					American Toad				Spring Peeper				Chorus Frog			
Analyte Name	Type of Effect	Species	Critical Body Residue (NOEC)	Units	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection/ Maximum RL	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum			--	mg/kg dw	180	85.6	NA	NA	36.25	ND	NA	NA	36.2	ND	NA	NA
Antimony			--	mg/kg dw	0.15	ND	NA	NA	0.14	ND	NA	NA	0.13	ND	NA	NA
Arsenic			--	mg/kg dw	0.65	0.31	NA	NA	0.26	ND	NA	NA	0.91	ND	NA	NA
Barium			--	mg/kg dw	111	71.8	NA	NA	113.67	78	NA	NA	106	73.2	NA	NA
Beryllium			--	mg/kg dw	0.3	ND	NA	NA	0.55	ND	NA	NA	0.55	ND	NA	NA
Boron			--	mg/kg dw	4.3	ND	NA	NA	3.73	ND	NA	NA	3.79	ND	NA	NA
Cadmium	Survival	*Rana*	47-100	mg/kg dw	0.27	0.15	<1	<1	0.27	0.13	<1	<1	0.17	0.14	<1	<1
		Bufo	200	mg/kg dw	0.27	0.15	<1	<1	0.27	0.13	<1	<1	0.17	0.14	<1	<1
	Growth*	*Rana*	47-100	mg/kg dw	0.27	0.15	<1	<1	0.27	0.13	<1	<1	0.17	0.14	<1	<1
		Bufo	28	mg/kg dw	0.27	0.15	<1	<1	0.27	0.13	<1	<1	0.17	0.14	<1	<1
Chromium			--	mg/kg dw	1.3	ND	NA	NA	1.2	ND	NA	NA	1.19	ND	NA	NA
Cobalt			--	mg/kg dw	0.45	0.28	NA	NA	0.61	0.23	NA	NA	0.43	0.21	NA	NA
Copper	Survival and Growth	*Rana*	16-79	mg/kg dw	11.1	6.9	<1	<1	43.31	15.99	1	3	15.4	10.1	<1	<1
		Bufo	93	mg/kg dw	11.1	6.9	<1	<1	43.31	15.99	<1	<1	15.4	10.1	<1	<1
Iron			--	mg/kg dw	634	238	NA	NA	470.44	224.47	NA	NA	226	132.00	NA	NA
Lead	Survival and Growth	*Rana*	700-870	mg/kg dw	1.5	0.63	<1	<1	0.56	0.32	<1	<1	0.61	0.33	<1	<1
		Bufo	620	mg/kg dw	1.5	0.63	<1	<1	0.56	0.32	<1	<1	0.61	0.33	<1	<1
Manganese			--	mg/kg dw	173	73.5	NA	NA	107.97	69	NA	NA	162	83.1	NA	NA
Mercury			--	mg/kg dw	0.14	0.11	NA	NA	0.2	0.12	NA	NA	0.15	0.11	NA	NA
Molybdenum			--	mg/kg dw	0.36	ND	NA	NA	0.45	0.33	NA	NA	0.32	ND	NA	NA
Nickel			--	mg/kg dw	1	ND	NA	NA	0.89	ND	NA	NA	0.88	ND	NA	NA
Selenium			--	mg/kg dw	3	2.11	NA	NA	3.86	1.81	NA	NA	2.51	1.96	NA	NA
Silver			--	mg/kg dw	0.05	0.03	NA	NA	0.09	0.04	NA	NA	0.04	0.03	NA	NA
Strontium			--	mg/kg dw	241	108	NA	NA	132.24	84	NA	NA	118	77.4	NA	NA
Thallium			--	mg/kg dw	0.14	ND	NA	NA	0.13	ND	NA	NA	0.12	ND	NA	NA
Vanadium			--	mg/kg dw	0.47	ND	NA	NA	0.42	ND	NA	NA	0.41	ND	NA	NA
Zinc	Survival and Growth	*Rana*	240-300	mg/kg dw	131	106	<1	<1	156.81	116.85	<1	<1	283	136	<1	1
		Bufo	250	mg/kg dw	131	106	<1	<1	156.81	116.85	<1	<1	283	136	<1	1

Notes: Critical body residues were obtained from NOEC (No Observed Effect Concentrations) values for survival and growth taken from Table 4-1 of Naval Facilities Engineering Command (2004).

* = NOEC critical body residues were reported from the control treatment and are not considered reliable effect concentrations; therefore, Low Observed Effect Concentration values were used.

Bufo = American toad (*Bufo americanus*) and *Rana* = leopard frog (*Rana pipiens*).

Mean HQ = Mean with Full RL / Critical Body Residue.

Maximum HQ = Maximum Detection or Maximum RL / Critical Body Residue.

When a range was presented for Critical Body Residues, the NOEC on the low end of the range was used as a basis of comparison.

Maximum detection or mean exceeds the limiting NOEC.

-- = No data available.

COPEC = Constituent of potential ecological concern.

HQ = Hazard quotient.

mg/kg dw = Milligram per kilogram dry weight.

NA = Not available.

ND = All samples were non-detects. The maximum RL is reported in the adjacent column instead of the maximum detection.

RL = Reporting limit.

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Table 9-8. Summary of Selenium and Strontium Concentrations in Amphibian Whole Body Tissue 2009-2011

Tennessee Valley Authority Kingston, Tennessee

Analyte Name	Chorus Frog 2009 (mg/kg dw)						Spring Peeper 2009 (mg/kg dw)						American Toad 2009 (mg/kg dw)					
	Reference[1]		North Embayment		West Embayment		Reference[1]		North Embayment		West Embayment		Reference[1]		North Embayment		West Embayment	
	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range
Selenium	NC ± NC	NC - NC	1.54 ± 0.23	1.24 - 1.86	1.85 ± 0.06	1.81 - 1.89	1.54 ± 0.35	0.96 - 2.2	NC ± NC	NC - NC	2.13 ± 0.57	1.2 - 2.89	1.73 ± 0.44	0.89 - 2.3	1.4 ± 0.46	0.93 - 2.3	2.03 ± 0.56	1.18 - 3.3
Strontium	NC ± NC	NC - NC	49.8 ± 12.7	30.5 - 70.6	61 ± 9.35	54.4 - 67.6	42.6 ± 21.5	21.5 - 121	NC ± NC	NC - NC	69.8 ± 31.1	30.4 - 125	106 ± 34.1	67 - 173	81 ± 26.8	42.9 - 133	114 ± 47.7	47 - 206

Analyte Name	Chorus Frog 2010 (mg/kg dw)						Spring Peeper 2010 (mg/kg dw)						American Toad 2010 (mg/kg dw)					
	Reference[1]		North Embayment		West Embayment		Reference[1]		North Embayment		West Embayment		Reference[1]		North Embayment		West Embayment	
	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range
Selenium	1.37 ± 0.38	0.99 - 2.16	1.72 ± 0.43	1.1 - 2.71	1.96 ± 0.53	0.87 - 2.51	1.39 ± 0.32	0.86 - 2.32	1.55 ± 0.4	1 - 2.05	1.81 ± 0.86	1.06 - 3.86	1.6 ± 0.29	1.1 - 2.25	2.01 ± 0.54	0.92 - 2.9	2.11 ± 0.45	1.4 - 3
Strontium	60.2 ± 19.3	29.5 - 99.3	64.3 ± 20.6	40.6 - 110	77.4 ± 22.1	34.9 - 118	48.6 ± 18	18 - 94.1	53.1 ± 4.57	49.1 - 58.6	83.7 ± 28.4	44.8 - 132	67 ± 30.4	34.2 - 121	112 ± 46.3	61.7 - 186	108 ± 58.7	42.1 - 241

Analyte Name	Chorus Frog 2011 (mg/kg dw)						Spring Peeper 2011 (mg/kg dw)						American Toad 2011 (mg/kg dw)					
	Reference[1]		North Embayment		West Embayment		Reference[1]		North Embayment		West Embayment		Reference[1]		North Embayment		West Embayment	
	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range	Mean ± SD[2]	Range
Selenium	1.15 ± 0.34	0.51 - 1.82	1.32 ± 0.16	1.13 - 1.55	1.49 ± 0.43	0.68 - 2.42	1.33 ± 0.28	0.85 - 2.17	1.43 ± 0.29	1.1 - 1.99	1.77 ± 0.42	0.84 - 2.14	1.74 ± 0.56	0.77 - 3.14	2.22 ± 0.86	1.2 - 4.28	2.66 ± 0.77	1.64 - 4.29
Strontium	41.4 ± 18.5	7.89 - 75.5	57.3 ± 21	27 - 88.8	52.3 ± 21.1	14.9 - 79.3	39.5 ± 19.5	10.7 - 93.3	49.2 ± 26.2	24.4 - 119	48.5 ± 15.6	27.6 - 68	88.8 ± 50.5	26.6 - 224	83.7 ± 49	31.4 - 189	178 ± 72.1	53.3 - 295

Notes:

[1] Location includes Dawson Farm, Rockytop Farm, and Walls.

[2] Mean calculations include reporting limits, which are substituted for non-detects.

dw = Dry weight.

mg/kg = Milligram per kilogram.

NC = Data not collected.

SD = Standard deviation.

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Table 9-9. Summary of COPEC Concentrations in Surface Water Compared to Available Aquatic Life Criteria

Tennessee Valley Authority **Kingston, Tennessee**

Dissolved Metal Concentrations (µg/L)

	Hardness (mg/L)[a]	Aluminum[b]	Arsenic	Cadmium	Chromium[c]	Chromium VI	Copper	Iron[b,d]	Lead	Mercury	Nickel	Selenium[b]	Silver[e]	Zinc
Acute Criteria	--	NA	340	2	NA	16	13	--	65	1.4	470	--	3.2	120
Chronic Criteria	--	NA	150	0.25	NA	11	9	--	2.5	0.77	52	--	--	120
CR_A	136	<50	1.36	**<0.33**	<0.33	2.1	2.65	<25	<0.33	<0.15	0.39	0.7	<0.33	<8.3
CR_B	138	142	1.58	**<0.33**	<0.33	2.1	2.37	129	<0.33	<0.15	0.42	0.37	<0.33	<8.3
CR_R	138	<50	0.52	**<0.33**	<0.33	2	0.69	77.7	<0.33	0.2	0.52	0.36	<0.33	<8.3
ER_A	129	<50	2.28	**<0.33**	<0.33	NA	1.4	<25	<0.33	<0.15	0.48	0.66	<0.33	8.51
ER_B	126	<50	2.32	**<0.33**	<0.33	NA	2.92	30.4	<0.33	<0.15	0.59	0.58	<0.33	<8.3
ER_C	122	<50	1.74	**<0.33**	<0.33	NA	2.12	<25	<0.33	<0.15	0.54	0.4	<0.33	<8.3
ER_R	95.7	<50	1.04	**<0.33**	<0.33	NA	0.41	<25	<0.33	<0.15	0.63	<0.33	<0.33	<8.3
TR_B	74.5	65	0.98	**<0.33**	<0.33	1.6	3.18	83.9	<0.33	<0.15	0.4	0.4	<0.33	<8.3
TR_R	66.2	<50	0.97	**<0.33**	<0.33	1.7	2.05	<25	<0.33	<0.15	0.34	0.39	<0.33	<8.3

Total Recoverable Metal Concentrations (µg/L)

	Hardness (mg/L)[a]	Aluminum	Arsenic[f]	Cadmium	Chromium[c]	Chromium VI [f]	Copper	Iron[d]	Lead	Mercury	Nickel	Selenium	Silver[e]	Zinc
Acute Criteria	--	750	340	2.12	NA	16.29	13.54	--	82.17	1.65	470.94	20	3.76	122.70
Chronic Criteria	--	87	150	0.28	NA	11.43	9.38	1000	3.16	0.91	52.16	5	--	121.70
CR_A	136	**214**	1.53	**<0.33**	0.46	--	1.95	150	0.37	0.229	0.76	0.76	<0.33	<8.3
CR_B	138	**139**	1.95	**<0.33**	0.39	--	2.56	133	<0.33	<0.15	0.59	0.38	<0.33	<8.3
CR_R	138	**107**	0.61	**<0.33**	0.51	--	1.58	126	0.34	<0.15	0.65	0.43	<0.33	<8.3
ER_A	129	**255**	2.52	**<0.33**	2.71	--	2.12	220	0.36	0.189	0.72	0.93	<0.33	13.7
ER_B	126	**319**	2.78	**<0.33**	0.5	--	1.73	251	0.44	0.186	0.86	0.55	<0.33	<8.3
ER_C	122	**339**	2.56	**<0.33**	0.47	--	0.98	316	0.58	<0.15	0.83	<0.33	<0.33	<8.3
ER_R	95.7	<50	1.3	**<0.33**	0.41	--	0.67	133	<0.33	0.166	0.72	0.38	<0.33	<8.3
TR_B	74.5	**263**	1.31	**<0.33**	0.43	--	2.19	236	0.47	<0.15	1.13	<0.33	<0.33	<8.3
TR_R	66.2	**206**	1.17	**<0.33**	0.38	--	1.29	199	<0.33	<0.15	0.6	0.45	<0.33	<8.3

Notes: Hardness-dependent metals criteria was calculated using a hardness value of 100 mg/L.

[a] Lowest hardness value sampled within a reach used for hardness-adjusted criteria calculations.

[b] Criteria only available as total recoverable metal concentrations.

[c] No critera available for combined chromium species.

[d] No acute criteria available.

[e] No chronic criteria available.

[f] Criteria only available as dissolved metal concentrations.

-- = Relevant criteria unavailable.

Bold = Indicates exceedance of chronic criteria.

COPEC = Constituent of potential ecological concern.

CR = Clinch River.

ER = Emory River.

µg/L = Microgram per liter.

mg/L = Milligram per liter.

NA = Data not available.

TR = Tennessee River.

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Table 9-10. Summary of COPEC Concentrations in Surface Water Compared to Effects Levels

Tennessee Valley Authority Kingston, Tennessee

Dissolved Metal Concentrations (µg/L)

	Hardness (mg/L)[a]	Aluminum[b]	Arsenic	Cadmium				Chromium[c]	Chromium VI	Copper		Iron[b,d]	Lead		Mercury	Nickel	Selenium[b]	Silver[e]	Zinc	
				Survival		Growth				Survival and Growth			Survival and Growth						Survival and Growth	
				Rana	*Bufo*	*Rana*	*Bufo*			*Rana*	*Bufo*		*Rana*	*Bufo*					*Rana*	*Bufo*
Effect Level (µg/L)		**10***	**10***	**1100****	**1100****	**11-1100****	**2.5****	**6.0***		**280-900****	**900****	**3.0***	**270-480****	**480****	**1.0***	**3.0***	**10***	**1.0***	**3000-5200****	**17000****
CR_A	136	**<50**	1.36	<0.33	<0.33	<0.33	<0.33	<0.33	2.1	2.65	2.65	**<25**	<0.33	<0.33	<0.15	0.39	0.7	<0.33	<8.3	<8.3
CR_B	138	**142**	1.58	<0.33	<0.33	<0.33	<0.33	<0.33	2.1	2.37	2.37	**129**	<0.33	<0.33	<0.15	0.42	0.37	<0.33	<8.3	<8.3
CR_R	138	**<50**	0.52	<0.33	<0.33	<0.33	<0.33	<0.33	2	0.69	0.69	**77.7**	<0.33	<0.33	0.2	0.52	0.36	<0.33	<8.3	<8.3
ER_A	129	**<50**	2.28	<0.33	<0.33	<0.33	<0.33	<0.33	NA	1.4	1.4	**<25**	<0.33	<0.33	<0.15	0.48	0.66	<0.33	8.51	8.51
ER_B	126	**<50**	2.32	<0.33	<0.33	<0.33	<0.33	<0.33	NA	2.92	2.92	**30.4**	<0.33	<0.33	<0.15	0.59	0.58	<0.33	<8.3	<8.3
ER_C	122	**<50**	1.74	<0.33	<0.33	<0.33	<0.33	<0.33	NA	2.12	2.12	**<25**	<0.33	<0.33	<0.15	0.54	0.4	<0.33	<8.3	<8.3
ER_R	95.7	**<50**	1.04	<0.33	<0.33	<0.33	<0.33	<0.33	NA	0.41	0.41	**<25**	<0.33	<0.33	<0.15	0.63	<0.33	<0.33	<8.3	<8.3
TR_B	74.5	**65**	0.98	<0.33	<0.33	<0.33	<0.33	<0.33	1.6	3.18	3.18	**83.9**	<0.33	<0.33	<0.15	0.4	0.4	<0.33	<8.3	<8.3
TR_R	66.2	**<50**	0.97	<0.33	<0.33	<0.33	<0.33	<0.33	1.7	2.05	2.05	**<25**	<0.33	<0.33	<0.15	0.34	0.39	<0.33	<8.3	<8.3

Total Recoverable Metal Concentrations (µg/L)

	Hardness (mg/L)[a]	Aluminum	Arsenic[f]	Cadmium				Chromium[c]	Chromium VI [f]	Copper		Iron[d]	Lead		Mercury[f]	Nickel	Selenium	Silver[e]	Zinc	
				Survival		Growth				Survival and Growth			Survival and Growth						Survival and Growth	
				Rana	*Bufo*	*Rana*	*Bufo*			*Rana*	*Bufo*		*Rana*	*Bufo*					*Rana*	*Bufo*
Effect Level (µg/L)		**10***	**10***	**1800-2600****	**1800****	**6-1800****	**2.5****	**6.0***		**390-1200****	**1200****	**3.0***	**5100-6200****	**6200****	**1.0***	**3.0***	**10***	**1.0***	**3900-6300****	**18000****
CR_A	136	**214**	1.53	<0.33	<0.33	<0.33	<0.33	0.46	--	1.95	1.95	**150**	0.37	0.37	0.229	0.76	0.76	<0.33	<8.3	<8.3
CR_B	138	**139**	1.95	<0.33	<0.33	<0.33	<0.33	0.39	--	2.56	2.56	**133**	<0.33	<0.33	<0.15	0.59	0.38	<0.33	<8.3	<8.3
CR_R	138	**107**	0.61	<0.33	<0.33	<0.33	<0.33	0.51	--	1.58	1.58	**126**	0.34	0.34	<0.15	0.65	0.43	<0.33	<8.3	<8.3
ER_A	129	**255**	2.52	<0.33	<0.33	<0.33	<0.33	2.71	--	2.12	2.12	**220**	0.36	0.36	0.189	0.72	0.93	<0.33	13.7	13.7
ER_B	126	**319**	2.78	<0.33	<0.33	<0.33	<0.33	0.5	--	1.73	1.73	**251**	0.44	0.44	0.186	0.86	0.55	<0.33	<8.3	<8.3
ER_C	122	**339**	2.56	<0.33	<0.33	<0.33	<0.33	0.47	--	0.98	0.98	**316**	0.58	0.58	<0.15	0.83	<0.33	<0.33	<8.3	<8.3
ER_R	95.7	**<50**	1.3	<0.33	<0.33	<0.33	<0.33	0.41	--	0.67	0.67	**133**	<0.33	<0.33	0.166	0.72	0.38	<0.33	<8.3	<8.3
TR_B	74.5	**263**	1.31	<0.33	<0.33	<0.33	<0.33	0.43	--	2.19	2.19	**236**	0.47	0.47	<0.15	1.13	<0.33	<0.33	<8.3	<8.3
TR_R	66.2	**206**	1.17	<0.33	<0.33	<0.33	<0.33	0.38	--	1.29	1.29	**199**	<0.33	<0.33	<0.15	0.6	0.45	<0.33	<8.3	<8.3

Notes:

[a] Lowest hardness value sampled within a reach used for hardness-adjusted criteria calculations.
[b] Criteria only available as total recoverable metal concentrations.
[c] No critera available for combined chromium species.
[d] No acute criteria available.
[e] No chronic criteria available.
[f] Criteria only available as dissolved metal concentrations.
*** =** LC_{10} values obtained from Westerman et al. 2003.
** = NOEC (No Observed Effect Concentrations) values for survival and growth for the American toad (*Bufo americanus*) and leopard frog (*Rana pipiens*) obtained from Tables 3-6 and 3-7 of Naval Facilities Engineering Command (2004).
-- = Relevant criteria unavailable.
Bold = Indicates exceedances of effect level.
COPEC = Constituent of potential ecological concern.
CR = Clinch River.
ER = Emory River.
µg/L = Microgram per liter.
mg/L = Milligram per liter.
NA = Data unavailable.
TR = Tennessee River.

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Table 9-11. COPEC Concentrations in Seasonally-Exposed Sediment Compared to Screening Values for Clinch River

Tennessee Valley Authority **Kingston, Tennessee**

			Clinch River Reaches							
			CR_A				CR_B			
Analyte Name	**Units**	**Screening Value**	**Maximum Detection**	**Mean with Full RL**	**Mean HQ**	**Maximum HQ**	**Maximum Detection**	**Mean with Full RL**	**Mean HQ**	**Maximum HQ**
Aluminum	mg/kg	225000	143000	44081	<1	<1	59400	27144	<1	<1
Antimony	mg/kg	12	2.52	1.47	<1	<1	1.73	1.48	<1	<1
Arsenic	mg/kg	7.24	63.4	19.24	3	9	82.6	18	2	11
Barium	mg/kg	--	190	110	NA	NA	216	113	NA	NA
Beryllium	mg/kg	--	4.39	1.18	NA	NA	1.7	0.84	NA	NA
Boron	mg/kg	--	60.5	42.69	NA	NA	45.7	19.17	NA	NA
Cadmium	mg/kg	1	ND	0.14	<1	NA	ND	0.14	<1	NA
Chromium	mg/kg	52.3	125	50.15	<1	2	71.3	39.66	<1	1
Cobalt	mg/kg	50	18.0	10.95	<1	<1	23.8	14.66	<1	<1
Copper	mg/kg	18.7	90.4	24	1	5	46.8	16.40	<1	3
Hex. Chromium	mg/kg	52.3	0.83	0.46	<1	<1	0.84	0.44	<1	<1
Lead	mg/kg	30.2	102	33	1	3	86.7	28.52	<1	3
Manganese	mg/kg	1100	1700	666	<1	2	3540	1183	1	3
Mercury	mg/kg	0.13	0.39	0.15	1	3	1	0.27	2	8
Molybdenum	mg/kg	--	ND	5.54	NA	NA	ND	5.75	NA	NA
Nickel	mg/kg	15.9	135	26.78	2	8	36.9	15.28	<1	2
Selenium*	mg/kg	2	ND	1.39	<1	NA	1.77	1.47	<1	<1
Silver	mg/kg	2	ND	0.69	<1	NA	ND	0.72	<1	NA
Strontium	mg/kg	--	43.6	22	NA	NA	42.1	17	NA	NA
Thallium	mg/kg	--	ND	1.39	NA	NA	3.11	1.62	NA	NA
Vanadium	mg/kg	--	193	60.53	NA	NA	63.5	42.75	NA	NA
Zinc	mg/kg	124	460	122.52	<1	4	194	66.75	<1	2
Calcium	mg/kg	--	3430	1669	NA	NA	4140	1570	NA	NA
Iron	mg/kg	--	93800	39600	NA	NA	49200	28877	NA	NA
Magnesium	mg/kg	--	5780	2746	NA	NA	7150	2284	NA	NA
Potassium	mg/kg	--	8880	5066	NA	NA	18100	4377	NA	NA
Sodium	mg/kg	--	284	178	NA	NA	219	157	NA	NA

Notes: Screening values based off of USEPA (United States Environmental Protection Agency) Region 4 Sediment Screening Value.

* = Screening value obtained from Lemley, A.D. 2002. Selenium assessment in aquatic ecosystems U.S. Forest Service, Blacksburg, VA.

-- = No screening value available.

Maximum detection exceeds the USEPA Region 4 Sediment Screening Value.

Mean with full RL exceeds the USEPA Region 4 Sediment Screening Value.

COPEC = Constituent of potential ecological concern.

CR = Clinch River.

HQ = Hazard quotient.

mg/kg = Milligram per kilogram.

NA = Not available.

ND = All samples were non-detects.

RL = Reporting limit.

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Table 9-12. Summary of COPEC Concentrations in Seasonally-Exposed Sediment Compared to Screening Values for Emory River

Tennessee Valley Authority **Kingston, Tennessee**

Analyte Name	Units	Screening Value	Emory River Reaches															
			ER_A				ER_B				ER_C				ER_Ref			
			Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum	mg/kg	225000	76500	29850.00	<1	<1	39400	17585.56	<1	<1	27100	9164	<1	<1	14800	8594.00	<1	<1
Antimony	mg/kg	12	1.8	1.52	<1	<1	2.26	1.44	<1	<1	ND	1.38	<1	NA	ND	1.39	<1	NA
Arsenic	mg/kg	7.24	32.3	14.34	2	4	62.4	15.18	2	9	5.17	2.51	<1	<1	5.4	2.97	<1	<1
Barium	mg/kg	--	245	142.20	NA	NA	478	125.41	NA	NA	447	92.48	NA	NA	90.4	45.38	NA	NA
Beryllium	mg/kg	--	2.19	1.20	NA	NA	3.52	1.08	NA	NA	1.09	0.66	NA	NA	0.769	0.58	NA	NA
Boron	mg/kg	--	88	23.25	NA	NA	51.8	14.71	NA	NA	10.3	6.38	NA	NA	ND	5.57	NA	NA
Cadmium	mg/kg	1	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA
Chromium	mg/kg	52.3	86	38.79	<1	2	42.4	22.35	<1	<1	24.3	9.96	<1	<1	13.8	9.01	<1	<1
Cobalt	mg/kg	50	46.6	18.75	<1	<1	38.1	13.74	<1	<1	20.4	7.14	<1	<1	10.5	5.70	<1	<1
Copper	mg/kg	18.7	31.7	17.57	<1	2	47.1	16.48	<1	3	13.2	5.08	<1	<1	6.83	5.46	<1	<1
Hex. Chromium	mg/kg	52.3	1.2	0.70	<1	<1	0.45	0.54	<1	<1	ND	0.59	<1	NA	0.37	1	<1	<1
Lead	mg/kg	30.2	126	27.63	<1	4	79.5	21.44	<1	3	14	6.69	<1	<1	10.4	7.07	<1	<1
Manganese	mg/kg	1100	2910	955.58	<1	3	4120	826.22	<1	4	2940	557.35	<1	3	689	315.38	<1	<1
Mercury	mg/kg	0.13	0.13	0.07	<1	1	0.12	0.07	<1	<1	ND	0.06	<1	NA	ND	0.06	<1	NA
Molybdenum	mg/kg	--	ND	5.66	NA	NA	ND	5.52	NA	NA	ND	5.52	NA	NA	ND	5.57	NA	NA
Nickel	mg/kg	15.9	40.6	19.83	1	3	54.7	19.07	1	3	22.4	8.56	<1	1	14.7	7.73	<1	<1
Selenium*	mg/kg	2	3.05	1.63	<1	2	3.64	1.53	<1	2	ND	1.38	<1	NA	ND	1.39	<1	NA
Silver	mg/kg	2	ND	0.71	<1	NA	ND	0.69	<1	NA	ND	0.69	<1	NA	ND	0.70	<1	NA
Strontium	mg/kg	--	149	39.87	NA	NA	321	43.27	NA	NA	19.9	8.13	NA	NA	16.3	8.05	NA	NA
Thallium	mg/kg	--	ND	1.42	NA	NA	ND	1.38	NA	NA	ND	1.38	NA	NA	ND	1.39	NA	NA
Vanadium	mg/kg	--	80.1	46.90	NA	NA	78.6	31.53	NA	NA	36.6	13.08	NA	NA	26.3	14.42	NA	NA
Zinc	mg/kg	124	132	58.99	<1	1	113	46.95	<1	<1	84.8	32.35	<1	<1	54.1	32.38	<1	<1
Calcium	mg/kg	--	3630	1712.17	NA	NA	58700	4810.78	NA	NA	1200	537.90	NA	NA	1630	764.40	NA	NA
Iron	mg/kg	--	48200	32966.67	NA	NA	40000	21851.11	NA	NA	19100	9607	NA	NA	18500	11126	NA	NA
Magnesium	mg/kg	--	9000	2544.17	NA	NA	7070	1807.61	NA	NA	2920	799.70	NA	NA	1490	773.20	NA	NA
Potassium	mg/kg	--	24700	4679.17	NA	NA	11700	2593.61	NA	NA	3340	1038.60	NA	NA	1480	835.60	NA	NA
Sodium	mg/kg	--	257	155.67	NA	NA	498	157.50	NA	NA	158	140.10	NA	NA	ND	139.20	NA	NA

Notes: Screening values based off of USEPA (United States Environmental Protection Agency) Region 4 Sediment Screening Value.
* = Screening value obtained from Lemley, A.D. 2002. Selenium assessment in aquatic ecosystems. U.S. Forest Service, Blacksburg, VA.
-- = No screening value available.
Maximum detection exceeds the USEPA Region 4 Sediment Screening Value.
Mean with full RL exceeds the USEPA Region 4 Sediment Screening Value.
COPEC = Constituent of potential ecological concern.
ER = Emory River.
HQ = Hazard quotient.
mg/kg = Milligram per kilogram.
NA = Not available.
ND = All samples were non-detects.
RL = Reporting limit.

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Table 9-13. Summary of COPEC Concentrations in Seasonally-Exposed Sediment Compared to Effects Levels for Clinch River

Tennessee Valley Authority **Kingston, Tennessee**

Analyte Name	Type of Effect	Species	Effect Level (NOEC)	Units	Clinch River Reaches							
					CR_A				CR_B			
					Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum			--	mg/kg	143000	44081	NA	NA	59400	27144	NA	NA
Antimony			--	mg/kg	2.52	1.47	NA	NA	1.73	1.48	NA	NA
Arsenic			--	mg/kg	63.4	19.24	NA	NA	82.6	18	NA	NA
Barium			--	mg/kg	190	110	NA	NA	216	113	NA	NA
Beryllium			--	mg/kg	4.39	1.18	NA	NA	1.7	0.84	NA	NA
Boron			--	mg/kg	60.5	42.69	NA	NA	45.7	19.17	NA	NA
Cadmium	Survival	*Rana*	580-760	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA
		Bufo	580	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA
	Growth	*Rana*	0.46-580	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA
		Bufo	0.32	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA
Chromium			--	mg/kg	125	50.15	NA	NA	71.3	39.66	NA	NA
Cobalt			--	mg/kg	18.0	10.95	NA	NA	23.8	14.66	NA	NA
Copper	Survival and Growth	*Rana*	64-200	mg/kg	90.4	24	<1	1	46.8	16.40	<1	<1
		Bufo	200	mg/kg	90.4	24	<1	<1	46.8	16.40	<1	<1
Hex. Chromium			--	mg/kg	0.83	0.46	NA	NA	0.84	0.44	NA	NA
Lead	Survival and Growth	*Rana*	2000-2400	mg/kg	102	33	<1	<1	86.7	28.52	<1	<1
		Bufo	2600	mg/kg	102	33	<1	<1	86.7	28.52	<1	<1
Manganese			--	mg/kg	1700	666	NA	NA	3540	1183	NA	NA
Mercury			--	mg/kg	0.39	0.15	NA	NA	1	0.27	NA	NA
Molybdenum			--	mg/kg	ND	5.54	NA	NA	ND	5.75	NA	NA
Nickel			--	mg/kg	135	26.78	NA	NA	36.9	15.28	NA	NA
Selenium*			2	mg/kg	ND	1.39	<1	NA	1.77	1.47	<1	<1
Silver			--	mg/kg	ND	0.69	NA	NA	ND	0.72	NA	NA
Strontium			--	mg/kg	43.6	22	NA	NA	42.1	17	NA	NA
Thallium			--	mg/kg	ND	1.39	NA	NA	3.11	1.62	NA	NA
Vanadium			--	mg/kg	193	60.53	NA	NA	63.5	42.75	NA	NA
Zinc	Survival and Growth	*Rana*	900-1200	mg/kg	460	122.52	<1	<1	194	66.75	<1	<1
		Bufo	1200	mg/kg	460	122.52	<1	<1	194	66.75	<1	<1
Calcium			--	mg/kg	3430	1669	NA	NA	4140	1570	NA	NA
Iron			--	mg/kg	93800	39600	NA	NA	49200	28877	NA	NA
Magnesium			--	mg/kg	5780	2746	NA	NA	7150	2284	NA	NA
Potassium			--	mg/kg	8880	5066	NA	NA	18100	4377	NA	NA
Sodium			--	mg/kg	284	178	NA	NA	219	157	NA	NA

Notes: Effect levels were obtained from NOEC (No Observed Effect Concentrations) values for survival and growth taken from Tables 3-6 and 3-7 of Naval Facilities Engineering Command (2004).
Bufo = American toad (*Bufo americanus*) and *Rana* = leopard frog (*Rana pipiens*).
When a range was presented for Critical Body Residues, the NOEC on the low end of the range was used as a basis of comparison.
Maximum detection exceeds the limiting NOEC.
* = Screening value obtained from Lemley, A.D. 2002. Selenium assessment in aquatic ecosystems. U.S. Forest Service, Blacksburg, VA.
-- = No effect level available.
COPEC = Constituent of potential ecological concern.
CR = Clinch River.
HQ = Hazard quotient.
mg/kg = Milligram per kilogram.
NA = Not available.
ND = All samples were non-detects.
RL = Reporting limit.

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Table 9-14. Summary of COPEC Concentrations in Seasonally-Exposed Sediment Compared to Effects Levels for Emory River

Tennessee Valley Authority **Kingston, Tennessee**

Analyte Name	Type of Effect	Species	Effect Level (NOEC)	Units	Emory River Reaches															
					ER_A				ER_B				ER_C				ER_Ref			
					Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ	Maximum Detection	Mean with Full RL	Mean HQ	Maximum HQ
Aluminum			--	mg/kg	76500	29850.00	NA	NA	39400	17585.56	NA	NA	27100	9164	NA	NA	14800	8594.00	NA	NA
Antimony			--	mg/kg	1.8	1.52	NA	NA	2.26	1.44	NA	NA	ND	1.38	NA	NA	ND	1.39	NA	NA
Arsenic			--	mg/kg	32.3	14.34	NA	NA	62.4	15.18	NA	NA	5.17	2.51	NA	NA	5.4	2.97	NA	NA
Barium			--	mg/kg	245	142.20	NA	NA	478	125.41	NA	NA	447	92.48	NA	NA	90.4	45.38	NA	NA
Beryllium			--	mg/kg	2.19	1.20	NA	NA	3.52	1.08	NA	NA	1.09	0.66	NA	NA	0.769	0.58	NA	NA
Boron			--	mg/kg	88	23.25	NA	NA	51.8	14.71	NA	NA	10.3	6.38	NA	NA	ND	5.57	NA	NA
Cadmium	Survival	*Rana*	580-760	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA
		Bufo	580	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA
	Growth	*Rana*	0.46-580	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA
		Bufo	0.32	mg/kg	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA	ND	0.14	<1	NA
Chromium			--	mg/kg	86	38.79	NA	NA	42.4	22.35	NA	NA	24.3	9.96	NA	NA	13.8	9.01	NA	NA
Cobalt			--	mg/kg	46.6	18.75	NA	NA	38.1	13.74	NA	NA	20.4	7.14	NA	NA	10.5	5.70	NA	NA
Copper	Survival and Growth	*Rana*	64-200	mg/kg	31.7	17.57	<1	<1	47.1	16.48	<1	<1	13.2	5.08	<1	<1	6.83	5.46	<1	<1
		Bufo	200	mg/kg	31.7	17.57	<1	<1	47.1	16.48	<1	<1	13.2	5.08	<1	<1	6.83	5.46	<1	<1
Hex. Chromium			--	mg/kg	1.2	0.70	NA	NA	0.45	0.54	NA	NA	ND	0.59	NA	NA	0.37	1	NA	NA
Lead	Survival and Growth	*Rana*	2000-2400	mg/kg	126	27.63	<1	<1	79.5	21.44	<1	<1	14	6.69	<1	<1	10.4	7.07	<1	<1
		Bufo	2600	mg/kg	126	27.63	<1	<1	79.5	21.44	<1	<1	14	6.69	<1	<1	10.4	7.07	<1	<1
Manganese			--	mg/kg	2910	955.58	NA	NA	4120	826.22	NA	NA	2940	557.35	NA	NA	689	315.38	NA	NA
Mercury			--	mg/kg	0.13	0.07	NA	NA	0.12	0.07	NA	NA	ND	0.06	NA	NA	ND	0.06	NA	NA
Molybdenum			--	mg/kg	ND	5.66	NA	NA	ND	5.52	NA	NA	ND	5.52	NA	NA	ND	5.57	NA	NA
Nickel			--	mg/kg	40.6	19.83	NA	NA	54.7	19.07	NA	NA	22.4	8.56	NA	NA	14.7	7.73	NA	NA
Selenium*			2	mg/kg	3.05	1.63	<1	<1	3.64	1.53	<1	2	ND	1.38	<1	NA	ND	1.39	<1	NA
Silver			--	mg/kg	ND	0.71	NA	NA	ND	0.69	NA	NA	ND	0.69	NA	NA	ND	0.70	NA	NA
Strontium			--	mg/kg	149	39.87	NA	NA	321	43.27	NA	NA	19.9	8.13	NA	NA	16.3	8.05	NA	NA
Thallium			--	mg/kg	ND	1.42	NA	NA	ND	1.38	NA	NA	ND	1.38	NA	NA	ND	1.39	NA	NA
Vanadium			--	mg/kg	80.1	46.90	NA	NA	78.6	31.53	NA	NA	36.6	13.08	NA	NA	26.3	14.42	NA	NA
Zinc	Survival and Growth	*Rana*	900-1200	mg/kg	132	58.99	<1	<1	113	46.95	<1	<1	84.8	32.35	<1	<1	54.1	32.38	<1	<1
		Bufo	1200	mg/kg	132	58.99	<1	<1	113	46.95	<1	<1	84.8	32.35	<1	<1	54.1	32.38	<1	<1
Calcium			--	mg/kg	3630	1712.17	NA	NA	58700	4810.78	NA	NA	1200	537.90	NA	NA	1630	764.40	NA	NA
Iron			--	mg/kg	48200	32966.67	NA	NA	40000	21851.11	NA	NA	19100	9607	NA	NA	18500	11126	NA	NA
Magnesium			--	mg/kg	9000	2544.17	NA	NA	7070	1807.61	NA	NA	2920	799.70	NA	NA	1490	773.20	NA	NA
Potassium			--	mg/kg	24700	4679.17	NA	NA	11700	2593.61	NA	NA	3340	1038.60	NA	NA	1480	835.60	NA	NA

Notes: Effect levels were obtained from NOEC (No Observed Effect Concentrations) values for survival and growth taken from Tables 3-6 and 3-7 of Naval Facilities Engineering Command (2004).
Bufo = American toad (*Bufo americanus*) and *Rana* = leopard frog (*Rana pipiens*).
When a range was presented for critical body residues, the NOEC on the low end of the range was used as a basis of comparison.
Maximum detection exceeds the limiting NOEC.
* = Screening value obtained from Lemley, A.D. 2002. Selenium assessment in aquatic ecosystems. U.S. Forest Service, Blacksburg, VA.
-- = No effect level available.
COPEC = Constituent of potential ecological concern.
ER = Emory River.
HQ = Hazard quotient.
mg/kg = Milligram per kilogram.
NA = Not available.
ND = All samples were non-detects.
RL = Reporting limit.