Rapid Bioassessment Methods for Accessing the Toxicity of Terrestrial Waste Sites at the Savannah River Site Using the Earth Worm, Eisenia Foetida

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RAPID BIOASSESSMENT METHODS FOR ASSESSING THE TOXICITY OF TERRESTRIAL WASTE SITES AT THE SAVANNAH RIVER SITE USING THE EARTHWORM, *Eisenia foetida* (U)

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EXECUTIVE SUMMARY

Studies were conducted to assess the feasibility of using the earthworm *Eisenia foetida* to evaluate the toxicity of contaminated soils at the Savannah River Site. Survival was assessed in several uncontaminated soils, including sandy loams and clayey loams, as well as in soils contaminated with coal fines, ash, diesel fuel, and heavy metals. In addition, behavioral responses, changes in biomass, and bioaccumulation of heavy metals were assessed as sublethal indicators of toxicity.

The results indicate excellent survival of *Eisenia foetida* in uncontaminated sandy and clayey soils. No amendment of these uncontaminated soils or addition of food was necessary to sustain the worms for the 14-day test period. In contaminated soils, no significant mortality was observed, except in soils have very low pH (< 3). However, sublethal responses were observed in earthworms exposed to several of the contaminated soils. These responses included worms clumping on the surface of the soil, worms clumping between the sides of the test container and the soil, increased burrowing times, reductions in biomass, and elevated concentrations of heavy metals in worm tissue.

In conclusion, earthworm mortality is not a sensitive indicator of SRS soil contamination, as evidenced by good survival of the earthworms in grossly contaminated soils. However, several sublethal responses were identified that can be used in assessing soil toxicity to earthworms. These responses include increases in burrowing time, increased weight loss, and bioaccumulation of heavy metals.

1.0 INTRODUCTION

Soil toxicity tests, using the earthworm *Eisenia foetida*, are a widely recognized tool for evaluating the toxicity of contaminated soils. Earthworms are ideal test organisms, due to their continual contact with the soil, their ingestion of soil particles, and ease of culture in the laboratory. Toxicity tests with earthworms are relatively simple and inexpensive to perform and the test results can be used not only to determine soil toxicity, but can also be used to determine uptake of soil contaminants by the worms and the potential for movement of contaminants up the food chain.

Although earthworm toxicity tests may be a valuable screening tool for the rapid assessment of waste sites at SRS and other DOE facilities, existing data indicate that *Eisenia* does best in loamy soils that have relatively high amounts of humus or other organic material, but generally will not survive for extended periods of time in the sandy and heavy clay soils that are common throughout much of the SRS (Edwards, 1992). Therefore, if toxicity assessments are performed using *Eisenia*, it may not be possible to distinguish between poor survival rates resulting from the effects of unsuitable soil texture and those resulting from the presence of contaminants. The primary objective of this task was to assess the feasibility of using earthworms for toxicity screening of waste site soils at SRS, by evaluating worm survival and sublethal responses in various uncontaminated and contaminated soils.

This investigation involved three sets of experiments. The first set of experiments assessed the survival of *Eisenia* in several uncontaminated soils from SRS in order to determine if amendment of the soils, via changes in particle size distribution and/or the addition of organic matter was necessary to prevent mortality during the 14-day test period. These tests were necessary in order to be able to separate the effects of unsuitable soil conditions from possible toxic effects of contaminants in waste site soils. The second set of experiments assessed the toxicity of several SRS waste site soils to *Eisenia*, using mortality as the test endpoint. The final set of experiments focused on sublethal indicators of toxicity with *Eisenia*, using some of the same waste site soils that were used previously, as well as one additional waste site soil.

2.0 METHODS

2.1 Culture Methods

The *Eisenia foetida* earthworms used in these experiments were obtained from Beaver River Associates, West Kingston, Rhode Island in May 1994. Upon receipt, the worms were placed in damp peat moss in three-gallon plastic containers (Rubbermaid tote boxes) and fed wetted alfalfa pellets twice weekly, using the culture methods described in La Tier and Landis, 1993. After a month, the worms were observed to be growing very slowly and there was no evidence of reproduction in the cultures. At this time the worms were transferred to composted horse manure and additional composted manure was added to the surface of the cultures weekly to provide additional food. Approximately every three months the worms were transferred to fresh composted manure, and the old bedding material was discarded. This method of culture yielded healthy cultures of worms with good rates of reproduction. All worms used in the toxicity tests were clitellid adults, with an average weight of greater than 300 mg.

2.2 Soils

Soils were collected from three uncontaminated locations and five waste site locations (Table 2-1). Approximately 20 kg of soil was collected at each location. The samples were placed in plastic bags and returned to the laboratory for processing and analyses. In the laboratory, a sample of each soil was dried at 105 °C for at least 24 hours and water holding capacity was determined (La Tier and Landis,1993). Organic content was determined by weighing approximately 10 g of the dried soil to the nearest 0.0001 g, ashing the sample in a crucible at a temperature of 550 °C for three hours, cooling the sample in a dessicator and reweighing. Organic matter was reported as the difference between dry and ashed weight. Metal analyses were performed on composted manure, synthetic reference soil, and the soils collected from waste sites known to contain metal contaminants, using inductively coupled plasma (ICP).

2.3 Toxicity Tests

Toxicity tests were conducted using the methods described in La Tier and Landis, (1993) and summarized as follows. Approximately 220 g of soil was wetted sufficiently to attain 75% water holding capacity. The soil was divided into three equal quantities and each aliquot was placed in a glass pint canning jar. Ten adult clitellid earthworms, with average weights of at least 300 mg were placed on the surface of the soil in each

sample jar and the lids were loosely screwed onto the jar. The jars were placed in an incubator at 22 °C ± 2 °C. At the end of 7 days and 14 days, survival rates were determined by gently shaking the soil from the jars onto a tray and counting the number of worms in the soil. After the 7-day observations, the soil was returned to the jars and the worms were placed back on the surface of the soil.

2-Chloracetamide was used as a reference toxicant in the toxicity tests (La Tier and Landis, 1993). Five concentrations of chloracetamide were added to a synthetic reference soil that consisted of 70% fine silica sand (70 mesh), 20% kaolin clay, and 10% peat moss. The synthetic soil was then hydrated to 75% moisture content. The LC50 values of the reference toxicant were determined. A negative control was also established using the synthetic soil without chloracetamide, in order to determine survival rates in the absence of the toxicant.

For the waste site soils, mortality was the primary endpoint in the initial round of testing that was performed. However, in subsequent testing, several sublethal indicators, including burrowing time, weight loss, other behavioral observations, and/or metal bioaccumulation were also assessed.

TABLE 2-1. Soils Selected for Acute Toxicity Testing with *Eisenia foetida*

Uncontaminated Soils	Soil Type
Orangeburg	Loamy sand; low organic content
Burma Road Clay Pit[1]	sandy clay loam; low organic content
Dorovan muck[2]	High water content; high organic content
Waste Site Soils	**Contaminants**
D-Area Coal Pile Runoff Basin	Metals, low pH
P-Area Coal Pile Runoff Basin	Metals, low pH
A-Area Burning Rubble Pit	Ash, metals
Silverton Road Site	Diesel fuel
Steed's Pond	Uranium, other metals

[1]Not a soil type, but a location. Includes subsoil layer of Orangeburg Association, but contains a much higher percentage of clay.

[2]This soil was characterized, but not used for toxicity testing, due to changes in soil structure that occurred during drying

3.0 RESULTS

3.1 Evaluations of Uncontaminated SRS Soils

3.1.1 Soil Sources/Characteristics

Three uncontaminated soil types were collected for toxicity evaluations: Orangeburg, Dorovan, and soil from the edges of the Burma Road clay pit. These three locations are representative of sandy loams, organic wetland soils, and clayey loams, respectively, and together provide a reasonable representation of the major types of soil that are present at the SRS. The characteristics of each of these soils is presented in Table 3-1.

Table 3-1. Characteristics of Orangeburg, Burma Road Clay, and Dorovan Soils

Parameter	Orangeburg	Burma Road Clay	Dorovan
Percent clay	4 to10	20 to 45	5 to 20
Percent organic matter	0.5 to 2	0.5 to 2	>60
pH	4.5 to 5.5	4.5 to 5.5	3.6 to 4.4
Moist bulk density (g/cc)	1.35 to 1.55	1.60 to 1.75	0.25 to 0.40
Permeability (in/hr)	2.0 to 6.0	0.6 to 2.0	0.6 to 2.0
Water capacity (in/in)	0.06 to 0.09	0.11 to 0.14	0.25 to 0.50

Source: U.S. Department of Agriculture, Soil Conservation Service. 1990. Soil Survey of Savannah River Plant Area, Parts of Aiken, Barnwell, and Allendale Counties, South Carolina.

The Dorovan soil was an extremely wet organic muck that contained approximately 60% organic material. When performing soil toxicity tests, soils are typically dried and then rehydrated to 70% water holding capacity. When the Dorovan soil was dried, it formed dried chunks of soil that would not rehydrate to a soil which resembled its original condition. Therefore, although water holding capacity and percent organic content were determined for this soil, toxicity tests were not performed with it. The remainder of Section 3.1 focuses on the Orangeburg and Burma Road clay pit soils.

In the initial investigations, it was believed that some amendment of the soils would probably be necessary to provide suitable substrate for the earthworms, so in addition to performing toxicity tests on these two soils, the Orangeburg soil was modified by sieving it through a 60 mesh sieve, in order to remove coarse sands. In addition, unsieved Orangeburg and Burma Road clay pit soils were amended by adding 5% and 10% (by weight) organic matter (peat moss) to the soil. Toxicity tests were run on these amended soils concurrently with the unamended soils.

3.1.2 Results of Toxicity Tests Conducted on Uncontaminated Soils

The results of the toxicity tests that were performed on uncontaminated soils are summarized in Table 3-2 and presented in entirety in Appendix 1.

TABLE 3-2 Percent Survival of *Eisenia foetida* in Amended and Unamended SRS Reference (Uncontaminated) Soils.

SOIL TYPE	REP. 1	REP. 2	REP. 3	MEAN
Orangeburg	100%	100%	80%	93%
Orangeburg + 5% organic	100%	100%	100%	100%
Orangeburg + 10% organic	100%	100%	90%	97%
Orangeburg, 60 mesh	100%	100%	100%	100%
Orangeburg, 60 mesh + 5% organic	100%	100%	100%	100%
Orangeburg, 60 mesh + 10% organic	100%	100%	100%	100%
Burma Road clay pit	100%	100%	100%	100%
Burma Road + 5% organic	100%	100%	90%	97%
Burma Road + 10% organic	100%	100%	90%	97%

The results of the toxicity tests show acceptable levels of survival (≥90%) for all of the unamended and amended soils that were tested. These results indicate that the sandy and clayey soils that dominate the SRS will support earthworms for the duration of a 14-day test and the results suggest that amendment of waste site soils will probably be unnecessary, unless the waste site soils are extremely coarse-grained.

3.2 Acute Toxicity of SRS Waste Site Soils

3.2.1 Soil Sources/Characteristics

Five waste site soils from the SRS were evaluated for acute toxicity. These soils and classes of toxicants associated with them are listed in Table 2-1. Soil Characterization data are presented in Table 3-3. Metal analyses for the D-Coal Pile Runoff Basin, P-Coal Pile Runoff Basin, and Steed's Pond, as well as for the composted bedding material and a synthetic reference soil are presented in Table 3-4.

The results of the metals analyses indicate that the compost had higher concentrations of calcium, potassium, magnesium, manganese, sodium, and zinc that the waste site soils. The synthetic reference soil had higher concentrations of calcium than the waste site soils. Of the remaining metals, most were higher in the waste site soils than in the compost or synthetic reference soil. The two coal pile runoff basin soils were fairly similar, with greatly elevated concentrations of aluminum and iron, and somewhat

elevated concentrations of arsenic, barium, beryllium, cadmium, cobalt, chromium, nickel, lead and vanadium.

Steed's Pond had very high concentrations of aluminum, chromium, iron, nickel, uranium, and vanadium, and somewhat elevated concentrations of arsenic, barium, beryllium, cadmium, cobalt, copper, and lead. Concentrations in the soils vs. earthworms is discussed in Section 3.4.4.

Table 3-3 Soil Characterization Data for Test Soils

Soil	pH	% Organic Content	Water Holding Capacity
June-July 1994			
Orangeburg	5.20	1.90	27.86 ml/100g
Burma Road Clay	5.04	1.24	40.68 ml/100g
Dorovan	4.05	72.53	166.6 ml/100g
Silverton Road Waste Site	5.71	16.66	106.49 ml/100g
A-Area Burning Rubble Pit	5.46	4.03	26.32 ml/100g
D-Coal Pile Runoff Basin	2.61	18.52	46.02 ml/100g
P-Coal Pile Runoff Basin	3.39	18.83	52.53 ml/100g
April 1995			
D-Coal Pile Runoff Basin	2.33		
DCPRB + Compost	2.62		
P-Coal Pile Runoff Basin	3.38		
Steed's Pond	3.65		
Compost	5.64		
Artificial Soil	6.19		

3.2.2 Results of Acute Toxicity Tests Conducted on SRS Waste Site Soils

The results of acute toxicity tests conducted on *Eisenia foetida* in five SRS waste site soils are summarized in Table 3-5 and presented in entirety in Appendix 2.

Table 3-4 Metal Concentrations (mg/kg) of Reference Soils and Waste Site Soils

Metal (mg/kg)	Compost	Artificial Soil	DCPRB	PCPRB	Steed's Pond
Aluminum	877	1490	4800	6020	29700
Arsenic	0.54	2.66	27.9	12.9	17.5
Barium	21	19.8	49.8	48.9	99.6
Beryllium	0.04	0.14	0.39	1.26	0.75
Calcium	3470	1470	224	380	142
Cadmium	0.37	0.11	1.22	0.45	1.22
Cobalt	0.6	0.2	1.46	2.99	3.7
Chromium	2.09	5	8.69	14.1	98
Copper	17	2.41	11.1	16.6	51.5
Iron	1150	2070	34900	12700	33700
Potassium	1820	27.8	494	140	200
Magnesium	1560	70.7	244	100	241
Manganese	174	5.77	25.6	8.59	141
Sodium	353	9.73	95.1	68.5	36
Nickel	0.98	0.46	6.23	6.93	745
Lead	4.85	2.65	11.1	6.5	47.5
Antimony	0.58	<DL	0.15	0.25	0.37
Selenium	1.09	<DL	1.42	2.01	0.75
Uranium	0.04	<DL	2.17	1.37	2140
Vanadium	2.91	10.4	23.9	32.5	73.7
Zinc	162	2.51	12.7	7.54	55.5

Table 3-5 Percent Survival of *Eisenia foetida* in SRS Waste Site Soils

SOIL TYPE	REP. 1	REP. 2	REP. 3	MEAN
June/July 1994				
D Coal Pile Runoff Basin	100%	100%	100%	100%
P Coal Pile Runoff Basin[1]	100%			100%
A Burning Rubble Pit	90%	90%	90%	90%
Silverton Road Site	100%	100%	100%	100%
March/April 1995				
D Coal Pile Runoff Basin	0%	0%	0%	0%
D CPRB + 50% compost	100%	100%	100%	100%
P Coal Pile Runoff Basin	100%	100%	100%	100%
Steed's Pond	100%	100%	100%	100%

[1]Only one replicate was tested.

The results indicate that with the exception of the D-Area coal pile runoff basin in April 1995, the waste site soils were not acutely toxic to *Eisenia foetida*. This waste site soil was not toxic when tested in July 1994. The difference in toxicity results in probably due to differences in pH The toxicity tests were performed on samples collected at different times (July and March) In July, the pH of the soil sample that was tested was 2.84, while the pH of the soil sample that was collected in March was substantially lower (2.33; Table 3-3). These toxicity results suggest that mortality of *Eisenia foetida* is not a sensitive indicator of contamination for SRS waste site soils, since the soils that were tested contained very high concentrations of contaminants.

3.3 Results of Toxicity Tests Conducted Using a Reference Toxicant

Two positive control toxicity tests were also performed using the reference toxicant, 2-chloracetamide, in order to document the sensitivity of the worms to a chemical for which there well-documented toxicity data (Table 3-6). These results indicate that the LC50 values (41.75 and 47.5 mg/kg) are reasonably close to the value reported in the literature (38.5 mg/kg; Edwards, 1984). These results suggest that the worms from our culture were healthy and responded normally to the reference toxicant. They also suggest that the responses of the worms in the waste site soils are credible.

Table 3-6 Percent Survival of *Eisenia foetida* in Toxicity Tests of a Reference Toxicant (2-Chloracetamide)

Test Conducted in September 1994

Concentration (mg/kg)	Rep. 1	Rep. 2	Rep. 3	Mean
0	100%	100%	100%	100%
28.5	100%	100%	100%	100%
38.5	90%	100%	100%	97%
50	20%	70%	20%	37%

LC50=47.5 mg/kg

Test Conducted in April 1995

Concentration (mg/kg)	Rep. 1	Rep. 2	Rep. 3	Mean
0	100%	100%	100%	100%
30	100%	100%	90%	97%
38.5	80%	60%	80%	73%
45	20%	20%	20%	20%
55	0%	0%	0%	0%

LC50=41.8 mg/kg

3.4 Sublethal Responses of *Eisenia foetida* to SRS Waste Site Soils

In the third round of testing, soils collected from the D-Area Coal Pile Runoff Basin and P Area Coal Pile Runoff Basin were retested, with the intent of focusing on sublethal indicators of toxicity. In addition, soil from the old pond bed of Steed's Pond was tested. Steed's Pond received effluents from M-Area and contains elevated concentrations of uranium and other metals. Because the D and P Coal Pile Runoff

Basin soils contained virtually no organic matter for the worms to eat, one additional treatment was tested, which consisted of a 50/50 mixture of D-Area Coal Pile Runoff Basin soil and compost. In addition to mortality, measurement endpoints included burrowing time, distribution in the soil, initial and final weights of the worms, change in weight, and percent weight loss.

3.4.1 Burrowing Time

The average time required for all of the worms to burrow into the soil when initially placed on the surface of the soil ranged from 5.5 minutes for the compost to >1 hour for the D-Coal Pile Runoff Basin and D-Coal Pile Runoff Basin + Compost treatments (Table 3-7). In the case of the D-Coal Pile Runoff Basin treatment, the worms never burrowed, but were found dead on the surface of the soil at the end of three days. The time required for the worms to burrow into the compost treatment was statistically compared to each of the other treatments, using a Mann-Whitney U Test. The results indicate that burrowing time was not significantly different for the artificial soil ($p=0.6579$), but was significantly longer for each of the waste site soils (Table 3-8; Appendix 4). Thus, burrowing time appears to be a good sublethal indicator of potential stress.

Table 3-8. Results of Mann-Whitney U Tests for Burrowing Time and Weight Loss

Treatment	Burrowing Time	Weight Loss
Reference soil	0.6579	0.0495
D-Coal Pile Runoff Basin	0.0369	-[a]
P-Coal Pile Runoff Basin	0.0495	0.0495
D-Coal Pile Runoff Basin + Compost	0.0369	0.0495
Steed's Pond	0.0495	0.0495

All results are compared to the results for the Compost treatment. $P<0.05$ is statistically significant.
[a]100% mortality; weight loss could not be determined.

3.4.2 Weight Loss

The earthworms in each of the treatments, including the compost and the artificial soil lost weight during the course of the 14-day test (Table 3-7), which suggests that the test conditions are somewhat stressful to the worms. The worms were reared in large (40 to 60 liter containers), and it is likely that the stress of the worms being handled while sorting and weighing them, and the stress of being placed into small (1/2 liter) containers affected them to some extent. The average percent weight loss of the

Table 3-7. Sublethal Responses of *Eisenia foetida* to Several Waste Site Soils

PARAMETER	ARTIFICIAL SOIL	COMPOST	STEED'S	P CPRB	D CPRB	CPRB + COMPOST
BURROWING TIME (minutes)	5.6	5.5	15.7	12.3	a	>60
14-day SURVIVAL	100%	100%	100%	100%	0%	100%
INITIAL WEIGHT/WORM (g)	0.308	0.306	0.302	0.298	0.296	0.302
FINAL WEIGHT/WORM (g)	0.256	0.267	0.242	0.223	–	0.242
WEIGHT CHANGE (g)	0.051	0.0393	0.0599	0.0745	–	0.0599
PERCENT WEIGHT LOSS	16.7	12.8	19.9	25.0	–	19.0
DISTRIBUTION	EVEN	EVEN	EVEN	CLUMPED NEAR BOTTOM	NEVER BURROWED	EVEN

[a] Worms never burrowed.

Steed's = Steed's Pond of Tim's Branch

P CPRB = P Area Coal Pile Runoff Basin

D CPRB = D Area Coal Pile Runoff Basin

D CPRB + Compost = 50% D CPRB + 50% Compost

worms during the 14 day test ranged from 12.8% for the compost to 25% for P-Coal Pile Runoff Basin. In the case of the D-Coal Pile Runoff Basin treatment, the worms experienced 100% mortality within a few days, so percent weight loss could not be determined. The percent weight loss was statistically compared to each of the other treatments, using a Mann-Whitney U Test. The results indicate that percent weight loss was significantly greater for each of the treatments, including the artificial soil (Table 3-9; Appendix 4). Thus, percent weight loss appears to be a good sublethal indicator of potential stress.

3.4.3 Distribution in the Soil

Observations during the first round of toxicity tests suggested that worms that were not obviously stressed were found distributed fairly evenly throughout the soil, while those in some of the treatments were found clumped together either in the bottom of the container or against the side of the container between the soil and the glass. Occasionally, the worms refused to burrow at all and remained clumped together on the surface of the soil. In order to determine the utility of using distribution as a sublethal indicator of stress, the distribution of the earthworms in each treatment was noted. The worms exposed to the D-Coal Pile Runoff Basin soil refused to burrow, while those in the P-Coal Pile Runoff Basin soil were found clumped together in the bottom of the jars. In the remainder of the treatments, the worms were fairly evenly distributed (Table 3-7). This suggests that extreme pH probably is responsible for the clumping behavior of the worms, but that the worms do not exhibit clumping behavior in some waste site soils. Therefore, although clumping certainly appears to be an indicator of severe stress, even distribution does not necessarily indicate lack of stress.

3.4.4 Bioaccumulation of Metals

As discussed in Section 3.2.1, the waste site soils contained elevated concentrations of most of the metals that were tested. However, fewer metals were found at elevated levels in the earthworms. In worms exposed to the coal pile runoff basin soils, aluminum, iron, lead, and nickel were slightly higher than those exposed to compost or artificial soil, but generally concentrations were less than a factor of two higher. However, in earthworms exposed to soil from Steed's Pond, barium, chromium, iron, manganese, lead and vanadium were somewhat elevated, while aluminum, nickel, and uranium were much higher. Aluminum levels were approximately 10 times higher in the Steed's Pond earthworms, nickel concentrations were approximately 25 times higher, and uranium, which was not detected in earthworms from the other treatments (detection limit was approximately 0.5 mg/kg) was detected at an average concentration of 116.67 mg/kg in earthworms from Steed's Pond.

These results indicate that many metals will bioaccumulate in earthworms. Elevated concentrations of these toxicants in earthworms can be used as an indication of exposure, and can also provide information useful in predicting the movement of metals to through the food chain to higher trophic levels. Elevated body burdens of metals is not necessarily an indication of stress, however. Further studies of the physiological responses of earthworms to elevated body burdens may be needed to document stress resulting from metal exposure.

Table 3-9. Average Metal Concentrations (mg/kg) in *Eisenia foetida* Exposed to Reference and Waste Site Soils

Metal (mg/kg)	Compost	Artificial Soil	DCPRB	PCPRB	Steed's Pond
Aluminum	53.83	66.1	107.27	129.67	576.67
Arsenic	10.46	17.19	7.58	7.67	11.4
Barium	1.02	1.11	0.68	0.7	3.75
Beryllium	0	0	0.01	0.01	0.01
Calcium	3620	3630	3563.33	3473.33	2786.67
Cadmium	5.94	5.87	5.1	6.12	6.5
Cobalt	7.99	9.93	5.82	7.59	10.03
Chromium	0.53	0.71	0.9	0.58	2.11
Copper	14.53	11.57	11.47	16.63	15.8
Iron	366.33	435.33	571.67	404.33	889.33
Potassium	6123.33	5840	6466.67	5306.67	5540
Magnesium	954	669.33	701	683	631.33
Manganese	16.6	7.36	10.05	10.38	49.17
Sodium	6790	5143.33	6543.33	4886.67	5363.33
Nickel	0.85	0.8	2.22	2.07	22.1
Lead	1.09	1.2	1.12	1.35	6.77
Antimony	2.62	2.6	1.99	2.22	2.13
Selenium	4.27	4.6	4.11	4.74	4.67
Uranium	<0.45	<0.51	<0.44	<0.58	116.67
Vanadium	0.27	0.45	0.35	0.28	1.38
Zinc	112.67	110.67	102.57	113.67	119.67

4.0 CONCLUSIONS

In conclusion, earthworm mortality is not a sensitive indicator of SRS soil contamination, as evidenced by good survival of the earthworms in grossly contaminated soils. However, several sublethal responses were identified that can be used in assessing soil toxicity to earthworms. These responses include increases in burrowing time, increased weight loss, and bioaccumulation of heavy metals in soils that contain elevated levels of metals.

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APPENDIX 1

Bench Sheets for Toxicity Testing of Uncontaminated Soils

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Burma Rd Clay Soil
Dilution/Concentration: 100%
Date Collected: 6/27/94
Collected by: W.L. Specht / S.N. Sydow
Start Date: 7/7/94
End Date: 7/21/94
pH: 5.04
pH meter: Orion It 031644
pH 4 Buffer: Fisher SB 98-500, Lot # 935207-24, exp 9/95
pH 7 Buffer: Fisher SB 107-500, Lot # 942613-24, exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	9/10	10/10

Notes/Observations:

14-days worms didn't re-burrow after 7-day check.

Rep 3 - one worm very sluggish

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Buena Rd Clay Soil
Dilution/Concentration: 95% soil 5% organic
Date Collected: 6/27/94
Collected by: W. L. Specht / S. N. Sydow
Start Date: 7/7/94
End Date: 7/21/94
pH: not measured
pH meter: —
pH 4 Buffer: —
pH 7 Buffer: —

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	9/10
14-Day Survival	10/10	10/10	9/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Burma Rd Soil
Dilution/Concentration: 90% soil 10% organic
Date Collected: 6/27/94
Collected by: W.L. Speidt / S.N. Sydow
Start Date: 7/7/94
End Date: 7/21/94
pH: Not measured
pH meter: —
pH 4 Buffer: —
pH 7 Buffer: —

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	9/10
14-Day Survival	10/10	10/10	9/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Orangeburg Soil
Dilution/Concentration: 100%
Date Collected: 6/14/94
Collected by: W.L. Specht / S.N. Sydow
Start Date: 6/16/94
End Date: 6/30/94
pH: 5.20
pH meter: Orion IT 031644
pH 4 Buffer: Fisher SB 98-500 Lot 935207-24 exp 9/95
pH 7 Buffer: Fisher SB 107-500 Lot 942613-24 exp 8/96
% organic matter = 1.9 %

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	8/10
14-Day Survival	10/10	10/10	8/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Orangeburg Soil

Dilution/Concentration: 90% orangeburg soil, 10% organic (peat moss)

Date Collected: 6/14/94

Collected by: W.L. Specht / S.N. Sydnor

Start Date: 6/16/94

End Date: 6/30/94

pH: 4.13

pH meter: Orion It 03164Y

pH 4 Buffer: Fisher SB98-500, Lot 935207-24, exp 9/95

pH 7 Buffer: Fisher SB 107-500, Lot 942613-24, exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	9/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Orangeburg Soil

Dilution/Concentration: 95% orangeburg; 5% organic (peat moss)

Date Collected: 6/14/94

Collected by: W.L. Specht / S.N. Sydow

Start Date: 6/16/94

End Date: 6/30/94

pH: 4.06

pH meter: Orion IT 031644

pH 4 Buffer: Fisher SB 98-500, Lot # 935207-24, exp 9/95

pH 7 Buffer: Fisher SB 107-500, Lot 942613-24, exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	10/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Orangeburg, Sieved 60 mesh
Dilution/Concentration: 100% Soil

Date Collected: 6/14/94
Collected by: W.L. Specht/S.N. Sydow

Start Date: 6/21/94
End Date: 7/5/94

pH: 4.79
pH meter: Orion IT 031644

pH 4 Buffer: Fisher SB 78-500
pH 7 Buffer: Fisher SB 107-500

% organic = 2.5%

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	10/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source Orangeburg, sieved 60 mesh
Dilution/Concentration 95% soil 5% yeast mix

Date Collected 6/14/94
Collected by W.L. Specht / S.N. Sydow

Start Date 6/21/94
End Date 7/5/94

pH 4.23
pH meter Orion IT 031644

pH 4 Buffer Fisher SB 98-500 Lot 935207-24
pH 7 Buffer Fisher SB 107-500 Lot 942613-24

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	8/10	10/10	10/10
14-Day Survival	8/10	~~10~~ 9/10	10/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source Orangeburg sieved 60 mesh

Dilution/Concentration 90% soil 10% peat moss

Date Collected 6/14/94

Collected by W.L. Specht / S.N. Sydow

Start Date 6/21/94

End Date 7/5/94

pH 4.00

pH meter Orion IT 031644

pH 4 Buffer Fisher SB98-500 Lot 935207-24

pH 7 Buffer Fisher SB 107-500 Lot #942613-24

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	10/10

Notes/Observations:

7-day - Rep 1. 2 worms very sluggish

APPENDIX 2
Bench Sheets for Toxicity Testing of Contaminated Soils

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: D Coal Pile Runoff Basin
Dilution/Concentration: 100%
Date Collected: 7/5/94
Collected by: W.L. Specht/S.N. Sydow
Start Date: 7/7/94
End Date: 7/21/94
pH: 2.84
pH meter: Orion IT 031644
pH 4 Buffer: Fisher SB98-500 Lot 935207-24
pH 7 Buffer: Fisher SB107-500 Lot 942613-24

% organic = 18.52%

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	10/10

Notes/Observations:

7-day worms were balled up on surface - had never burrowed. Worms were inactive when first removed, but became active within 1 minute of removal

14 day - worms still balled up on surface - never burrowed.

contaminant = coal particulates

EARTHWORM TOXICITY TESTING BENCH SHEET

Source P coal Pile Runoff Basin
Dilution/Concentration 100%

Date Collected 6/17/94
Collected by W.L. Specht / S.N. Sydow

Start Date 6/23/94
End Date 7/7/94

pH 3.39
pH meter Orion #t 031644

pH 4 Buffer Fisher SB 98-500
Lot 935207-24
exp 9/95
pH 7 Buffer Fisher SB 107-500
Lot 942613-24
exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10		
7-Day Survival	10/10		
14-Day Survival	10/10		

Notes/Observations:

Just ran 1 replicate, since it seemed doubtful that worms can survive in this waste soil.

14-day - guessed wrong. Test will be repeated with 3 replicates at a later date

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: A Area Burning Rubble Pit Dilution/Concentration: 100%

Date Collected: 7/5/94 Collected by: W.L. Specht / S.N. Sydow

Start Date: 7/6/94 End Date: 7/20/94

pH: 5.46 pH meter: Orion IT 031644

pH 4 Buffer: Fisher SB 98-500 Lot 935207-24 pH 7 Buffer: Fisher SB 107-500 Lot 942613-24

% organic = 4.03%

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	9/10	9/10	10/10
14-Day Survival	9/10	9/10	9/10

Notes/Observations:

7-days - worms were active & behaving normally

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Silverton Burning Rubble Pit
Dilution/Concentration: 100%
Date Collected: 7/5/94
Collected by: W.L. Specht / S.N. Sydelko
Start Date: 7/7/94
End Date: 7/21/94
pH: 5.71
pH meter: Orion IT 031644
pH 4 Buffer: Fisher SB 98-500 Lot 935207-24
pH 7 Buffer: Fisher SB 107-500 Lot 942613-24
% organic = 16.667%

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	10/10

Notes/Observations:

7-day standing water on top of Reps 1 & 2
7-day Rep 1 All worms found in top half of soil
Reps 2 & 3 worms distributed evenly throughout soil
14 day 1 baby worm in Rep 2

contaminant = ash

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloroacetamide Kodak Lot 910478

Dilution/Concentration 0 mg/kg (control)

Date Collected —

Collected by Run W.C. Specht

Start Date 9/21/94

End Date 10/5/94

pH 6.65

pH meter orion LT 031644

pH 4 Buffer Fisher SS 98-500 Lot # 935207-24 exp 9/95

pH 7 Buffer Fisher SS 107-500 Lot # 942613-24 exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10/10	10/10	10/10
14-Day Survival	10/10	10/10	10/10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloracetamide Kodak Lot 910478

Dilution/Concentration 28.5 mg/kg

Date Collected ——

Run Collected by W. L. Specht

Start Date 9/21/94

End Date 10/5/94

pH 6.65

pH meter Orion IT 03164

pH 4 Buffer Fisher SB 98-500 Lot # 935207-24 exp 9/95

pH 7 Buffer Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10	10	10
14-Day Survival	10	10	10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloroacetamide

Dilution/Concentration 38.5 mg/kg

Date Collected ———

Collected by R.M. W. L. Specht

Start Date 9/21/94

End Date 10/5/95

pH 6.65

pH meter Orion IT 03164Y

pH 4 Buffer Fisher SB98-500 Lot # 935207-24 exp 9/95

pH 7 Buffer Fisher SB 107-500 Lot # 942613-24 exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	10	10	10
14-Day Survival	9	10	10

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloroacetamide

Dilution/Concentration 50 mg/kg

Date Collected —

~~Collected~~ Run by W. C. Spacht

Start Date 9/21/94

End Date 10/5/94

pH 6.65

pH meter Orion IT 03164Y

pH 4 Buffer Fisher SB98-500
Lot # 935207-24
exp 9/95

pH 7 Buffer Fisher SB107-500
Lot # 942613-24
exp 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
7-Day Survival	2	7	2
14-Day Survival	2	7	2

Notes/Observations:

APPENDIX 3
Bench Sheets for Sublethal Responses Toxicity Tests

EARTHWORM TOXICITY TESTING BENCH SHEET

Source	Compost	Dilution/Concentration	100%
Date Collected	3/15/95	Collected by	W.L. Specht
Start Date	4/5/95	End Date	4/19/95
pH	5.64	pH meter	Orion IT 031644
pH 4 Buffer	Fisher SB 98-500 Lot # 935207-24 exp. 9/95	pH 7 Buffer	Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	5.5 min	5.6 min	5.4 min
Initial Weight (g)	3.0915	3.2211	2.8788
Mean W_i/Worm (g)	0.3092	0.3221	0.2879
14-day Final Weight (g)	2.655	2.874	2.485
Mean W_f/Worm (g)	0.2655	0.2874	0.2485
Δ Weight/Worm	0.0437	0.0347	0.0394
% Weight Loss	14.1	10.8	13.7
7-Day Survival	10	10	10
14-Day Survival	10	10	10

Notes/Observations:

7-day worms were evenly distributed

14-day worms were evenly distributed

EARTHWORM TOXICITY TESTING BENCH SHEET

Source	Artificial Soil (negative control)	Dilution/Concentration	100%
Date Collected		Collected by	W.L. Specht
Start Date	4/5/95	End Date	4/19/95
pH	6.19	pH meter	Orion IT 031644
pH 4 Buffer	Fisher SB 98-500 Lot #935207-24 exp. 9/95	pH 7 Buffer	Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	5:22	7:30	4:00
Initial Weight (g)	3.2410	3.1820	2.8060
Mean W_i/Worm (g)	0.3241	0.3182	0.2806
14-day Final Weight (g)	2.753	2.712	2.220
Mean W_f/Worm (g)	0.2753	0.2712	0.2220
Δ Weight/Worm	0.0488	0.0470	0.0586
% Weight Loss	15.1	14.8	20.9
7-Day Survival	10	10	10
14-Day Survival	10	10	10

Notes/Observations:

7-day worms are evenly distributed

14-day worms are evenly distributed

EARTHWORM TOXICITY TESTING BENCH SHEET

Source	D coal Pile Runoff Basin	Dilution/Concentration	100%
Date Collected	3/29/95	Collected by	W.L. Specht
Start Date	4/5/95	End Date	4/19/95
pH	2.33	pH meter	Orion IT 031644
pH 4 Buffer	Fisher SB 98-500 Lot # 935207-24 exp. 9/95	pH 7 Buffer	Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	>1 hr	>1 hr	>1 hr
Initial Weight (g)	2.823	3.198	2.859
Mean W_i/Worm (g)	0.2823	0.3198	0.2859
14-day Final Weight (g)	—	—	—
Mean W_f/Worm (g)	—	—	—
Δ Weight/Worm	—	—	—
% Weight Loss	—	—	—
7-Day Survival	0	0	0
14-Day Survival			

Notes/Observations:

7-day Reps 1 & 2 all worms were on top of the soil & dead. They never burrowed. Rep 3 all worms were in the bottom, against the glass, in a clump. All were dead.

EARTHWORM TOXICITY TESTING BENCH SHEET

Source	P coal Pile Runoff Basin	Dilution/Concentration	100%
Date Collected	3/29/95	Collected by	W.L. Specht
Start Date	4/6/95	End Date	4/20/95
pH	3.38	pH meter	Orion IT 031644
pH 4 Buffer	Fisher SB 98-500 Lot # 935207-24 exp. 9/95	pH 7 Buffer	Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	14.00	9.3	13.5
Initial Weight (g)	3.000	2.894	3.037
Mean W_i/Worm (g)	.3000	.2894	.3037
14-day Final Weight (g)	2.208	2.298	2.189
Mean W_f/Worm (g)	0.2208	0.2298	0.2189
Δ Weight/Worm	0.0792	0.0596	0.0848
% Weight Loss	26.4	20.6	27.9
7-Day Survival	10	10	10
14-Day Survival	10	10	10

Notes/Observations:

7-day worms were all balled up together, between the side of the jar & the soil.

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: D coal P.G Runoff + compost
Dilution/Concentration: 50%
Date Collected: 3/29/95
Collected by: W.L. Specht
Start Date: 4/6/95
End Date: 4/20/95
pH: 2.62
pH meter: Orion IT 031644
pH 4 Buffer: Fisher SB 98-500, Lot # 935207-24, exp. 9/95
pH 7 Buffer: Fisher SB 107-500, Lot # 942613-24, exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	>1 hr	>1 hr	>1 hr
Initial Weight (g)	3.1388	3.1758	2.9920
Mean W_i/Worm (g)	0.3139	0.3176	0.2992
14-day Final Weight (g)	2.489	2.697	2.181
Mean W_f/Worm (g)	0.2489	0.2697	0.2181
Δ Weight/Worm	0.065	0.0479	0.0811
% Weight Loss	~~0.210~~ 20.7	~~0.151~~ 15.1	27.1
7-Day Survival	10	10	10
14-Day Survival	10	10	10

Notes/Observations:

7-day Worms were clumped together; Rep 1 on bottom; Rep 2 on side, against glass; Rep 3 on top

EARTHWORM TOXICITY TESTING BENCH SHEET

Source: Steed's Pond
Dilution/Concentration: 100%
Date Collected: 3/29/95
Collected by: W.L. Specht
Start Date: 4/5/95
End Date: 4/19/95
pH: 3.65
pH meter: Orion IT 031644
pH 4 Buffer: Fisher SB 98-500, Lot # 935207-24, exp. 9/95
pH 7 Buffer: Fisher SB 107-500, Lot # 942613-24, exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	8:54	21:38	16:38
Initial Weight (g)	2.971	2.949	3.138
Mean W_i/Worm (g)	0.2971	0.2949	0.3138
14-day Final Weight (g)	2.450	2.466	2.343
Mean W_f/Worm (g)	0.2450	0.2466	0.2343
Δ Weight/Worm	0.0521	0.0483	0.0795
% Weight Loss	17.5	16.4	25.3
7-Day Survival	10	10	10
14-Day Survival	10	10	10

Notes/Observations:

7-day - worms were distributed evenly

14-day - worms were distributed evenly

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloroacetamide Kodak Lot 910478

Dilution/Concentration 30 mg/kg

Date Collected _____

Collected by W.L. Specht

Start Date 4/5/95

End Date 4/19/95

pH 6.19

pH meter Orion IT 031644

pH 4 Buffer Fisher SB 98-500 Lot # 935207-24 exp. 9/95

pH 7 Buffer Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	11:00	10:55	4:05
Initial Weight (g)	3.043	2.810	3.161
Mean W_i/Worm (g)	0.3043	0.2810	0.3161
14-day Final Weight (g)	2.506	2.363	2.642
Mean W_f/Worm (g)	0.2506	0.2363	0.2935 ~~0.2642~~ WJS
Δ Weight/Worm	0.0537	0.0447	0.0226
% Weight Loss	17.6	15.9	7.1
7-Day Survival	10	10	9
14-Day Survival	10	10	9

Notes/Observations:

7-day worms are evenly distributed

14-day worms evenly distributed

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloroacetamide Kodak Lot # 910478

Dilution/Concentration 38.5 mg/kg

Date Collected _____

Collected by W.L. Specht

Start Date 4/5/95

End Date 4/19/95

pH 6.19

pH meter Orion IT 031644

pH 4 Buffer Fisher SB 98-500 Lot # 935207-24 exp. 9/95

pH 7 Buffer Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	8.0	8.0	8.1
Initial Weight (g)	3.223	3.391	3.135
Mean W_i/Worm (g)	0.3223	0.3391	0.3135
14-day Final Weight (g)	2.108	1.598	2.255
Mean W_f/Worm (g)	0.2635	0.266	0.2819
Δ Weight/Worm	0.0588	0.0731	.0316
% Weight Loss	18.2	21.6	10.1
7-Day Survival	8	6	8
14-Day Survival	8	6	8

Notes/Observations:

7-day worms evenly distributed

14-day - worms evenly distributed

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloracetamide Kodak Lot # 910478

Dilution/Concentration 45 mg/kg

Date Collected _____

Collected by W. L. Specht

Start Date 4/5/95

End Date 4/19/95

pH 6.20

pH meter Orion IT 031644

pH 4 Buffer Fisher SB 98-500 Lot # 935207-24 exp. 9/95

pH 7 Buffer Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	7.2	7.5	7.3
Initial Weight (g)	3.248	2.883	3.046
Mean W_i/Worm (g)	0.3248	0.2883	0.3046
14-day Final Weight (g)	0.438	0.450	0.420
Mean W_f/Worm (g)	0.219	0.225	0.210
Δ Weight/Worm	0.1058	0.0633	0.0946
% Weight Loss	32.6	22.0	31.1
7-Day Survival	2	2	2
14-Day Survival	2	2	2

Notes/Observations:

EARTHWORM TOXICITY TESTING BENCH SHEET

Source 2-chloroacetanilide Kodak Lot 910478

Dilution/Concentration 55 mg/kg

Date Collected _____

Collected by W. L. Specht

Start Date 4/5/95

End Date 4/19/95

pH 6.19

pH meter Orion IT 031644

pH 4 Buffer Fisher SB 98-500 Lot # 935207-24 exp. 9/95

pH 7 Buffer Fisher SB 107-500 Lot # 942613-24 exp. 8/96

Parameter	Rep 1	Rep 2	Rep 3
Number of worms	10	10	10
Burrowing Time (minutes)	8.5	12.7	18.6
Initial Weight (g)	2.786	3.127	3.324
Mean W_i/Worm (g)	0.2786	0.3127	0.3324
14-day Final Weight (g)	–	–	–
Mean W_f/Worm (g)	–	–	–
Δ Weight/Worm	–	–	–
% Weight Loss	–	–	–
7-Day Survival	0	0	0
14-Day Survival	–	–	–

Notes/Observations:

APPENDIX 4
Results of Mann-Whitney U Tests

-> TITLE 'Weight Loss M-W'.

-> SET LENGTH = NONE.

-> MISSING VALUES WTLOSS (99999).

-> LIST VARIABLES = ALL.

456 bytes of memory required for the LIST procedure.
240 bytes have already been acquired.
216 bytes remain to be acquired.

REP	BURTIME	UNITS	LOCATION	LOCCODE	WTLOSS
1.00	5.50	Minutes	Compost	1.00	14.10
1.00	5.40	Minutes	ArtSoil	2.00	15.10
1.00	60.00	Minutes	DCoal	3.00	99999.00
1.00	14.00	Minutes	PCoal	4.00	26.40
1.00	60.00	Minutes	DCPR	5.00	20.70
1.00	8.90	Minutes	Steeds	6.00	17.50
2.00	5.60	Minutes	Compost	1.00	10.80
2.00	7.50	Minutes	ArtSoil	2.00	14.80
2.00	60.00	Minutes	DCoal	3.00	99999.00
2.00	9.30	Minutes	PCoal	4.00	20.60
2.00	60.00	Minutes	DCPR	5.00	15.10
2.00	21.60	Minutes	Steeds	6.00	16.40
3.00	5.40	Minutes	Compost	1.00	13.70
3.00	4.00	Minutes	ArtSoil	2.00	20.90
3.00	60.00	Minutes	DCoal	3.00	99999.00
3.00	13.50	Minutes	PCoal	4.00	27.90
3.00	60.00	Minutes	DCPR	5.00	27.10
3.00	16.60	Minutes	Steeds	6.00	25.30

Number of cases read: 18 Number of cases listed: 18

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= wtloss BY loccode (1 2).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

WILOSS
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 2.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= wtloss BY loccode (1 3).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

WILOSS
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
.00	0	LOCCODE = 3.00
	3	Total

This test cannot be performed on empty groups.

Preceding task required 2.00 seconds elapsed.

-> NPAR TESTS /M-W= wtloss BY loccode (1 4).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

WTLOSS
by LOCCODE

Mean Rank	Cases	
2.00	3.	LOCCODE = 1.00
5.00	3	LOCCODE = 4.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= wtloss BY loccode (1 5).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

WILOSS
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 5.00
	6	Total

U	W	Exact 2-Tailed P	Corrected for ties Z	Corrected for ties 2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required 2.00 seconds elapsed.

-> NPAR TESTS /M-W= wtloss BY loccode (1 6).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

WILOSS
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 6.00
	6	Total

U	W	Exact 2-Tailed P	Corrected for ties Z	Corrected for ties 2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required .00 seconds elapsed.

```
-> TITLE
->  'Burrowing time by Soil Type-MW'.

-> SUBTITLE
->  ' '.

-> SET LENGTH = NONE.

-> LIST VARIABLES = ALL.

456 bytes of memory required for the LIST procedure.
240 bytes have already been acquired.
216 bytes remain to be acquired.
```


REP	BURTIME	UNITS	LOCATION	LOCCODE	WILOSS
1.00	5.50	Minutes	Compost	1.00	14.10
1.00	5.40	Minutes	ArtSoil	2.00	15.10
1.00	60.00	Minutes	DCoal	3.00	99999.00
1.00	14.00	Minutes	PCoal	4.00	26.40
1.00	60.00	Minutes	DCPR	5.00	20.70
1.00	8.90	Minutes	Steeds	6.00	17.50
2.00	5.60	Minutes	Compost	1.00	10.80
2.00	7.50	Minutes	ArtSoil	2.00	14.80
2.00	60.00	Minutes	DCoal	3.00	99999.00
2.00	9.30	Minutes	PCoal	4.00	20.60
2.00	60.00	Minutes	DCPR	5.00	15.10
2.00	21.60	Minutes	Steeds	6.00	16.40
3.00	5.40	Minutes	Compost	1.00	13.70
3.00	4.00	Minutes	ArtSoil	2.00	20.90
3.00	60.00	Minutes	DCoal	3.00	99999.00
3.00	13.50	Minutes	PCoal	4.00	27.90
3.00	60.00	Minutes	DCPR	5.00	27.10
3.00	16.60	Minutes	Steeds	6.00	25.30

```
Number of cases read:  18    Number of cases listed:  18
```



```
Preceding task required .00 seconds elapsed.

-> MISSING VALUES ALL (99999).

>Error # 4808 in column 16.  Text: UNITS
```

>Missing values are not available for long string variables.
>This command not executed.

-> NPAR TESTS /M-W= burtime BY loccode(1 2).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
3.83	3	LOCCODE = 1.00
3.17	3	LOCCODE = 2.00
	6	Total

U	W	Exact 2-Tailed P	Corrected for ties Z	Corrected for ties 2-Tailed P
3.5	11.5	.7000	-.4428	.6579

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(1 3).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 3.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-2.0868	.0369

Preceding task required 1.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(1 4).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 4.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required 1.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(1 5).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 5.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-2.0868	.0369

Preceding task required 1.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(1 6).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 1.00
5.00	3	LOCCODE = 6.00

--
6 Total

U	W	Exact 2-Tailed P	Corrected for ties Z	2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(2 2).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 2.00
.00	0	LOCCODE = 2.00
	--	
	3	Total

This test cannot be performed on empty groups.

Preceding task required 2.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(2 3).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 2.00
5.00	3	LOCCODE = 3.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-2.0868	.0369

Preceding task required..00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(2 4).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 2.00
5.00	3	LOCCODE = 4.00
	6	Total

	Exact	Corrected for ties

U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(2 5).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 2.00
5.00	3	LOCCODE = 5.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-2.0868	.0369

Preceding task required 2.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(2 6).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 2.00
5.00	3	LOCCODE = 6.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-1.9640	.0495

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(3 3).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 3.00
.00	0	LOCCODE = 3.00
	3	Total

This test cannot be performed on empty groups.

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(3 4).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
5.00	3	LOCCODE = 3.00
2.00	3	LOCCODE = 4.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	15.0	.1000	-2.0868	.0369

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(3 5).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
3.50	3	LOCCODE = 3.00
3.50	3	LOCCODE = 5.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
4.5	10.5	1.0000	.0000	1.0000

Preceding task required 1.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(3 6).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
5.00	3	LOCCODE = 3.00
2.00	3	LOCCODE = 6.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	15.0	.1000	-2.0868	.0369

Preceding task required 1.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(4 4).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 4.00
.00	0	LOCCODE = 4.00
	3	Total

This test cannot be performed on empty groups.

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(4 5).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 4.00
5.00	3	LOCCODE = 5.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
.0	6.0	.1000	-2.0868	.0369

Preceding task required 1.00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(4 6).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
3.00	3	LOCCODE = 4.00
4.00	3	LOCCODE = 6.00
	6	Total

		Exact	Corrected for ties	
U	W	2-Tailed P	Z	2-Tailed P
3.0	9.0	.7000	-.6547	.5127

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(5 5).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
2.00	3	LOCCODE = 5.00
.00	0	LOCCODE = 5.00
	--	
	3	Total

This test cannot be performed on empty groups.

Preceding task required .00 seconds elapsed.

-> NPAR TESTS /M-W= burtime BY loccode(5 6).

***** Workspace allows for 18724 cases for NPAR tests *****

- - - - - Mann-Whitney U - Wilcoxon Rank Sum W Test

BURTIME
by LOCCODE

Mean Rank	Cases	
5.00	3	LOCCODE = 5.00
2.00	3	LOCCODE = 6.00

--
6 Total

U	W	Exact 2-Tailed P	Corrected for ties Z	2-Tailed P
.0	15.0	.1000	-2.0868	.0369

Preceding task required 1.00 seconds elapsed.

APPENDIX 5
Metal Concentrations in Test Soils and Earthworms

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999887779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: COMPS
Lab ID	: 9508156-01
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	-4.18	62.3	62.3	UGKG	1.0	NRM	08/24/95	1843	71530	1
Aluminum		877000	298	500	UGKG	1.0					
Arsenic		537	46.5	125	UGKG	1.0					
Barium		21000	1.66	75.0	UGKG	1.0					
Beryllium	J	39.8	0.285	75.0	UGKG	1.0					
Calcium		3470000	500	500	UGKG	1.0					
Cadmium		372	2.43	50.0	UGKG	1.0					
Cobalt		604	4.40	100	UGKG	1.0					
Chromium		2090	14.9	100	UGKG	1.0					
Copper		17000	13.5	100	UGKG	1.0					
Iron		1150000	253	450	UGKG	1.0					
Potassium		1820000	161	12500	UGKG	1.0					
Magnesium		1560000	58.8	500	UGKG	1.0					
Manganese		174000	2.41	50.0	UGKG	1.0					
Sodium		353000	390	2500	UGKG	1.0					
Nickel		975	20.2	250	UGKG	1.0					
Lead		4850	28.3	125	UGKG	1.0					
Antimony		583	24.0	125	UGKG	1.0					
Selenium		1090	35.8	125	UGKG	1.0					
Thallium	U	-214	51.8	125	UGKG	1.0					
Uranium by ICP	U	44.4	151	500	UGKG	1.0					
Vanadium		2910	5.85	250	UGKG	1.0					
Zinc		162000	135	250	UGKG	2.0	NRM	08/24/95	2300	71530	1

The following prep procedures were performed:
TRACE

FGD 08/23/95 1730 71530 2

P O Box 30712 • Charleston, SC 29417 • (803) 556-8171 • Fax (803) 766-1178

Printed on recycled paper

9508156-01

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999887791	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: ARTS
Lab ID	: 9508156-04
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	-154	60.5	60.5	UGKG	1.0	NRM	08/24/95	1857	71530	1
Aluminum		1490000	289	486	UGKG	1.0					
Arsenic		2660	45.2	122	UGKG	1.0					
Barium		19800	1.61	72.9	UGKG	1.0					
Beryllium		138	0.277	72.9	UGKG	1.0					
Calcium		1470000	486	486	UGKG	1.0					
Cadmium		105	2.36	48.6	UGKG	1.0					
Cobalt		204	4.28	97.2	UGKG	1.0					
Chromium		5000	14.5	97.2	UGKG	1.0					
Copper		2410	13.1	97.2	UGKG	1.0					
Iron		2070000	245	437	UGKG	1.0					
Potassium		27800	156	12200	UGKG	1.0					
Magnesium		70700	57.1	486	UGKG	1.0					
Manganese		5770	2.34	48.6	UGKG	1.0					
Sodium		9730	379	2430	UGKG	1.0					
Nickel		461	19.6	243	UGKG	1.0					
Lead		2650	27.5	122	UGKG	1.0					
Antimony	U	-62.4	23.3	122	UGKG	1.0					
Selenium	U	-75.1	34.7	122	UGKG	1.0					
Thallium	U	-446	101	243	UGKG	2.0	NRM	08/24/95	2328	71530	1
Uranium by ICP	U	-3930	293	972	UGKG	2.0					
Vanadium		10400	5.69	243	UGKG	1.0	NRM	08/24/95	1857	71530	1
Zinc		2510	65.6	122	UGKG	1.0					

The following prep procedures were performed:

TRACE FGD 08/23/95 1730 71530 2

P O Box 30712 • Charleston, SC 29417 • (803) 556-8171 • Fax (803) 766-1178

9508156-04

Printed on recycled paper.

09/01/95 14:59 (803 852 5812 GEN. ENGINEERING 008

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID	: DCPRBS
Lab ID	: 9508156-03
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	20.9	60.5	60.5	UGKG	1.0	NRM	08/24/95	1852	71530	1
Aluminum		4800000	289	486	UGKG	1.0					
Arsenic		27900	45.2	122	UGKG	1.0					
Barium		49800	1.61	72.9	UGKG	1.0					
Beryllium		389	0.277	72.9	UGKG	1.0					
Calcium		224000	486	486	UGKG	1.0					
Cadmium		1220	2.36	48.6	UGKG	1.0					
Cobalt		1460	4.28	97.2	UGKG	1.0					
Chromium		8690	14.5	97.2	UGKG	1.0					
Copper		11100	13.1	97.2	UGKG	1.0					
Iron		34900000	1230	2190	UGKG	5.0	NRM	08/24/95	2323	71530	1
Potassium		494000	156	12200	UGKG	1.0	NRM	08/24/95	1852	71530	1
Magnesium		244000	57.1	486	UGKG	1.0					
Manganese		25600	2.34	48.6	UGKG	1.0					
Sodium		95100	379	2430	UGKG	1.0					
Nickel		6230	19.6	243	UGKG	1.0					
Lead		11100	27.5	122	UGKG	1.0					
Antimony		145	23.3	122	UGKG	1.0					
Selenium		1420	34.7	122	UGKG	1.0					
Thallium	U	-44.3	252	608	UGKG	5.0	NRM	08/24/95	2323	71530	1
Uranium by ICP		2170	146	486	UGKG	1.0	NRM	08/24/95	1852	71530	1
Vanadium		23900	5.69	243	UGKG	1.0					
Zinc		12700	65.6	122	UGKG	1.0					

The following prep procedures were performed:
TRACE FGD 08/23/95 1730 71530 2

GENERAL ENGINEERING LABORATORIES

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID : PCPRBS
Lab ID : 9508156-02
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	-3.27	59.3	59.3	UGKG	1.0	NRM	08/24/95	1847	71530	1
Aluminum		6020000	283	476	UGKG	1.0					
Arsenic		12900	44.3	119	UGKG	1.0					
Barium		48900	1.58	71.4	UGKG	1.0					
Beryllium		1260	0.271	71.4	UGKG	1.0					
Calcium		380000	476	476	UGKG	1.0					
Cadmium		447	2.31	47.6	UGKG	1.0					
Cobalt		2990	4.19	95.2	UGKG	1.0					
Chromium		14100	14.2	95.2	UGKG	1.0					
Copper		16600	12.8	95.2	UGKG	1.0					
Iron		12700000	481	857	UGKG	2.0	NRM	08/24/95	2318	71530	1
Potassium		140000	153	11900	UGKG	1.0	NRM	08/24/95	1847	71530	1
Magnesium		100000	55.9	476	UGKG	1.0					
Manganese		8590	2.29	47.6	UGKG	1.0					
Sodium		68500	371	2380	UGKG	1.0					
Nickel		6930	19.2	238	UGKG	1.0					
Lead		6500	26.9	119	UGKG	1.0					
Antimony		249	22.8	119	UGKG	1.0					
Selenium		2010	34.0	119	UGKG	1.0					
Thallium	U	-187	49.3	119	UGKG	1.0					
Uranium by ICP		1370	143	476	UGKG	1.0					
Vanadium		32500	5.57	238	UGKG	1.0					
Zinc		7540	64.3	119	UGKG	1.0					

The following prep procedures were performed:

TRACE	FGD	08/23/95	1730	71530	2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID : STEDS
Lab ID : 9508156-20
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver		10900	59.8	59.8	UGKG	1.0	NRM	08/24/95	2025	71530	1
Aluminum		29700000	1430	2400	UGKG	5.0	NRM	08/24/95	2349	71530	1
Arsenic		17500	44.6	120	UGKG	1.0	NRM	08/24/95	2025	71530	1
Barium		99600	1.59	72.0	UGKG	1.0					
Beryllium		750	0.274	72.0	UGKG	1.0					
Calcium		142000	480	480	UGKG	1.0					
Cadmium		1220	2.33	48.0	UGKG	1.0					
Cobalt		3700	4.22	96.0	UGKG	1.0					
Chromium		98000	14.3	96.0	UGKG	1.0					
Copper		51500	12.9	96.0	UGKG	1.0					
Iron		33700000	1210	2160	UGKG	5.0	NRM	08/24/95	2349	71530	1
Potassium		200000	154	12000	UGKG	1.0	NRM	08/24/95	2025	71530	1
Magnesium		241000	56.4	480	UGKG	1.0					
Manganese		141000	2.31	48.0	UGKG	1.0					
Sodium		36000	374	2400	UGKG	1.0					
Nickel		745000	96.8	1200	UGKG	5.0	NRM	08/24/95	2349	71530	1
Lead		47500	27.1	120	UGKG	1.0	NRM	08/24/95	2025	71530	1
Antimony		373	23.0	120	UGKG	1.0					
Selenium		750	34.3	120	UGKG	1.0					
Thallium	U	-329	248	600	UGKG	5.0	NRM	08/24/95	2349	71530	1
Uranium by ICP		2140000	722	2400	UGKG	5.0					
Vanadium		73700	5.62	240	UGKG	1.0	NRM	08/24/95	2025	71530	1
Zinc		55500	64.8	120	UGKG	1.0					

The following prep procedures were performed:

TRACE	FGD	08/23/95	1730	71530	2

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9508156-20

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999387779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: COMP-1
Lab ID	: 9508156-08
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	53.9	177	177	UGKG	1.0	NRM	08/24/95	1915	71530	1
Aluminum		58400	847	1420	UGKG	1.0					
Arsenic		11100	132	356	UGKG	1.0					
Barium		1130	4.72	214	UGKG	1.0					
Beryllium	J	1.78	0.812	214	UGKG	1.0					
Calcium		3580000	1420	1420	UGKG	1.0					
Cadmium		5540	6.91	142	UGKG	1.0					
Cobalt		7860	12.5	285	UGKG	1.0					
Chromium		523	42.4	285	UGKG	1.0					
Copper		15400	38.4	285	UGKG	1.0					
Iron		342000	719	1280	UGKG	1.0					
Potassium		6340000	458	35600	UGKG	1.0					
Magnesium		976000	167	1420	UGKG	1.0					
Manganese		22200	6.85	142	UGKG	1.0					
Sodium		6930000	1110	7120	UGKG	1.0					
Nickel		859	57.5	712	UGKG	1.0					
Lead		1070	80.5	356	UGKG	1.0					
Antimony		3000	68.2	356	UGKG	1.0					
Selenium		4270	102	356	UGKG	1.0					
Thallium	U	-1300	147	356	UGKG	1.0					
Uranium by ICP	U	-114	429	1420	UGKG	1.0					
Vanadium	J	299	16.7	712	UGKG	1.0					
Zinc		114000	192	356	UGKG	1.0					

The following prep procedures were performed:

TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999887791	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: COMP-2
Lab ID	: 9508156-09
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	35.0	158	158	UGKG	1.0	NRM	08/24/95	1920	71530	1
Aluminum		51100	756	1270	UGKG	1.0					
Arsenic		8770	118	318	UGKG	1.0					
Barium		1010	4.21	191	UGKG	1.0					
Beryllium	J	1.86	0.724	191	UGKG	1.0					
Calcium		3410000	1270	1270	UGKG	1.0					
Cadmium		6010	6.16	127	UGKG	1.0					
Cobalt		7840	11.2	254	UGKG	1.0					
Chromium		482	37.8	254	UGKG	1.0					
Copper		13700	34.2	254	UGKG	1.0					
Iron		359000	641	1140	UGKG	1.0					
Potassium		5760000	408	31800	UGKG	1.0					
Magnesium		921000	149	1270	UGKG	1.0					
Manganese		13900	6.11	127	UGKG	1.0					
Sodium		6610000	991	6350	UGKG	1.0					
Nickel		839	51.2	635	UGKG	1.0					
Lead		1090	71.8	318	UGKG	1.0					
Antimony		2210	60.8	318	UGKG	1.0					
Selenium		4240	90.8	318	UGKG	1.0					
Thallium	U	-1250	131	318	UGKG	1.0					
Uranium by ICP	U	-244	382	1270	UGKG	1.0					
Vanadium	J	264	14.9	635	UGKG	1.0					
Zinc		108000	171	318	UGKG	1.0					

The following prep procedures were performed:

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Laboratory Certifications

STATE	GEL	EPI
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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID : COMP-3
Lab ID : 9508156-10
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	46.7	185	185	UGKG	1.0	NRM	08/24/95	1924	71530	1
Aluminum		52000	885	1490	UGKG	1.0					
Arsenic		11500	138	372	UGKG	1.0					
Barium		917	4.93	223	UGKG	1.0					
Beryllium	J	1.90	0.848	223	UGKG	1.0					
Calcium		3870000	1490	1490	UGKG	1.0					
Cadmium		6280	7.22	149	UGKG	1.0					
Cobalt		8280	13.1	298	UGKG	1.0					
Chromium		598	44.3	298	UGKG	1.0					
Copper		14500	40.1	298	UGKG	1.0					
Iron		398000	751	1340	UGKG	1.0					
Potassium		6270000	478	37200	UGKG	1.0					
Magnesium		965000	175	1490	UGKG	1.0					
Manganese		13900	7.16	149	UGKG	1.0					
Sodium		6830000	1160	7440	UGKG	1.0					
Nickel		861	60.0	744	UGKG	1.0					
Lead		1110	84.1	372	UGKG	1.0					
Antimony		2650	71.3	372	UGKG	1.0					
Selenium		4300	106	372	UGKG	1.0					
Thallium	U	-1380	154	372	UGKG	1.0					
Uranium by ICP	U	-778	448	1490	UGKG	1.0					
Vanadium	J	261	17.4	744	UGKG	1.0					
Zinc		116000	201	372	UGKG	1.0					

The following prep procedures were performed:
TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID	: ART-1
Lab ID	: 9508156-05
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	94.2	202	202	UGKG	1.0	NRM	08/24/95	1901	71530	1
Aluminum		35800	966	1620	UGKG	1.0					
Arsenic		8530	151	406	UGKG	1.0					
Barium		922	5.38	244	UGKG	1.0					
Beryllium	U	-0.685	0.926	244	UGKG	1.0					
Calcium		3650000	1620	1620	UGKG	1.0					
Cadmium		5730	7.88	162	UGKG	1.0					
Cobalt		10300	14.3	325	UGKG	1.0					
Chromium		449	48.4	325	UGKG	1.0					
Copper		10500	43.8	325	UGKG	1.0					
Iron		414000	820	1460	UGKG	1.0					
Potassium		5710000	522	40600	UGKG	1.0					
Magnesium		660000	191	1620	UGKG	1.0					
Manganese		6760	7.81	162	UGKG	1.0					
Sodium		5110000	1270	8120	UGKG	1.0					
Nickel	J	697	65.5	812	UGKG	1.0					
Lead		1100	91.8	406	UGKG	1.0					
Antimony		2160	77.8	406	UGKG	1.0					
Selenium		4850	116	406	UGKG	1.0					
Thallium	U	-1020	168	406	UGKG	1.0					
Uranium by ICP	U	-658	489	1620	UGKG	1.0					
Vanadium	J	324	19.0	812	UGKG	1.0					
Zinc		112000	219	406	UGKG	1.0					

The following prep procedures were performed:

TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID : ART-2
Lab ID : 9508156-06
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	65.0	189	189	UGKG	1.0	NRM	08/24/95	1906	71530	1
Aluminum		79700	904	1520	UGKG	1.0					
Arsenic		36000	141	380	UGKG	1.0					
Barium		1160	5.04	228	UGKG	1.0					
Beryllium	J	5.07	0.866	228	UGKG	1.0					
Calcium		3570000	1520	1520	UGKG	1.0					
Cadmium		6420	7.37	152	UGKG	1.0					
Cobalt		11100	13.4	304	UGKG	1.0					
Chromium		1070	45.3	304	UGKG	1.0					
Copper		13800	41.0	304	UGKG	1.0					
Iron		510000	768	1370	UGKG	1.0					
Potassium		5950000	489	38000	UGKG	1.0					
Magnesium		678000	179	1520	UGKG	1.0					
Manganese		8470	7.31	152	UGKG	1.0					
Sodium		5450000	1190	7600	UGKG	1.0					
Nickel		873	61.3	760	UGKG	1.0					
Lead		1190	85.9	380	UGKG	1.0					
Antimony		2670	72.8	380	UGKG	1.0					
Selenium		4950	109	380	UGKG	1.0					
Thallium	U	-1120	157	380	UGKG	1.0					
Uranium by ICP	U	-121	458	1520	UGKG	1.0					
Vanadium	J	613	17.8	760	UGKG	1.0					
Zinc		113000	205	380	UGKG	1.0					

The following prep procedures were performed:

TRACE	FGD	08/23/95	1730	71530	2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999887791	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID	: ART-3
Lab ID	: 9508156-07
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	34.4	213	213	UGKG	1.0	NRM	08/24/95	1911	71530	1
Aluminum		82800	1020	1710	UGKG	1.0					
Arsenic		7050	159	428	UGKG	1.0					
Barium		1240	5.68	257	UGKG	1.0					
Beryllium	J	1.77	0.976	257	UGKG	1.0					
Calcium		3670000	1710	1710	UGKG	1.0					
Cadmium		5470	8.30	171	UGKG	1.0					
Cobalt		8400	15.1	342	UGKG	1.0					
Chromium		599	51.0	342	UGKG	1.0					
Copper		10400	46.1	342	UGKG	1.0					
Iron		382000	865	1540	UGKG	1.0					
Potassium		5860000	550	42800	UGKG	1.0					
Magnesium		670000	201	1710	UGKG	1.0					
Manganese		6850	8.23	171	UGKG	1.0					
Sodium		4870000	1340	8560	UGKG	1.0					
Nickel	J	820	69.1	856	UGKG	1.0					
Lead		1300	96.7	428	UGKG	1.0					
Antimony		2970	82.0	428	UGKG	1.0					
Selenium		3990	122	428	UGKG	1.0					
Thallium	U	-1200	177	428	UGKG	1.0					
Uranium by ICP	U	-204	515	1710	UGKG	1.0					
Vanadium	J	422	20.0	856	UGKG	1.0					
Zinc		107000	231	428	UGKG	1.0					

The following prep procedures were performed:

TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID	: DCPRB-1
Lab ID	: 9508156-11
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	40.3	182	182	UGKG	1.0	NRM	08/24/95	1943	71530	1
Aluminum		82200	868	1460	UGKG	1.0					
Arsenic		6970	136	365	UGKG	1.0					
Barium		521	4.83	219	UGKG	1.0					
Beryllium	J	7.37	0.831	219	UGKG	1.0					
Calcium		3620000	1460	1460	UGKG	1.0					
Cadmium		4940	7.07	146	UGKG	1.0					
Cobalt		5840	12.8	292	UGKG	1.0					
Chromium		709	43.4	292	UGKG	1.0					
Copper		11900	39.3	292	UGKG	1.0					
Iron		504000	736	1310	UGKG	1.0					
Potassium		6110000	469	36500	UGKG	1.0					
Magnesium		670000	171	1460	UGKG	1.0					
Manganese		8950	7.01	146	UGKG	1.0					
Sodium		6290000	1140	7290	UGKG	1.0					
Nickel		2830	58.8	729	UGKG	1.0					
Lead		1080	82.4	365	UGKG	1.0					
Antimony		1690	69.8	365	UGKG	1.0					
Selenium		4310	104	365	UGKG	1.0					
Thallium	U	-989	151	365	UGKG	1.0					
Uranium by ICP	U	-409	439	1460	UGKG	1.0					
Vanadium	J	283	17.1	729	UGKG	1.0					
Zinc		99700	197	365	UGKG	1.0					

The following prep procedures were performed:
TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID : DCPRB-2
Lab ID : 9508156-12
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	25.9	181	181	UGKG	1.0	NRM	08/24/95	1948	71530	1
Aluminum		188000	865	1450	UGKG	1.0					
Arsenic		9760	135	364	UGKG	1.0					
Barium		1180	4.82	218	UGKG	1.0					
Beryllium	J	13.2	0.829	218	UGKG	1.0					
Calcium		3700000	1450	1450	UGKG	1.0					
Cadmium		5840	7.05	145	UGKG	1.0					
Cobalt		6200	12.8	291	UGKG	1.0					
Chromium		1320	43.3	291	UGKG	1.0					
Copper		12300	39.2	291	UGKG	1.0					
Iron		827000	734	1310	UGKG	1.0					
Potassium		6190000	467	36400	UGKG	1.0					
Magnesium		702000	171	1450	UGKG	1.0					
Manganese		11200	6.99	145	UGKG	1.0					
Sodium		6000000	1130	7270	UGKG	1.0					
Nickel		2130	58.7	727	UGKG	1.0					
Lead		1330	82.2	364	UGKG	1.0					
Antimony		1960	69.6	364	UGKG	1.0					
Selenium		4130	104	364	UGKG	1.0					
Thallium	U	-940	150	364	UGKG	1.0					
Uranium by ICP	U	-567	438	1450	UGKG	1.0					
Vanadium	J	575	17.0	727	UGKG	1.0					
Zinc		105000	196	364	UGKG	1.0					

The following prep procedures were performed:
TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: DCPRB-3
Lab ID	: 9508156-13
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	28.8	224	224	UGKG	1.0	NRM	08/24/95	1953	71530	1
Aluminum		51600	1070	1800	UGKG	1.0					
Arsenic		6000	167	450	UGKG	1.0					
Barium		350	5.96	270	UGKG	1.0					
Beryllium	J	3.45	1.02	270	UGKG	1.0					
Calcium		3370000	1800	1800	UGKG	1.0					
Cadmium		4520	8.72	180	UGKG	1.0					
Cobalt		5420	15.8	360	UGKG	1.0					
Chromium		656	53.6	360	UGKG	1.0					
Copper		10200	48.5	360	UGKG	1.0					
Iron		384000	908	1620	UGKG	1.0					
Potassium		7100000	578	45000	UGKG	1.0					
Magnesium		731000	211	1800	UGKG	1.0					
Manganese		10000	8.65	180	UGKG	1.0					
Sodium		7340000	1400	8990	UGKG	1.0					
Nickel		1700	72.5	899	UGKG	1.0					
Lead		955	102	450	UGKG	1.0					
Antimony		2320	86.1	450	UGKG	1.0					
Selenium		3890	129	450	UGKG	1.0					
Thallium	U	-970	186	450	UGKG	1.0					
Uranium by ICP	U	-1130	541	1800	UGKG	1.0					
Vanadium	J	200	21.0	899	UGKG	1.0					
Zinc		103000	243	450	UGKG	1.0					

The following prep procedures were performed:

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STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999887791	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID : PCPRB-1
Lab ID : 9508156-14
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	57.1	244	244	UGKG	1.0	NRM	08/24/95	1957	71530	1
Aluminum		123000	1170	1960	UGKG	1.0					
Arsenic		6480	182	490	UGKG	1.0					
Barium		656	6.50	294	UGKG	1.0					
Beryllium	J	7.03	1.12	294	UGKG	1.0					
Calcium		3470000	1960	1960	UGKG	1.0					
Cadmium		6140	9.51	196	UGKG	1.0					
Cobalt		7930	17.2	392	UGKG	1.0					
Chromium		558	58.4	392	UGKG	1.0					
Copper		16700	52.8	392	UGKG	1.0					
Iron		404000	990	1760	UGKG	1.0					
Potassium		5000000	630	49000	UGKG	1.0					
Magnesium		670000	230	1960	UGKG	1.0					
Manganese		9790	9.43	196	UGKG	1.0					
Sodium		4650000	1530	9800	UGKG	1.0					
Nickel		2170	79.1	980	UGKG	1.0					
Lead		1700	111	490	UGKG	1.0					
Antimony		2110	93.9	490	UGKG	1.0					
Selenium		4760	140	490	UGKG	1.0					
Thallium	U	-1120	203	490	UGKG	1.0					
Uranium by ICP	U	-541	590	1960	UGKG	1.0					
Vanadium	J	267	22.9	980	UGKG	1.0					
Zinc		116000	265	490	UGKG	1.0					

The following prep procedures were performed:
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WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: PCBRB-2
Lab ID	: 9508156-15
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	9.24	240	240	UGKG	1.0	NRM	08/24/95	2002	71530	1
Aluminum		108000	1150	1930	UGKG	1.0					
Arsenic		7940	179	483	UGKG	1.0					
Barium		547	6.40	290	UGKG	1.0					
Beryllium	J	4.07	1.10	290	UGKG	1.0					
Calcium		3290000	1930	1930	UGKG	1.0					
Cadmium		6170	9.36	193	UGKG	1.0					
Cobalt		7880	17.0	386	UGKG	1.0					
Chromium		532	57.5	386	UGKG	1.0					
Copper		15800	52.0	386	UGKG	1.0					
Iron		380000	975	1740	UGKG	1.0					
Potassium		5340000	620	48300	UGKG	1.0					
Magnesium		662000	227	1930	UGKG	1.0					
Manganese		9960	9.28	193	UGKG	1.0					
Sodium		5000000	1510	9650	UGKG	1.0					
Nickel		1720	77.9	965	UGKG	1.0					
Lead		1220	109	483	UGKG	1.0					
Antimony		2330	92.4	483	UGKG	1.0					
Selenium		4720	138	483	UGKG	1.0					
Thallium	U	-1160	200	483	UGKG	1.0					
Uranium by ICP	U	-537	581	1930	UGKG	1.0					
Vanadium	J	269	22.6	965	UGKG	1.0					
Zinc		111000	261	483	UGKG	1.0					

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TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID	: PCBRB-3
Lab ID	: 9508156-16
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	11.1	236	236	UGKG	1.0	NRM	08/24/95	2007	71530	1
Aluminum		158000	1130	1890	UGKG	1.0					
Arsenic		8600	176	474	UGKG	1.0					
Barium		885	6.28	284	UGKG	1.0					
Beryllium	J	8.80	1.08	284	UGKG	1.0					
Calcium		3660000	1890	1890	UGKG	1.0					
Cadmium		6040	9.19	189	UGKG	1.0					
Cobalt		6970	16.7	379	UGKG	1.0					
Chromium		646	56.4	379	UGKG	1.0					
Copper		17400	51.0	379	UGKG	1.0					
Iron		429000	956	1700	UGKG	1.0					
Potassium		5580000	609	47400	UGKG	1.0					
Magnesium		717000	223	1890	UGKG	1.0					
Manganese		11400	9.11	189	UGKG	1.0					
Sodium		5010000	1480	9470	UGKG	1.0					
Nickel		2330	76.4	947	UGKG	1.0					
Lead		1140	107	474	UGKG	1.0					
Antimony		2220	90.7	474	UGKG	1.0					
Selenium		4750	135	474	UGKG	1.0					
Thallium	U	-602	196	474	UGKG	1.0					
Uranium by ICP	U	-739	570	1890	UGKG	1.0					
Vanadium	J	314	22.2	947	UGKG	1.0					
Zinc		114000	256	474	UGKG	1.0					

The following prep procedures were performed:

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STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001

Contact: Mr. Bob Craig

Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: STED-1
Lab ID	: 9508156-17
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	135	204	204	UGKG	1.0	NRM	08/24/95	2011	71530	1
Aluminum		317000	976	1640	UGKG	1.0					
Arsenic		11500	153	410	UGKG	1.0					
Barium		3150	5.44	246	UGKG	1.0					
Beryllium	J	6.77	0.935	246	UGKG	1.0					
Calcium		2890000	1640	1640	UGKG	1.0					
Cadmium		6670	7.95	164	UGKG	1.0					
Cobalt		9300	14.4	328	UGKG	1.0					
Chromium		1330	48.9	328	UGKG	1.0					
Copper		14700	44.2	328	UGKG	1.0					
Iron		696000	828	1480	UGKG	1.0					
Potassium		5770000	527	41000	UGKG	1.0					
Magnesium		647000	193	1640	UGKG	1.0					
Manganese		45600	7.89	164	UGKG	1.0					
Sodium		5500000	1280	8200	UGKG	1.0					
Nickel		17100	66.2	820	UGKG	1.0					
Lead		6170	92.7	410	UGKG	1.0					
Antimony		2170	78.6	410	UGKG	1.0					
Selenium		4410	117	410	UGKG	1.0					
Thallium	U	-886	170	410	UGKG	1.0					
Uranium by ICP		105000	494	1640	UGKG	1.0					
Vanadium	J	798	19.2	820	UGKG	1.0					
Zinc		120000	221	410	UGKG	1.0					

The following prep procedures were performed:
TRACE FGD 08/23/95 1730 71530 2

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Laboratory Certifications

STATE	GEL	EPI
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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193 Report Date: September 01, 1995

Sample ID : STED-2
Lab ID : 9508156-18
Matrix : Soil
Date Collected : 07/20/95
Date Received : 08/02/95
Priority : Routine
Collector : Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver		374	202	202	UGKG	1.0	NRM	08/24/95	2016	71530	1
Aluminum		1030000	966	1620	UGKG	1.0					
Arsenic		10800	151	406	UGKG	1.0					
Barium		4900	5.38	244	UGKG	1.0					
Beryllium	J	27.7	0.926	244	UGKG	1.0					
Calcium		2650000	1620	1620	UGKG	1.0					
Cadmium		6730	7.88	162	UGKG	1.0					
Cobalt		10300	14.3	325	UGKG	1.0					
Chromium		3340	48.4	325	UGKG	1.0					
Copper		16700	43.8	325	UGKG	1.0					
Iron		1240000	820	1460	UGKG	1.0					
Potassium		5360000	522	40600	UGKG	1.0					
Magnesium		633000	191	1620	UGKG	1.0					
Manganese		50600	7.81	162	UGKG	1.0					
Sodium		5280000	1270	8120	UGKG	1.0					
Nickel		30800	65.5	812	UGKG	1.0					
Lead		7140	91.8	406	UGKG	1.0					
Antimony		1860	77.8	406	UGKG	1.0					
Selenium		4480	116	406	UGKG	1.0					
Thallium	U	-842	168	406	UGKG	1.0					
Uranium by ICP		133000	489	1620	UGKG	1.0					
Vanadium		2360	19.0	812	UGKG	1.0					
Zinc		124000	219	406	UGKG	1.0					

The following prep procedures were performed:
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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Westinghouse Savannah River Co.
EPD-Building 773-58A
Aiken, South Carolina 29808-0001
Contact: Mr. Bob Craig
Project Description: Analytical Services for SRS Environmental Characterization

cc: WSRC00193

Report Date: September 01, 1995

Sample ID	: STED-3
Lab ID	: 9508156-19
Matrix	: Soil
Date Collected	: 07/20/95
Date Received	: 08/02/95
Priority	: Routine
Collector	: Client

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	M
Metals Analysis											
Silver	U	190	219	219	UGKG	1.0	NRM	08/24/95	2020	71530	1
Aluminum		383000	1050	1760	UGKG	1.0					
Arsenic		11900	164	440	UGKG	1.0					
Barium		3190	5.83	264	UGKG	1.0					
Beryllium	J	8.79	1.00	264	UGKG	1.0					
Calcium		2820000	1760	1760	UGKG	1.0					
Cadmium		6090	8.54	176	UGKG	1.0					
Cobalt		10500	15.5	352	UGKG	1.0					
Chromium		1660	52.4	352	UGKG	1.0					
Copper		16000	47.4	352	UGKG	1.0					
Iron		732000	889	1580	UGKG	1.0					
Potassium		5490000	566	44000	UGKG	1.0					
Magnesium		614000	207	1760	UGKG	1.0					
Manganese		51300	8.47	176	UGKG	1.0					
Sodium		5310000	1370	8800	UGKG	1.0					
Nickel		18400	71.0	880	UGKG	1.0					
Lead		7010	99.4	440	UGKG	1.0					
Antimony		2370	84.3	440	UGKG	1.0					
Selenium		5120	126	440	UGKG	1.0					
Thallium	U	-1080	182	440	UGKG	1.0					
Uranium by ICP		112000	530	1760	UGKG	1.0					
Vanadium		989	20.6	880	UGKG	1.0					
Zinc		115000	238	440	UGKG	1.0					

The following prep procedures were performed:

TRACE	FGD	08/23/95	1730	71530	2

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