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Results of the Radiological and Chemical Characterization of Surface Impoundments 3539 and 3540 at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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EXECUTIVE SUMMARY

A radiological and chemical characterization survey of impoundments 3539 and 3540 at the Oak Ridge National Laboratory (ORNL) was conducted during December 1997. Impoundments 3539 and 3540 are located in the Surface Impoundments Operable Unit (SIOU) of Waste Area Group 1. The investigation was performed by the Measurement Applications and Development Group of the Life Sciences Division of ORNL at the request of the Department of Energy (DOE) Office of Environmental Restoration.

Sampling was conducted in order to quantify the presence of polychlorinated biphenyls (PCBs), Resource Conservation and Recovery Act (RCRA) constituents, and other contaminants of interest in support of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remediation for the SIOU.

The survey included collection of sediment/clay samples, quality control blank water samples and equipment rinsate samples for chemical and radiological analysis. Results show the samples contain traces of various organic, inorganic, and radioactive materials. Of particular interest are PCB values which demonstrate the impoundments are not regulated under the Toxic Substances Control Act.

The results for some contaminants of interest are summarized as follows:

Contaminant	Impoundment 3539		Impoundment 3540	
	Average	Range	Average	Range
Total PCBs (ppm)	5	4-8	5	3-8
Total plutonium (pCi/g)	4	1-7	4	2-5
Total uranium (pCi/g)	11	0.4-47	9	0.5-22
Cesium-137 (pCi/g)	143	100-180	68	62-78
Strontium (pCi/g)	45	32-55	51	38-67
Curium-243/244 (pCi/g)	12	8-16	16	12-19
Europium-152 (pCi/g)	15	11-19	11	10-13
TCLP mercury (μg/L)	<20	No range	<20	No range

1. INTRODUCTION

A radiological and chemical characterization investigation of impoundments 3539 and 3540 at Oak Ridge National Laboratory (ORNL) was conducted during December 1997. The investigation was performed by the Measurement Applications and Development Group of the Life Sciences Division of ORNL at the request of the Department of Energy (DOE) Office of Environmental Restoration. Characterization data obtained from the representative sampling of the sediment/clay materials was used to determine if the impoundments are regulated under the Resource Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA) and provide additional information on other potential contaminants.

Impoundments 3539 and 3540 are located in the Surface Impoundments Operable Unit (SIOU) of Waste Area Group (WAG) 1. SIOU consists of four impoundments located in the main plant area of Oak Ridge National Laboratory, just north of White Oak Creek. The two impoundments sampled contain approximately 40 cubic yards of sediment which include organic materials. Figure 1 shows the general location of impoundments 3539 and 3540.

The survey included the following:

- collection of sediment/clay samples for various chemical and radiological analyses,
- collection of quality control blank water samples and equipment rinsate samples for similar analysis, and
- survey of each sediment sample for beta-gamma radiation at the time of collection.

1.1 SITE HISTORY

Surface Impoundments Operable Unit (SIOU) was used for management of low-level radioactive wastes generated from experiments and material processing at ORNL. Impoundments 3539 and 3540 were constructed in 1964 and used as a dual-surge basin system designed to alternately receive and discharge process waste streams from the Building 4500 complex.[1] Process wastes were ultimately discharged into White Oak Creek, following verification of radionuclide content and pH adjustments. If the waste exceeded the acceptable release limits in place during the period of operations, it was pumped to an adjacent impoundment to be treated at the Process Waste Treatment Plant.

After impoundments 3539 and 3540 were removed from routine service in 1990, they were used occasionally to collect process wastewater when the holding capacity of the current storage tanks for the Process Waste Treatment Plant was exceeded. An additional surge tank was put into service in 1996 to store process wastewater during wet weather. The impoundments were then removed from the waste management emergency service inventory and made available for remediation.

Impoundments 3539 and 3540 were built by excavation and construction of earthen dikes along the western sides. They are lined with compacted clay and a layer of riprap around the inside slope faces. The impoundments are 100 ft by 58 ft, sloping down to 80 ft by 33 ft at the bottom.[2]

1.2 PROJECT OBJECTIVES

Sampling was conducted in order to quantify the presence of polychlorinated biphenyls (PCBs), RCRA constituents, and other contaminants of interest in support of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remediation for the SIOU.

2. SURVEY METHODS

2.1 SAMPLE COLLECTION

A description of sampling methods is provided in "Sampling and Analysis Plan: SIOU Impoundments 3539 and 3540 Sampling Project" (SAP, see Appendix A). Health and safety support was provided as specified in "Health and Safety Addendum: Sediment Sampling, Impoundments SIOU 3539 and 3540" (see Appendix B), a project-specific addendum to the original health and safety plan, "WAG 1 Surface Impoundments Operable Unit (SIOU) Treatability Study," SSHASP No 001-226/0010 0396.

Sediment/clay samples were collected from the bottom of each pond using a decontaminated coring sampler, as described in LMES procedure *Collection of Sediment Samples*, ESP-304-1. The stainless steel push corer was inserted into the sediment and removed manually. A flat-bottomed boat and walkboards were used to gain access to some sampling locations. Three composite samples were obtained from 36 locations in each pond. One composite sample consisted of sample media from 18 locations, using a statistically generated 2-feet by 2-feet grid of random numbered locations. Alternate points on the grid were sampled if some of the first 18 locations were unsuitable to obtain a representative core of the pond bottom (i.e., top of riprap, in concrete sump). The second and third composite samples were collected from systematic locations on the grid, which resulted in the collection of nine samples from the west side of the pond and nine from the east side of the pond. The sampled media contained organic materials such as leaves, small twigs, decomposed organic materials, and about 0.1 foot of clay.

Each composite sample was homogenized, then bottled, labeled and preserved according to specifications of the SAP and *Quality Assurance Plan for the Oak Ridge National Laboratory Environmental Restoration Program*, ORNL/ER-225/R1. Samples, accompanied by chain-of-custody forms, were taken to the ORNL Analytical Services Organization for chemical and radionuclide analysis.

2.2 QUALITY CONTROL

Field quality control samples were taken during the project. The composite sample taken from 18 random locations in Impoundment 3539 was split for separate analyses. Two field blank water samples were taken, at the beginning and end of sampling activities, respectively. An equipment rinsate blank was taken from each impoundment. Quality control samples were analyzed according to the SAP.

A quality assurance field surveillance was conducted on December 11, 1997 to verify that field activities were being conducted in accordance with the sampling and analysis plan. One positive and three negative observations were noted in Environmental Management and Enrichment Facilities Field Surveillance Report #97SIOU-1 dated December 16, 1997. The observations noted, however, were not related to and had no impact on the quality of samples or the data obtained for this project. The observations addressed administrative and documentation deficiencies.

2.3 RADIATION MEASUREMENTS

A description of typical methods and instrumentation providing guidance for the conduct of the radiological aspects of the survey is presented in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program,* ORNL/TM-8600 (April 1987)[3] and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).[4]

Sediment samples were scanned for beta-gamma radiation at the time of collection using a portable Bicron Analyst scaler/ratemeter with an Eberline HP-210 Geiger-Mueller pancake detector (<2 mg/cm^2 wall thickness) with fine mesh screen. The purpose of this check was to observe any anomalies in contamination distribution and for contamination control.

Prior to exiting the site, survey personnel were checked for beta-gamma contamination. A Bicron Analyst meter with an HP-260 probe ("pancake") was used to check for beta-gamma contamination.

3. SURVEY RESULTS

3.1 OBSERVATIONS

The sampling and analysis effort determined the average concentrations for the TSCA, RCRA and other contaminants of interest. Sampling locations at impoundments 3539 and 3540 for the 18-point composite are shown in Fig. 4. The east/west composite sampling locations are shown in Fig. 5.

Tables 1-4 show the results of chemical and radionuclide analysis of samples and quality control samples taken from Impoundments 3539 and 3540. Results show the samples contain traces of various organic, inorganic, and radioactive materials. Of particular interest are the PCB values (less than 50 ppm), which demonstrate the impoundments not to be TSCA-regulated.

REFERENCES

1. Site Characterization Summary Report for Waste Area Grouping 1 at Oak Ridge National Laboratory, Oak Ridge, Tennessee, DOE/OR-1043/V1-V5&D1. U.S. Department of Energy, Oak Ridge, TN.

2. *Remedial Investigation/Feasibility Study for Surface Impoundments Operable Unit Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1346&D2, Jacobs ER Team and Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee, November 1995.

3. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.

4. Oak Ridge National Laboratory, Health Sciences Research Division, *Measurement Applications and Development Group Guidelines*, ORNL-6782, Martin Marietta Energy Systems, Inc., January 1995.

ORNL-DWG 98-4156

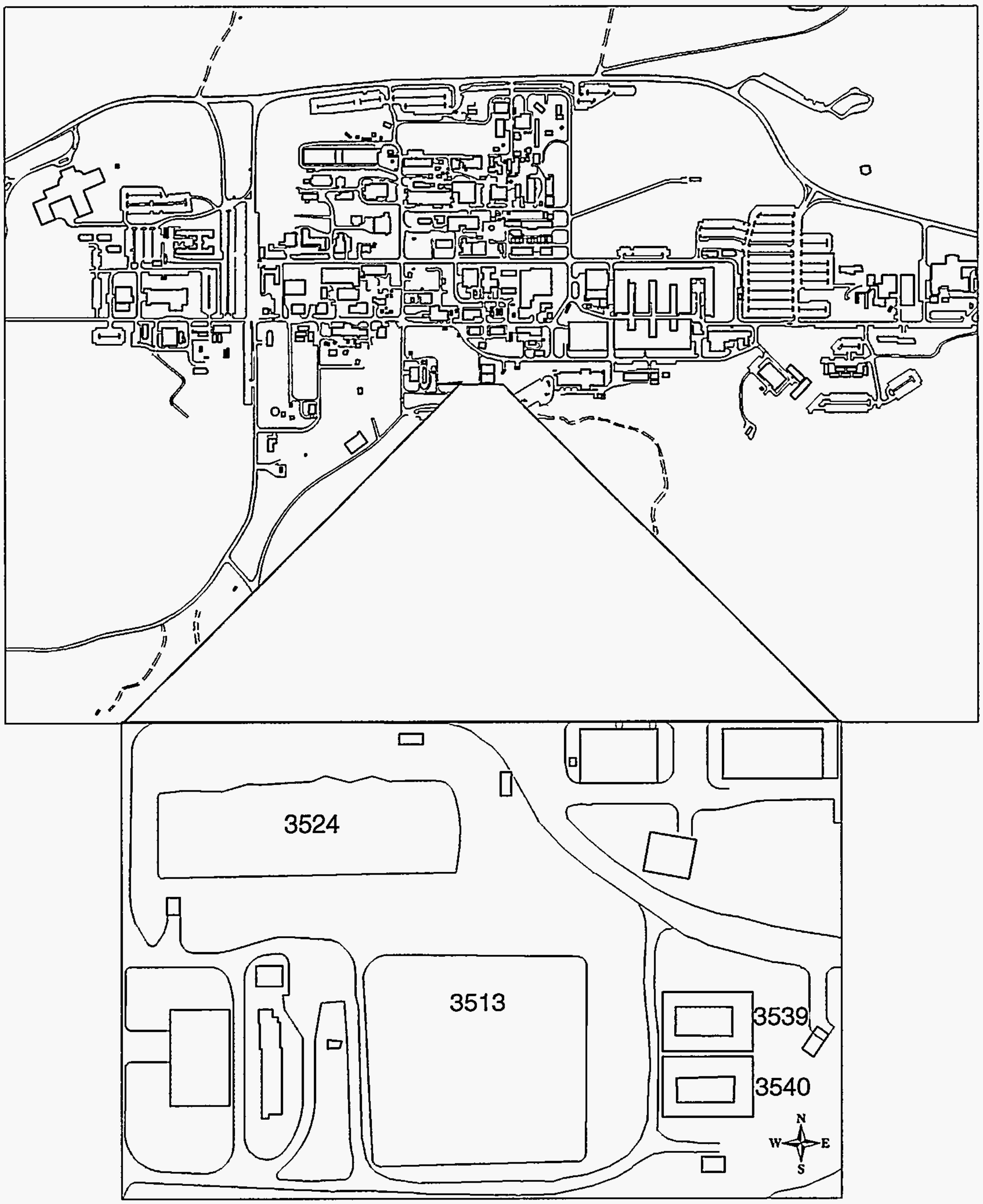

Fig. 1. Location of ponds 3539 and 3540 on the ORNL site.

ORNL-PHOTO 1161-98

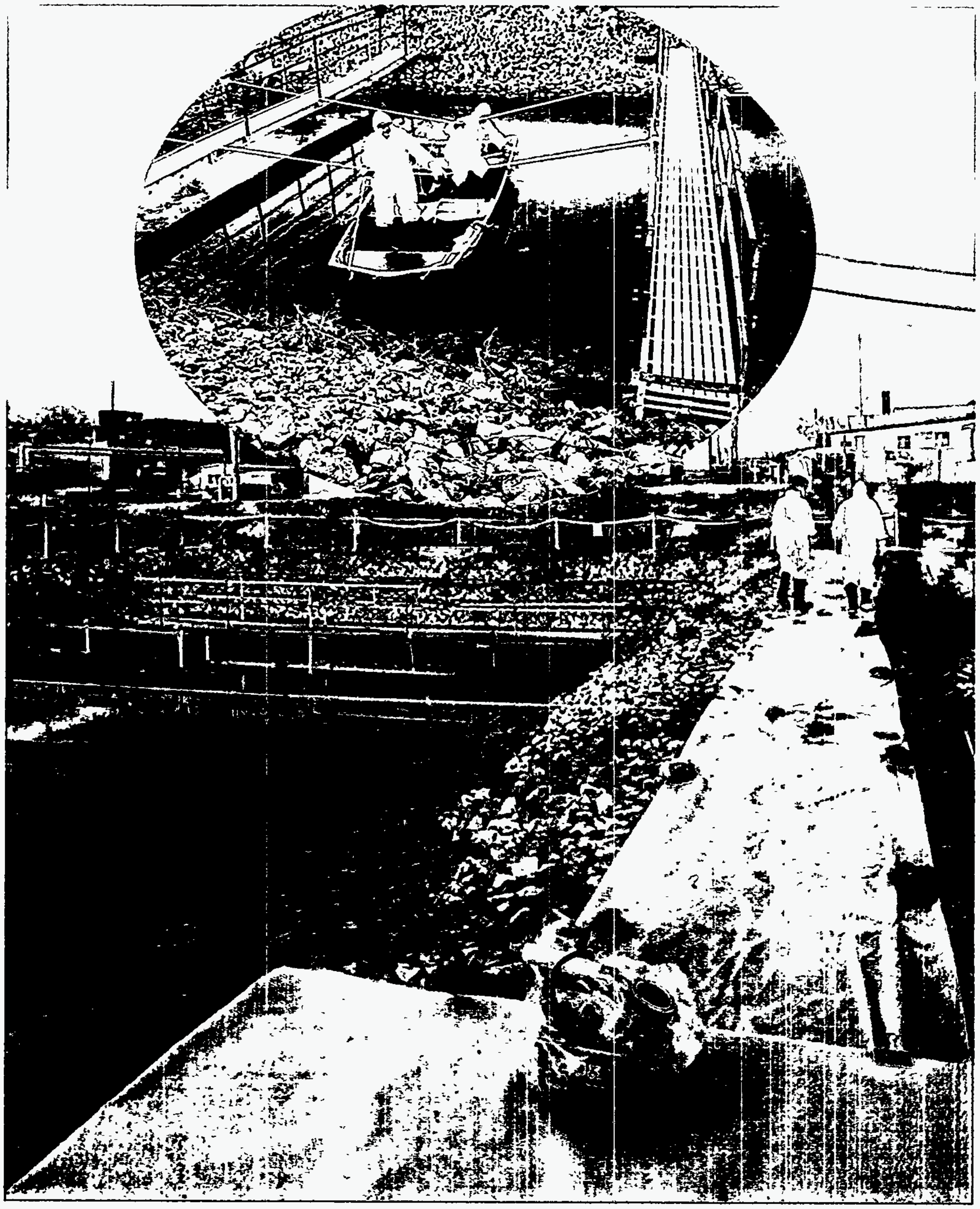

Fig. 2. View of boat operations and pond 3539.

ORNL-PHOTO 1162-98

Fig. 3. Sediment sampling from the boat and view of pond 3540.

ORNL-DWG 98-4157

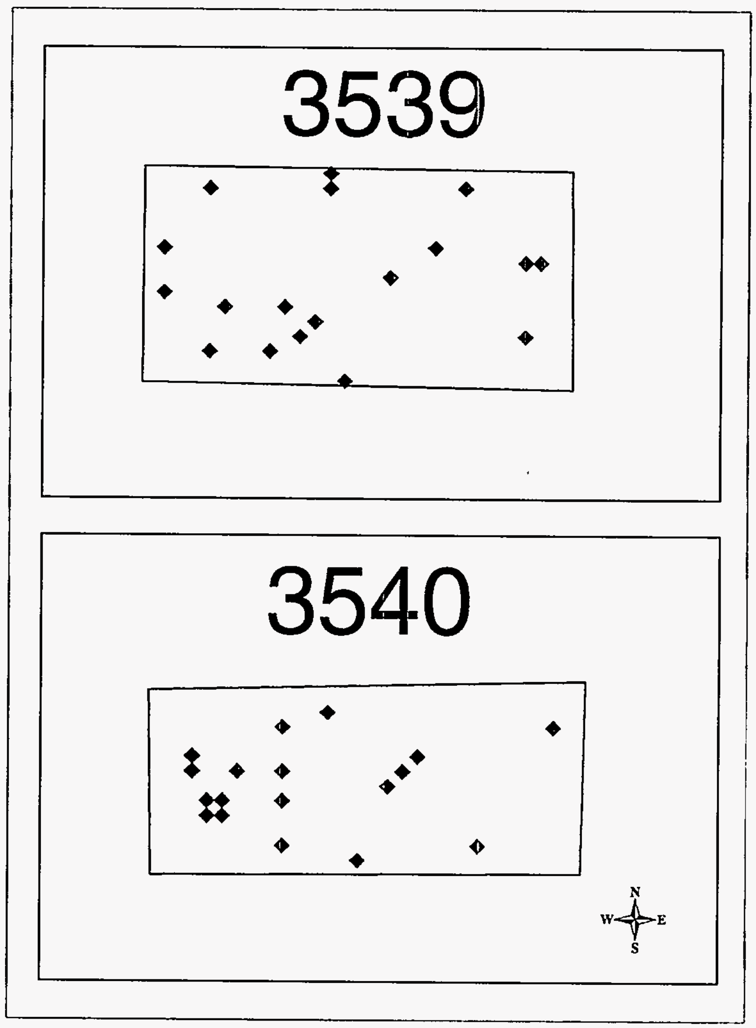

Fig. 4. Sampling locations for the 18-point composites from impoundments 3539 and 3540. Locations may vary from SAP due to accessibility (see Sect. 6.3.2 of SAP).

ORNL-DWG 98-4158

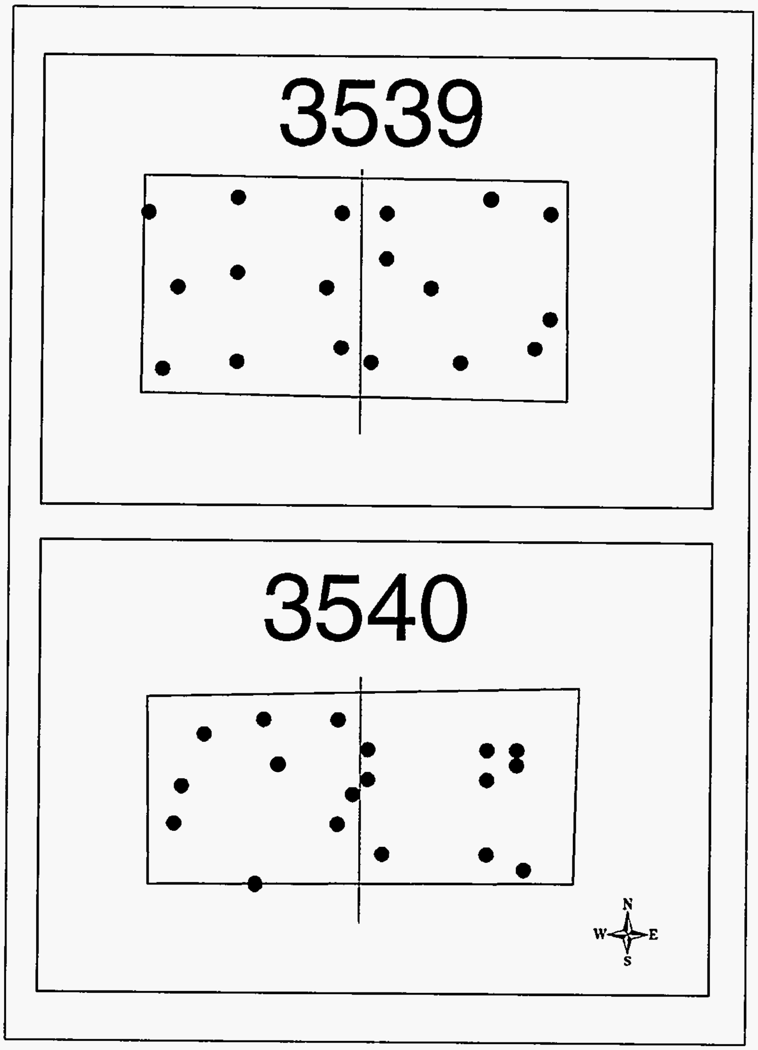

Fig. 5. Grid sample locations for the east/west composites from impoundments 3539 and 3540.

Table 1. Results of analysis of sediment samples taken from impoundment 3539

Analyte	Unit[a]	SIOU39COMP1[b]	SIOU39WEST[c]	SIOU39EAST[d]	SIOU39DUP1[e]
		TCLP for: Semi-Volatiles, Metals, Pesticides, Herbicides			
Antimony	mg/L	<0.40	<0.40	<0.40	<0.40
Arsenic	mg/L	<0.40	<0.40	<0.40	<0.40
Barium	mg/L	<1.0	1.2	<1.0	1.0
Beryllium	mg/L	<0.0020	0.0020	<0.0020	<0.0020
Cadmium	mg/L	0.071	0.10	0.24	0.065
Chromium	mg/L	<0.040	<0.040	<0.040	<0.040
Copper	mg/L	0.81	1.56	<0.040	0.74
Lead	mg/L	2.8	3.4	<0.20	2.5
Nickel	mg/L	0.27	0.41	<0.10	0.30
Silver	mg/L	<0.040	<0.040	<0.040	<0.040
Vanadium	mg/L	<0.040	<0.040	<0.040	<0.040
Zinc	mg/L	3.4	3.3	7.7	3.1
Mercury	μg/L	<20	<20	<20	<20
Selenium	μg/L	<20	<20	<20	<20
2,4-D	μg/L	<4	<4	<4	<4
Silvex	μg/L	<4	<4	<4	<4
Chlordane	μg/L	<13	<13	<13	<13
Endrin	μg/L	<1.6	<1.6	<1.6	<1.6
Heptachlor	μg/L	<0.8	<0.8	<0.8	<0.8
Heptachlor epoxide	μg/L	<0.8	<0.8	<0.8	<0.8
Lindane	μg/L	<0.8	<0.8	<0.8	<0.8

Table 1 (continued)

Analyte	Unit[a]	SIOU39COMP1[b]	SIOU39WEST[c]	SIOU39EAST[d]	SIOU39DUP1[e]
Methoxychlor	μg/L	<8	<8	<8	<8
Toxaphene	μg/L	<13	<13	<13	<13
1,4-Dichlorobenzene	μg/kg	<10	<10	<10	<10
2,4,5-Trichlorophenol	μg/kg	<10	<10	<10	<10
2,4,6-Trichlorophenol	μg/kg	<10	<10	<10	<10
2,4-Dinitrotoluene	μg/kg	<10	<10	<10	<10
2-Methylphenol	μg/kg	<10	<10	<10	<10
3- and 4- Methylphenol	μg/kg	<10	<10	<10	<10
Hexachlorobenzene	μg/kg	<10	<10	<10	<10
Hexachlorobutadiene	μg/kg	<10	<10	<10	<10
Hexachloroethane	μg/kg	<10	<10	<10	<10
Nitrobenzene	μg/kg	<10	<10	<10	<10
Pentachlorophenol	μg/kg	<10	<10	<10	<10
Pyridine	μg/kg	<10	<10	<10	<10
		PCBs (Total and Aroclor-Specific)			
Aroclor-1016	μg/kg	<490	<2200	<360	<480
Aroclor-1221	μg/kg	<490	<2200	<360	<480
Aroclor-1232	μg/kg	<490	<2200	<360	<480
Aroclor-1242	μg/kg	<490	<2200	<360	<480
Aroclor-1248	μg/kg	<490	<2200	<360	< 480
Aroclor-1254	μg/kg	7600	3600	4000	5900
Aroclor-1260	μg/kg	< 490	<2200	<360	< 480

Table 1 (continued)

Analyte	Unit[a]	SIOU39COMP1[b]	SIOU39WEST[c]	SIOU39EAST[d]	SIOU39DUP1[e]
PCB, Total	μg/kg	7600	3600	4000	5900
Reactive Cyanide, Reactive Sulfide, Oil and Grease, Total Organic Halogen (TOX)					
Cyanide	mg/kg	<50	<50	<50	<50
Hydrogen Sulfide	mg/kg	125	70	110	200
Oil and Grease	μg/g	700	490	650	1300
Total Organic Halides (TOX)	μg/g	<25	<25	<25	<25
Radionuclides (dry weight basis)					
Americium-241	pCi/g	2.1 ± 0.25	1.7 ± 0.21	0.96 ± 0.16	1.9 ± 0.22
Curium-243/244	pCi/g	16 ± 1.2	8.0 ± 0.65	8.2 ± 0.70	14 ± 1.1
Neptunium-237	pCi/g	0.015 ± 0.042	0.011 ± 0.037	0.018 ± 0.035	0.039 ± 0.059
Plutonium-238	pCi/g	6.9 ± 1.3	4.2 ± 0.8	3.2 ± 0.6	5.5 ± 1.1
Plutonium-239/240	pCi/g	2.7 ± 0.6	2.0 ± 0.4	1.3 ± 0.3	2.5 ± 0.6
Thorium-228	pCi/g	16 ± 4	16 ± 4	9.1 ± 2.3	16 ± 4
Thorium-230	pCi/g	2.2 ± 0.1	1.2 ± 0.42	1.2 ± 0.43	1.8 ± 0.6
Thorium-232	pCi/g	13 ± 3	13 ± 4	9.0 ± 2.5	14 ± 4
Uranium-233[f]	pCi/g	6	3	3	6
Uranium-234	pCi/g	24 ± 4	16 ± 3	14 ± 3	47 ± 9
Uranium-235	pCi/g	0.67 ± 0.23	0.52 ± 0.19	0.44 ± 0.19	1.0 ± 0.3
Uranium-238	pCi/g	9.4 ± 1.8	7.0 ± 1.4	5.4 ± 1.2	9.0 ± 1.9
Carbon-14	pCi/g	38.8 ± 25	36.4 ± 24	27.3 ± 22	94.0 ± 23
Cesium-137	pCi/g	180 ± 17	130 ± 13	100 ± 6.3	160 ± 19
Cobalt-60	pCi/g	1.8 ± 0.17	1.5 ± 0.18	0.93 ± 0.12	1.5 ± 0.16

Table 1 (continued)

Analyte	Unit[a]	SIOU39COMP1[b]	SIOU39WEST[c]	SIOU39EAST[d]	SIOU39DUP1[e]
Europium-152	pCi/g	19 ± 1.3	13 ± 0.87	11 ± 0.75	16 ± 1.0
Europium-154	pCi/g	4.5 ± 0.58	4.0 ± 0.60	3.1 ± 0.58	3.9 ± 0.35
Europium-155	pCi/g	1.6 ± 0.66	2.2 ± 0.58	3.2 ± 0.64	4.3 ± 0.87
Osmium-191	pCi/g	3.2 ± 1.3	1.4 ± 1.0	1.7 ± 0.85	2.6 ± 1.1
Potassium-40	pCi/g	11 ± 2.3	11 ± 2.2	8.2 ± 2.0	12 ± 2.1
Alpha activity	pCi/g	97 ± 13	100 ± 10	76 ± 11	130 ± 20
Beta activity	pCi/g	340 ± 19	280 ± 20	170 ± 10	360 ± 20
Technetium-99	pCi/g	14 ± 2	14 ± 2	6.7 ± 0.4	11 ± 2
Strontium-90	pCi/g	45 ± 2	46 ± 2	32 ± 1	55 ± 2
Tritium	pCi/g	<168	475 ± 110	165 ± 95	<143

[a]Conversion factors: mg/L = ppm, μg/L = ppb, μg/g = ppm, mg/kg = ppm, μg/kg = ppb.
[b]SIOU39COMP1 corresponds to Lab Sample ID A97345006 and Chain of Custody Number 103958.
[c]SIOU39WEST corresponds to Lab Sample ID A973490044 and Chain of Custody Number 103960.
[d]SIOU39EAST corresponds to Lab Sample ID A973460109 and Chain of Custody Number 103959.
[e]SIOU39DUP1 corresponds to Lab Sample ID A973450007and Chain of Custody Number 103958.
[f]Uranium-233 values are estimated based on visual observations of the spectra by the authors. ASO documentation qualifies U-233 present but does not quantify any values.

Table 2. Results of analysis of quality control blank water samples taken during the impoundments 3539 and 3540 sampling project

Analyte	Unit[a]	SIOUFB1[b]	SIOUFB2[c]	SIOU39ERB1[d]	SIOU40ERB1[e]
		TCLP for: Semi-Volatiles, Metals, Pesticides, Herbicides			
Antimony	mg/L	<0.40	<0.40	<0.40	<0.40
Arsenic	mg/L	<0.40	<0.40	<0.40	<0.40
Barium	mg/L	<1.0	<1.0	<1.0	<1.0
Beryllium	mg/L	<0.0020	<0.0020	<0.0020	<0.0020
Cadmium	mg/L	<0.020	<0.020	<0.020	<0.020
Chromium	mg/L	<0.040	<0.040	<0.040	<0.040
Copper	mg/L	<0.040	<0.040	<0.040	<0.040
Lead (by ICPAES)	mg/L	<0.20	<0.20	<0.20	<0.20
Nickel	mg/L	<0.10	<0.10	<0.10	<0.10
Silver	mg/L	<0.040	<0.040	<0.040	<0.040
Vanadium	mg/L	<0.040	<0.040	<0.040	<0.040
Zinc	mg/L	<1.0	<1.0	<1.0	<1.0
Mercury	μg/L	<20	<20	<20	<20
Lead (by GFAA)	μg/L	<10	<10	<10	<12.6
Selenium	μg/L	<20	<20	<20	<20
2,4-D	μg/L	<120	<4	<4	<4
Silvex	μg/L	<40	<4	<4	<4
Chlordane	μg/L	<10	<13	<13	<13
Endrin	μg/L	<2	<1.6	<1.6	<1.6
Heptachlor	μg/L	<1	<0.8	<0.8	<0.8
Heptachlor epoxide	μg/L	<1	<0.8	<0.8	<0.8

Table 2 (continued)

Analyte	Unit[a]	SIOUFB1[b]	SIOUFB2[c]	SIOU39ERB1[d]	SIOU40ERB1[e]
Lindane	μg/L	<1	<0.8	<0.8	<0.8
Methoxychlor	μg/L	<10	<8	<8	<8
Toxaphene	μg/L	<50	<13	<13	<13
1,4-Dichlorobenzene	μg/L	<40	<10	<11	<10
2,4,5-Trichlorophenol	μg/L	<40	<10	<11	<10
2,4,6-Trichlorophenol	μg/L	<40	<10	<11	<10
2,4-Dinitrotoluene	μg/L	<40	<10	<11	<10
2-Methylphenol	μg/L	<40	<10	<11	<10
3- and 4- Methylphenol	μg/L	<40	<10	<11	<10
Hexachlorobenzene	μg/L	<40	<10	<11	<10
Hexachlorobutadiene	μg/L	<40	<10	<11	<10
Hexachloroethane	μg/L	<40	<10	<11	<10
Nitrobenzene	μg/L	<40	<10	<11	<10
Pentachlorophenol	μg/L	<40	<10	<11	<10
Pyridine	μg/L	<80	<20	<11	<20
		PCBs (Total and Aroclor-Specific)			
Aroclor-1016	μg/L	0.5	50	50	50
Aroclor-1221	μg/L	0.5	50	50	50
Aroclor-1232	μg/L	0.5	50	50	50
Aroclor-1242	μg/L	0.5	50	50	50
Aroclor-1248	μg/L	0.5	50	50	50
Aroclor-1254	μg/L	0.2	50	50	50

Table 2 (continued)

Analyte	Unit[a]	SIOUFB1[b]	SIOUFB2[c]	SIOU39ERB1[d]	SIOU40ERB1[e]
Aroclor-1260	μg/L	0.5	50	50	50
PCB, Total	μg/L	0.2	50	50	50
Reactive Cyanide, Reactive Sulfide, Oil and Grease, Total Organic Carbon (TOC), Total Organic Halogen (TOX)					
Cyanide	mg/kg	<50	<50	<50	<50
Hydrogen Sulfide	mg/kg	<50	<50	<50	<50
Oil and Grease	mg/L	<5.4	<5.3	<5.0	<5.3
Total Organic Carbon (TOC)	mg/L	<10	No data	<10	18
Total Organic Halides (TOX)	μg/L	13.6	<10	12.3	<10
Radionuclides					
Americium-241	pCi/L	-0.0057 ± 0.36	0.10 ± 0.30	-0.04 ± 0.25	0.05 ± 0.26
Curium-243/244	pCi/L	-0.013 ± 0.20	-0.016 ± 0.094	0.01 ± 0.25	0.05 ± 0.23
Neptunium-237	pCi/L	0.17 ± 0.39	0.01 ± 0.13	0.05 ± 0.26	0.09 ± 0.24
Plutonium-238	pCi/L	0.05 ± 0.29	-0.09 ± 0.18	-0.03 ± 0.18	0.01 ± 0.24
Plutonium-239/240	pCi/L	0.023 ± 0.090	-0.02 ± 0.13	0.022 ± 0.085	0.02 ± 0.17
Thorium-228	pCi/L	0.21 ± 0.43	0.10 ± 0.43	0.13 ± 0.35	0.70 ± 0.63
Thorium-230	pCi/L	0.59 ± 0.57	0.89 ± 0.74	0.11 ± 0.27	0.22 ± 0.35
Thorium-232	pCi/L	0.01 ± 0.16	0.07 ± 0.18	0.01 ± 0.15	-0.01 ± 0.17
Uranium-234	pCi/L	0.11 ± 0.22	0.07 ± 0.17	0.17 ± 0.30	0.19 ± 0.35
Uranium-235	pCi/L	0 ± 0.027	0 ± 0.027	0.05 ± 0.25	-0.07 ± 0.17
Uranium-238	pCi/L	0.064 ± 0.15	0.13 ± 0.25	0.30 ± 0.39	0.31 ± 0.37
Carbon-14	pCi/L	6510 ± 6800	2960 ± 6700	2410 ± 6700	2870 ± 6700
Cesium-137	pCi/L	-0.26 ± 2.4	-0.076 ± 2.3	-0.86 ± 2.6	1.8 ± 2.4

Table 2 (continued)

Analyte	Unit[a]	SIOUFB1[b]	SIOUFB2[c]	SIOU39ERB1[d]	SIOU40ERB1[e]
Cobalt-60	pCi/L	-0.45 ± 2.1	1.2 ± 2.4	3.2 ± 3.3	1.1 ± 2.4
Alpha activity	pCi/L	-1.3 ± 1.5	0.6 ± 2.3	0.3 ± 1.2	0.3 ± 2.6
Beta activity	pCi/L	-4.5 ± 6.1	0.4 ± 7.3	3.4 ± 7.1	2.8 ± 6.7
Technetium-99	pCi/L	-1 ± 15	6 ± 15	6 ± 15	3 ± 15
Strontium-89/90	pCi/L	2 ± 10	1.0 ± 9.8	-1 ± 10	-1 ± 10
Tritium	pCi/ml	<45	<46	<46	<46

[a] Conversion factors: mg/L = ppm, μg/L = ppb, mg/kg = ppm, μg/kg = ppb.
[b] SIOUFB1 corresponds to Lab Sample ID A973380012 and Chain of Custody Numbers 103955 and 103956.
[c] SIOUFB2 corresponds to Lab Sample ID A973530034 and Chain of Custody Number 103966.
[d] SIOU39ERB1 corresponds to Lab Sample ID A973490043 and Chain of Custody Number 103961.
[e] SIOU40ERB1 corresponds to Lab Sample ID A973510115 and Chain of Custody Number 103964.

Table 3. Results of analysis of sediment samples taken from impoundment 3540

Analyte	Unit[a]	SIOU40COMP1[b]	SIOU40WEST[c]	SIOU40EAST[d]
		TCLP for: Semi-Volatiles, Metals, Pesticides, Herbicides		
Antimony	mg/L	<0.40	<0.44	<0.40
Arsenic	mg/L	<0.40	<0.40	<0.40
Barium	mg/L	1.4	1.4	<1.0
Beryllium	mg/L	<0.0020	0.0030	<0.0020
Cadmium	mg/L	0.038	0.17	0.081
Chromium	mg/L	<0.040	<0.040	<0.040
Copper	mg/L	<0.040	2.3	0.89
Lead	mg/L	1.4	4.6	2.6
Nickel	mg/L	0.49	0.44	0.39
Silver	mg/L	<0.040	<0.040	<0.040
Vanadium	mg/L	<0.040	<0.040	<0.040
Zinc	mg/L	3.8	7.0	4.2
Mercury	μg/L	<20	<20	<20
Selenium	μg/L	<20	<20	<20
2,4-D	μg/L	<4	<4	<4
Silvex	μg/L	<4	<4	<4
Chlordane	μg/L	<13	<13	<13
Endrin	μg/L	<1.6	<1.6	<1.6
Heptachlor	μg/L	<0.8	<0.8	<0.8
Heptachlor epoxide	μg/L	<0.8	<0.8	<0.8
Lindane	μg/L	<0.8	<0.8	<0.8

Table 3 (continued)

Analyte	Unit[a]	SIOU40COMP1[b]	SIOU40WEST[c]	SIOU40EAST[d]
Methoxychlor	μg/L	<8	<8	<8
Toxaphene	μg/L	<13	<13	<13
1,4-Dichlorobenzene	μg/kg	<10	<10	<10
2,4,5-Trichlorophenol	μg/kg	<10	<10	<10
2,4,6-Trichlorophenol	μg/kg	<10	<10	<10
2,4-Dinitrotoluene	μg/kg	<10	<10	<10
2-Methylphenol	μg/kg	<10	<10	<10
3- and 4- Methylphenol	μg/kg	<10	<10	<10
Hexachlorobenzene	μg/kg	<10	<10	<10
Hexachlorobutadiene	μg/kg	<10	<10	<10
Hexachloroethane	μg/kg	<10	<10	<10
Nitrobenzene	μg/kg	<10	<10	<10
Pentachlorophenol	μg/kg	<10	<10	<10
Pyridine	μg/kg	<10	<20	<20
		PCBs (Total and Aroclor-Specific)		
Aroclor-1016	μg/kg	<2000	<1500	<1500
Aroclor-1221	μg/kg	<2000	<1500	<1500
Aroclor-1232	μg/kg	<2000	<1500	<1500
Aroclor-1242	μg/kg	<2000	<1500	<1500
Aroclor-1248	μg/kg	<2000	<1500	<1500
Aroclor-1254	μg/kg	4600	8000	2700
Aroclor-1260	μg/kg	2000	1500	1500

Table 3 (continued)

Analyte	Unit[a]	SIOU40COMP1[b]	SIOU40WEST[c]	SIOU40EAST[d]
PCB, Total	μg/kg	4600	8000	2700
Reactive Cyanide, Reactive Sulfide, Oil and Grease, Total Organic Halogen (TOX)				
Cyanide	mg/kg	<50	<50	<50
Hydrogen Sulfide	mg/kg	120	70	50
Oil and Grease	μg/g	2100	1700	280
Total Organic Halides (TOX)	μg/g	25	<25	30
Radionuclides (dry weight basis)				
Americium-241	pCi/g	2.9 ± 0.44	1.4 ± 0.19	2.0 ± 0.22
Curium-243/244	pCi/g	19 ± 1.8	12 ± 0.92	18 ± 1.3
Neptunium-237	pCi/g	0.091 ± 0.084	0.017 ± 0.036	0.014 ± 0.034
Plutonium-238	pCi/g	4.9 ± 1	3.3 ± 0.7	3.9 ± 0.8
Plutonium-239/240	pCi/g	2.9 ± 0.6	2.4 ± 0.5	5.1 ± 1
Thorium-228	pCi/g	16 ± 4	12 ± 4	13 ± 3
Thorium-230	pCi/g	1.8 ± 0.5	1.2 ± 1	1.3 ± 0.4
Thorium-232	pCi/g	10 ± 3	11 ± 4	9.4 ± 2.3
Uranium-233[e]	pCi/g	1	2	1
Uranium-234	pCi/g	19 ± 4	14 ± 3	22 ± 4
Uranium-235	pCi/g	0.66 ± 0.22	0.48 ± 0.18	0.50 ± 0.19
Uranium-238	pCi/g	9.4 ± 1.8	7.2 ± 1.4	8.0 ± 1.6
Carbon-14	pCi/g	19.2 ± 21	26.2 ± 22	22.9 ± 21
Cesium-137	pCi/g	78 ± 6.1	63 ± 7.5	62 ± 6.1
Cobalt-60	pCi/g	0.89 ± 0.15	0.94 ± 0.15	1.2 ± 0.15

Table 3 (continued)

Analyte	Unit[a]	SIOU40COMP1[b]	SIOU40WEST[c]	SIOU40EAST[d]
Europium-152	pCi/g	13 ± 0.90	10 ± 0.74	11 ± 0.84
Europium-154	pCi/g	4.1 ± 0.73	2.7 ± 0.29	3.0 ± 0.53
Europium-155	pCi/g	2.1 ± 0.71	4.0 ± 0.77	1.5 ± 0.64
Osmium-191	pCi/g	2.7 ± 1.0	2.6 ± 0.66	1.3 ± 0.66
Potassium-40	pCi/g	10 ± 3.0	6.8 ± 2.0	7.7 ± 2.0
Alpha activity	pCi/g	110 ± 10	66 ± 10	100 ± 10
Beta activity	pCi/g	270 ± 20	160 ± 10	210 ± 10
Technetium-99	pCi/g	17 ± 2	10 ± 2	9.2 ± 0.6
Strontium-90	pCi/g	67 ± 2	38 ± 2	48 ± 2
Tritium	pCi/g	<142	<149	<146

[a] Conversion factors: mg/L = ppm, μg/L = ppb, μg/g = ppm, mg/kg = ppm, μg/kg = ppb.
[b] SIOU40COMP1 corresponds to Lab Sample ID A973490068 and Chain of Custody Number 103962.
[c] SIOU40WEST corresponds to Lab Sample ID A973520166 and Chain of Custody Number 103965.
[d] SIOU40EAST corresponds to Lab Sample ID A973510116 and Chain of Custody Number 103963.
[e] Uranium-233 values are estimated based on visual observations of the spectra by the authors. ASO documentation qualifies U-233 present but does not quantify any values.

Table 4. Results of particle-size test for sediment samples from impoundments 3539 and 3540

Project Sample ID	Diameter (μm)			
	10% Passthrough	100% Passthrough	50% Passthrough	90% Passthrough
SIOU39COMP1	2.94	176	13.93	62.44
SIOU39WEST	2.87	125	8.26	45.89
SIOU39EAST	2.55	125	8.69	56.23
SIOU39DUP1	2.92	176	14.80	61.08
SIOU40COMP1	3.22	176	17.71	56.93
SIOU40WEST	2.86	176	8.49	50.73
SIOU40EAST	2.82	125	10.97	54.34

APPENDIX A

SAMPLING AND ANALYSIS PLAN

SIOU Impoundments 3539 and 3540 Sampling Project

Date Issued - ***March 11, 1998***
Revision 3

Prepared by:

ORNL / MAD

Measurement Applications and Development Group
Life Sciences Division
Oak Ridge National Laboratory

SAMPLING AND ANALYSIS PLAN APPROVALS AND CONCURRENCES
(Original signed and located in project files)

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D. A. Rose / D. E. Rice
Site Health and Safety Officers

__________________________ Date: __________________
D. A. Rose
MAD Field Team Leader

TABLE OF CONTENTS

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AMS	American Meteorological Society
EPA	Environmental Protection Agency
ER	Environmental Restoration
ERB	Equipment Rinsate Blank
SHEST	Safety & Health Evaluation Support Team
LMER	Lockheed Martin Energy Research
LMES	Lockheed Martin Energy Systems
MAD	Measurement Applications and Development Group
ORNL	Oak Ridge National Laboratory
PCB	Polychlorinated Biphenyl
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
S&A	Sampling and Analysis
SAP	Sampling and Analysis Plan
SIOU	Surface Impoundment Operable Unit
TCLP	Toxicity Characteristic Leaching Procedure
TID	Tamper Indicator Device
TSCA	Toxic Substances Control Act

REVISION LOG

Revision No.		Description of Changes
0	11-5-97	New Document
1	11-26-97	P.1; Changed "SMO" to "Analytical" & "Christy Anderson" to "Angela Barnard-Hatmaker" Corrected Tables 2 & 3 Analytical Methods to reflect proper methods for sediment matrix Included typed names on the sign off page Added REVISION LOG
2	12-9-97	Changed Tables 2 & 3 sample volumes per ASO recommendations. Section 6.3.2, Added systematic composite sample requirements and deleted requirements for field duplicates.
3	2-20-98	Modifications resulting from QA Surveillance (97SIOU-1). This revision is for documentation purposes only, sampling and analyses are complete. The following sections were modified: 4.0 Table 1, 6.2, 6.3.1, 6.3.2, 6.3.3, and 6.3.5.

Sampling and Analysis Plan for SIOU Impoundments 3539 and 3540 Sampling Project

1. PURPOSE

This Sampling and Analysis Plan (SAP) describes the methodology to obtain further characterization information on the sediment/clay materials found in the SIOU Impoundments 3539 and 3540, located at Oak Ridge National Laboratory (ORNL). Characterization data obtained from the representative sampling of the sediment/clay materials will be used to evaluate the impoundment closure conditions.

2. OBJECTIVES

The objective of this SAP is to describe the procedure for obtaining sufficient and valid analytical data on sediment/clay materials to evaluate RCRA and/or TSCA regulatory applicability. Additionally, analytical data will be obtained to evaluate radiological and sediment/clay physical properties. This will provide information for subsequent treatment, storage, packaging, and shipment to off-site facilities.

3. SCOPE

This plan provides supplemental instructions to guidelines and procedures established for Sampling and Analysis (S&A) activities. Standard procedures may be referenced throughout this plan as applicable, and are available for review if necessary.

4. ORGANIZATION AND RESPONSIBILITIES

Overall coordination and implementation of the S&A activities described in this plan are the responsibility of the MAD Field Team Leader. The MAD Field Team Leader will require input and support from personnel of various ORNL organizations. The roles and responsibilities of these personnel are listed in Table 1.

Table 1. Roles and Responsibilities

Role	Person	Phone	Responsibility
MAD Field Team Leader	Doug Rose	574-5837	Oversees all activities involving sampling, maintains field logbook, access to the work areas, and support of outside organizations
SHEST Coordinator	Greg Rowland	576-6445	Coordinates all aspects of the characterization project relating to SHEST support
Quality Assurance	Tom Koepp	576-8057	Coordinates QA support and ensures QA compliance for the project
Analytical Coordinator	Angela Barnard-Hatmaker	241-9669	Ensures the requirements of the SAP are met by the laboratories and provides customer interface
Project Manager	Robert Dean	574-7951	Oversees project management and sampling activities
Project Manager	Rob Coe	241-5026	Provides engineering support for the project
MAD Project Manager	Michael Murray	574-5838	Oversees all MAD group activities, interfaces with project managers, ensures proper training and documentation.
Health and Safety Officer	Dennis Rice	576-8565	Provides health and safety oversight and assists in sampling activities

5. SAMPLE DESCRIPTION

The sediment/clay identified for characterization using this SAP is currently contained on the bottom of SIOU Impoundments 3539 and 3540. The impoundments were used as part of the system for management of low-level radioactive wastes generated from experiments and material processing at ORNL. The impoundments contain ~40 cubic yards of sediment which include organic materials. The media constituents will contain organic materials such as leaves, small twigs, decomposed organic materials, and about 0.1 foot of the clay liner. The various sediment depths have been estimated using earlier collected data.

6. SAMPLING

6.1 NOTIFICATION

The MAD Field Team Leader will notify the analytical organization and the project management before sampling activities begin. This notification is needed to allow the Analytical Coordinator time to schedule programmatic activities. The Analytical Coordinator shall notify laboratory analysis personnel regarding the time and date of sampling operations.

6.2 PRE-SAMPLING MEETINGS

The MAD Project Manager will schedule and conduct a pre-sampling meeting with project personnel prior to sampling operations. The objectives of this meeting will be to discuss sampling operation logistics and other details, resolve any technical or operational issues, and ensure schedules are agreed upon by all responsible organizations. The Project Manager will also verify training records pertinent to this project are complete and available for inspection.

6.3 SAMPLING OPERATIONS

The MAD Field Team Leader will ensure sampling activities adhere to the SAP and the Health and Safety Plan, and applicable LMER and LMES procedures. **Sampling shall not be initiated prior to receipt of a signed copy of the SAP**. Signed copies of the SAP will be distributed prior to the initiation of sampling activities.

6.3.1 Logbook Entries

The Field Team leader (or designee) will maintain a logbook to provide project information and a daily written record of all sampling activities. The logbook will be maintained in accordance with *Quality Assurance Plan for the Oak Ridge National Laboratory Environmental Restoration Program*, ORNL/ER-225/R1. Project information should include personnel contacts, trainings activities and site data. Each daily logbook entry should include, but is not limited to, the following items:

- sediment/sludge/sample description (e.g., color, texture, solids content);
- sample container IDs;
- approximate amount of material in each sample container;
- customer sample numbers;
- personnel; and
- chain-of-custody number.

6.3.2 Sample Collection Overview

Sampling activities will require collection of three types of analytical samples. The samples will consist of composite random samples, composite systematic, and field quality control (QC) samples. Sampling will involve intrusive and random methods. The sampling team will follow the general guidelines of the LMES procedure *Collection of Sediment Samples,* ESP-304-1, Rev. 1, dated February 28, 1996. Location samples will be collected and contained in appropriate sample containers (specified in Table 2). In all sampling instances, a one-tenth foot clay (liner) portion will be included with the sediment/sludge. The one-tenth foot section of the clay (liner) will be homogenized as part of the sample.

Four composite samples will be collected from each pond. Each composite sample will consist of sampled media from 18 randomly selected locations. The sample locations will be selected from a grid system generated by MAD personnel. The grid system will be designated as 2 feet x 2 feet and will lie on an X-Y axis relative to the ORNL grid north direction from the impoundments (see Attachments A and B). The number of samples collected should represent the media of each impoundment. At the direction of the DOE Project manager and the LMER Project manager, the number of composite samples may be altered based on changing project goals and/or analytical data as it becomes available.

Seventy-two (72) sampling locations will be selected from each impoundment for active sampling activities. From these seventy-two locations, eighteen numerically labeled locations will be selected for each of the four (4) composite samples to be collected in each impoundment (i.e., the first eighteen locations labeled with #1 will comprise the #1 composite sample). Alternative locations will be generated during the random grid selection for intrusion refusal at initial locations. The statistical basis for this sampling regime was provided by Jacobs Engineering (see Attachment C). The Field Team Leader will make the decision for sample collections at each location. Conditions such as insufficient sediment/sludge, etc., will determine the location changes to be made, if necessary.

The systematic composite samples will consist of sediment collected from 9 grid point locations on the west side of each pond and a similar composite from the east side of each pond. A grid will be established to designate 18 distinct sampling blocks (9 per east/west side). A sediment/clay sample will be collected from each of the 9 blocks and then added to the composite.

Specific equipment for taking samples may include stainless collection devices (Shelby tubes, stainless steel trays, AMS coring devices, etc.), a low-volume pump and related equipment for removing excess liquid from the sample locations, and a modified stainless steel drum for creating a seal and containing the sediment/sludge in the selected sample location. Other supplies and equipment will include standard sample bottles, sample handling tools such as stainless steel scoops and spatulas, and radiological contamination control supplies. Any deviations from this method will be approved by the MAD Field Team Leader, project management, and/or the Analytical Coordinator. Equipment that is fabricated and designed on-site must meet the requirements for analytical standards, and support the needs of the sampling team. The equipment should be designed with decontamination processes in mind, and should be fabricated from materials meeting analysis criteria.

Table 2. Requirements for Sediment Samples				
Analyte	**Analytical Methods**	**Container Type**	**Preservative**	**Sample Volumes**
TCLP for: Semi-volatiles, metals (including Hg, Cu, and Zn), pesticides, herbicides	SW-846, 1311 UTS 6010, 7421, 7470, 7740, 8080	1 liter, amber, with Teflon-lined lid	4 degrees C	1 liter **(Fill sample jar completely)**
PCBs (total and Aroclor-specific)	SW-846, 8081	1 liter, amber, with Teflon-lined lid	4 degrees C	1 liter
Reactive cyanide, Reactive sulfide	SW-846, Methods 7.3.3.2, 7.3.4.2	1 liter, amber, with Teflon-lined lid	4 degrees C	1 liter **(Fill sample jar completely)**
Oil and Grease	SW-846, Method 9071A			
Total organic carbon (TOC), total organic halogen (TOX)	EPA 415.1 (TOC) SW-846, Method 9020B (TOX)			
Particle size analysis	ASTM D422			
Radionuclides Isotopic-Pu Isotopic-U Isotopic-Th Technicium-99 Americium-241 Neptunium-237 Gamma Spectroscopy Strontium-90 Gross Alpha/Beta Tritium Carbon-14	 Alpha Spectroscopy Alpha Spectroscopy Alpha Spectroscopy Liquid Scintillation Alpha Spectroscopy Alpha Spectroscopy Gamma Emitters Beta GPC Gross Alpha/Beta Liquid Scintillation Liquid Scintillation	1 liter, amber, with Teflon-lined lid	4 degrees C	2 liters

Table 3. Requirements for Field QC Samples					
Sample Type	**Analytes**	**Analytical Methods**	**Container Type**	**Preservative**	**Sample Volume**
Field Duplicate	Same as Table 2	Same as Table 2	Same as Table 2	Same as Table 2	Same as Table 2
Equipment Rinsate Blank	**TCLP for:** Semi-volatiles, metals (including Hg, Cu, and Zn), pesticides, herbicides	SW-846, 6010A, 7470	1 liter, amber, w/teflon lined lid	4 degrees C	3 liter **(Fill sample jar completely)**
	PCBs (total and Aroclor-specific)	SW-846, 8081	1 liter, amber, w/teflon lined lid	4 degrees C	1 liter
	Reactive cyanide, Reactive sulfide	SW-846, Methods 7.3.3.2, 7.3.4.2	1 liter, amber, w/teflon lined lid	4 degrees C	1 liter
	Oil and Grease	SW-846, Method 413.2	1 liter, amber, w/teflon lined lid	4 degrees C	1 liter
	Total organic carbon (TOC), total organic halogen (TOX)	EPA 415.1 (TOC) SW-846, Method 9020B (TOX)	250 ml., amber, w/teflon lined lid, (1) 250 ml for TOC, (1) 250 ml. for TOX	4 degrees C	250 ml. **(Fill each 250 ml. Sample bottle completely)**
	Radionuclides Isotopic-Pu Isotopic-U Isotopic-Th Technicium-99 Americium-241 Neptunium-237 Gamma Spectroscopy Strontium-90 Gross Alpha/Beta Tritium Carbon-14	 Alpha Spectroscopy Alpha Spectroscopy Alpha Spectroscopy Liquid Scintillation Alpha Spectroscopy Alpha Spectroscopy Gamma Emitters Beta GPC Gross Alpha/Beta Liquid Scintillation Liquid Scintillation	1 liter amber w/teflon lined lid	4 degrees C	2 liters
Field Blank	Same as ERBs	Same as ERBs	Same as ERBs	Same as ERBs	Same as ERBs

6.3.3 Sample Collection Methodology

After the conclusion of the pre-sampling meeting, all materials necessary for sample collection will be staged and inspected prior to entering the radiological buffer area. A Field Blank (FB) sample and the Equipment Rinsate Blank (ERB) samples will be collected at this time for the deionized water and on all reusable sampling equipment (see Table 3 for field QC requirements). The selected sampling locations will then be accessed using a boat and/or walkboards strategically located across the impoundments.

After proceeding to the selected sample location, verify the coordinates and log the location. If the water level is high enough to be a problem for sampling tool, the modified drum may be placed, seated into the clay impoundment liner, and the water contained inside the modified drum may be removed using a peristaltic pumping system. The excess water will be returned to the impoundment through the discharge line of the system. When sufficient water is removed from the sampling location within the drum, a three-inch stainless steel AMS coring tool will be inserted into the sediment. The AMS tool will be seated into sediment until the tool meets resistance. At this time, it will be assumed that the tool has contacted the clay liner. The sampling team will continue the insertion until approximately 0.1 foot of clay is contained in the tool. The team will then remove the tool from the pond. **(Note: The sampling team should use caution when removing the tool. The butterfly closure on the tool should provide a seal, but the team must ensure that all sample contents, including the 0.1 foot portion of the clay, is removed with the tool).**

The sampled materials will be removed from the AMS tool using a stainless steel spatula and placed into a stainless steel holding tray. Field radiological measurements will be recorded at this time. The 0.1 ft. clay portion of the sample will be retained and homogenized with the remaining sample materials. Stainless steel tools and spatulas will be used to homogenize the materials. When initial homogenization is completed, the sampled materials will be transferred to the composite sample container. **(Note: Simple field decontamination measures may be necessary to ensure contamination controls. If deemed necessary by the sampling team, or Radiation Protection personnel, sampling equipment may be rinsed during sampling activities using de-ionized water).**

The methods described above will be repeated until all eighteen samples for each composite have been collected and placed into the composite sample container. Any excess impoundment water will be removed prior to homogenization of the composite sample. To facilitate the compositing and homogenizing process and provide better contamination control, moving the sample indoors is desired. Free standing water should be removed from the sample homogenization. The sample will be homogenized using stainless tools and steel spatulas. The homogenized sample will be packaged and prepared for laboratory delivery using the information contained in Table 2 of this SAP, QA requirements, and ORNL standard radiological protection procedures. All tools, equipment, and containers used for a sample shall be cleaned/ decontaminated and rinsed before reuse (see section 6.3.4).

6.3.4 Field QC Samples

When required by EPA standards, and when specified by the MAD Field Team Leader, Field QC samples will be collected during the sampling activities. Collect the QC samples in accordance with this SAP and applicable procedures. Sampling shall be consistent with EPA's *Test Methods for Evaluating Solid Waste,* SW-846, Third Edition. Preservation of equipment rinsate blanks (ERBs) and field duplicates shall adhere to the methods described in this SAP. Field Duplicates will be collected for a selected composite sample from each impoundment.

ERBs shall be collected on reusable sampling equipment. Collect one ERB prior to sampling activities on all reusable sampling equipment which is anticipated to be used in the sampling activities. At a specified time during sampling activities (preferably after relocating to the second impoundment), collect a second ERB on sampling equipment used during the sampling activities. A field duplicate sample will be collected from each impoundment for a selected composite sample. The MAD field team leader will specify the time and location of the collection of the composite duplicate sample.

A field blank will also be collected. The field blank sample will be collected from the source of the equipment decontamination water. The container and sample sizes for the Field QC samples are specified in Table 3. The field blank will be collected prior to sampling activities.

6.3.5 Sampling Equipment Decontamination

Nondisposable sampling equipment shall be decontaminated and documented in accordance with *Cleaning and Decontaminating Sample Containers and Sampling Devices,* ESP-801.

6.3.6 Sample Identification

Samples will be identified using the following identification coding and qualifiers. Reference information for sample identifications can be found in the document *Work Plan, Health and Safety Plan, and Quality Assurance Project Plan for K-1420 Waste Area Grouping*, K/ER-34.

6.3.7 Identification Numbering

Project Code(s):	SIOU39 =	SIOU 3539 Designation
	SIOU40 =	SIOU 3540 Designation

Qualifiers:
Sediment/Clay random composite sample designation = COMP#
Sediment/Clay systematic composite = East or West
Field Duplicate Designation = DUP
Equipment Rinsate Blank Designation = ERB
Field Blank Designation = FB

Examples:	Sediment/Clay Sample:	SIOU39COMP1 = SIOU 3539 Composite Sample #1
		SIOU40West = SIOU 3540 West side composite sample
	Field QC Samples:	SIOU40ERB2 = SIOU 3540 Equipment Rinsate Blank Sample #2
		SIOUFB1 = SIOU Project Field Blank Sample #1

6.3.8 Sample Labels

Sample labeling will be conducted in accordance with this SAP and *Quality Assurance Plan for the Oak Ridge National Laboratory Environmental Restoration Program*, ORNL/ER-225/R1. Appropriate sample labels (e.g., Analytical, PCB, Radioactive) will be affixed to all sample containers prior to or at the time of sampling. To the extent practicable, sample bottles will be labeled prior to filling. Sample labels will be waterproof paper or plastic with gummed backs or waterproof tags, as appropriate. Labels will be completed with black indelible ink and will include, as a minimum, the following information:

- sample name;
- unique customer sample number (**Note: Do not hyphenate customer sample numbers.**);
- sampler's name;
- date and time of collection; and
- location of collection.

6.3.9 Sample Chain of Custody

The integrity of a sample from the time of sampling through receipt into the laboratory is assured by strict adherence to the *Quality Assurance Plan for the Oak Ridge National Laboratory Environmental Restoration Program*, ORNL/ER-225/R1. Copies of the completed chain-of-custody forms shall be provided to the MAD Field Team Leader upon completion of sampling activities, or after direct delivery to the laboratory. The following information, as a minimum, must be included on the chain-of-custody forms:

- unique sample number;
- signature of sample collector;

- date and time of collection;
- sample matrix type (i.e., sludge, soil, etc);
- sample site;
- number of containers;
- sample handling and preservatives;
- date and time custody is accepted and relinquished;
- signature of each custodian; and
- sampling and analysis requested.

6.3.10 Tamper Indicator Device

A tamper indicator device (TID) assures that unauthorized additions to a container's contents can be visually detected. The TID shall be placed in a manner such that opening the container breaks the seal. A TID shall be placed on the following containers:

- containers that were sampled;
- analytical samples not delivered to the laboratory within 24 hours of sampling or not stored in a secure storage facility; and
- storage and transport packages such as ice coolers, etc.

6.3.11 Sample Management

The condition of samples (e.g., temperature, presence of TIDs, hazard labels, samples shipped on ice, etc.) shall be checked and documented by laboratory personnel upon arrival at the laboratory. Samples shall be stored at the laboratory at 4 ± 2 degrees Celsius.

7. ANALYTICAL REQUIREMENTS

The Analytical Coordinator will ensure that all analyses are performed in accordance with this SAP and all QC is performed in accordance with SW-846 and *Analytical Master Specifications,* dated September 1996, and this SAP. The primary regulatory methods for compliance are the applicable methods described in SW-846. Any deviations from specified methods or parameters must be approved and documented by the Project Manager or his/her designee prior to making changes. **Analytical activities shall not be initiated prior to receipt of a signed copy of the SAP.** The laboratory shall:

- archive all samples for 60 days;
- notify the MAD Field Team Leader immediately of any QC failures that would require resampling;
- report data on an as-received basis unless otherwise specified; and
- representatively obtain subsamples for analysis, rather than attempting to select the "cleanest" or "dirtiest" portion of the sample; and
- supply Level 4 package for analysis data.

8. QUALITY ASSURANCE (QA) REQUIREMENTS

At the direction of the Project Management, selected portions of a SAP prepared by Jacobs Engineering of Oak Ridge, TN (dated October 1997) were incorporated into this SAP. The selected portions include Attachment C of this plan (which deals with the statistical random start grids for sample collections) and the analyte requirement information in Table 2 and Table 3. Any exceptions or deviations to this plan require authorization from the Project Manager and MAD Field Team Leader. The stated sample collection procedure, *Collection of Sediment Samples,* ESP-304-1, Rev. 1, dated February 28, 1996, may be "red-lined" during activities to reflect actual sample collection methods used by the sampling team. The "red-line" instances will be documented in the project field logbook and must be approved by the MAD Field Team Leader.

Authorizations for deviations to procedures and this SAP can be made via telephone, verbal communications, or written instructions. When authorization is other than written correspondence, the Project Manager or MAD Field

Team Leader shall document the date, requestor's name, and the deviation or exception. Deviations from analytical activities shall be approved by the Project Manager prior to implementation and documented by the Analytical Coordinator. Nonconforming items shall be administered by guidance in the *Health Sciences Research Division Management Plan*, MP-96-HSRD-001.

The QA Specialist or his/her designee may conduct a surveillance during sampling operations. Requirements such as chain-of-custody, sample labels, tamper-proof seals, field logbook entries, and the collection of QC samples will be reviewed for compliance to the procedures mentioned in this SAP. This surveillance report and any corrective action documentation will become part of the program's QA records. QA and other relevant project documentation will be maintained with the MAD Group for a minimum of three years.

The Analytical Coordinator will ensure that analytical data obtained complies with applicable SW-846 regulatory methods, *Analytical Master Specifications,* dated September 1996, and this SAP. The primary regulatory methods for compliance are the applicable methods described in SW-846.

In addition to the above quality controls measures, the project will follow the guidelines and requirements of the *Quality Assurance Plan for the Oak Ridge National Laboratory Environmental Restoration Program*, ORNL/ER-225/R1.

9. DATA DELIVERABLES

The data deliverables for this project will be Level 4. The Analytical Coordinator will ensure that analytical data is reported to the appropriate personnel. All analytical results (Level 3) will be provided as they become available. Complete data packages (Level 4) will be provided within 30 days of the initial analytical results.

10. DATA REVIEW AND VALIDATION

The data package for this project will be validated according to Level 3 requirements as outlined in the *Analytical Master Specification.* Ten percent of the data packages will be validated according to Level 4 requirements of the *Analytical Master Specification*. If there are no major quality control concerns, no further validation will be required. If major quality control concerns are found, additional validation will be required. A validation report will be prepared and provided to the Project Manager.

11. HEALTH AND SAFETY (H&S)

Health and Safety (H&S) support will be obtained from site H&S organizations. Preliminary reviews (e.g., Site Safety Reviews, Radiation Work Permits, etc.), requests for H&S services, and establishment of communication with H&S organizations are addressed in the project-specific addendum for the original Health and Safety Plan, *WAG 1 Surface Impoundments Operable Unit (SIOU) Treatability Study,* SSHASP No 001-226/0010 0396. The listing for the new personnel is contained in the H&S addendum prepared for the project. An additional SSHO will be appointed for the project to act as an alternate and assist in any scheduling conflicts that may arise during the project activities. No additional hazards other than those addressed in the original plan are anticipated.

12. REFERENCES

Cleaning and Decontaminating Sample Containers and Sampling Devices. ESP-801. Revision 0. Martin Marietta Energy Systems. August 27, 1988.

Analytical Master Specification, Sample Management Organization, draft dated September 1996.

Test Methods for Evaluating Solid Waste. SW-846, Third Edition. Environmental Protection Agency. November 1986.

Quality Assurance Plan for the Oak Ridge National Laboratory Environmental Restoration Program, ORNL/ER-225/R1.

Collection of Sediment Samples, ESP-304-1, Rev. 1. February 28, 1996.

Health Sciences Research Division Management Plan, MP-96-HSRD-001, January 1996.

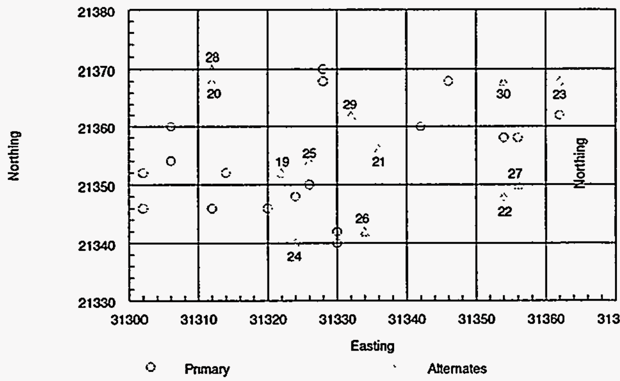
ATTACHMENT A

Pond 3539

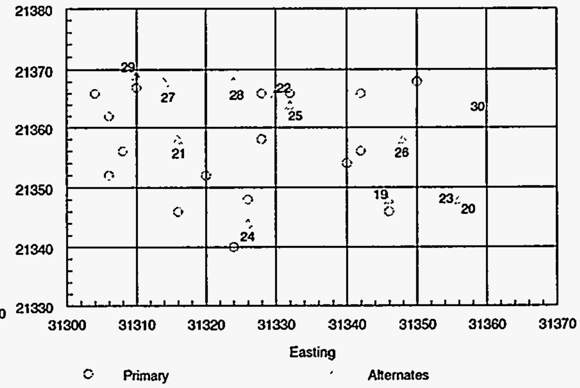
	Composite #1		Composite #2		Composite #3		Composite #4	
	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing
1	31302	21346	31342	21356	31340	21370	31336	21348
2	31324	21348	31328	21366	31350	21340	31360	21360
3	31330	21340	31342	21366	31352	21344	31334	21346
4	31328	21368	31326	21348	31324	21362	31362	21350
5	31354	21358	31308	21356	31352	21362	31310	21354
6	31312	21346	31306	21362	31356	21348	31330	21348
7	31306	21354	31346	21346	31338	21354	31350	21366
8	31326	21350	31316	21346	31336	21360	31318	21348
9	31330	21342	31350	21368	31360	21340	31356	21362
10	31328	21370	31306	21352	31322	21356	31340	21352
11	31362	21362	31304	21366	31312	21360	31360	21354
12	31356	21358	31310	21368	31326	21362	31354	21368
13	31306	21360	31328	21358	31352	21346	31322	21344
14	31314	21352	31340	21354	31362	21354	31328	21356
15	31346	21368	31320	21352	31308	21358	31302	21362
16	31342	21360	31324	21340	31344	21350	31358	21368
17	31302	21352	31358	21366	31356	21352	31350	21360
18	31320	21346	31332	21360	31340	21346	31316	21368
19	31322	21352	31346	21348	31332	21356	31336	21368
20	31312	21368	31356	21348	31358	21352	31318	21350
21	31336	21356	31314	21368	31328	21368	31332	21364
22	31354	21348	31330	21366	31316	21364	31310	21366
23	31362	21368	31356	21348	31308	21368	31348	21348
24	31324	21340	31326	21344	31348	21364	31342	21360
25	31326	21354	31332	21364	31314	21364	31348	21352
26	31334	21342	31348	21358	31320	21356	31306	21352
27	31356	21350	31316	21358	31344	21366	31310	21364
28	31312	21370	31324	21368	31348	21366	31332	21356
29	31332	21362	31310	21368	31316	21352	31338	21352
30	31354	21368			31336	21366		

Attachment A
(continued)

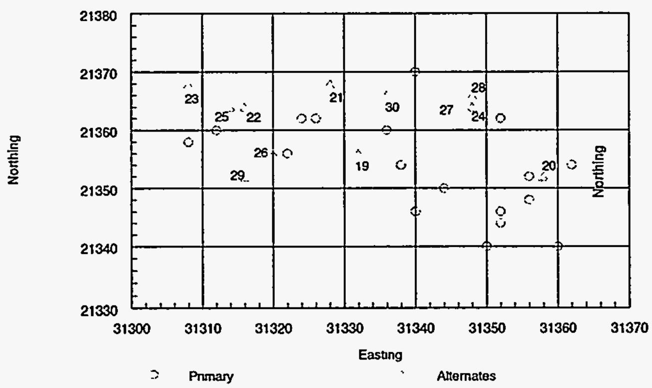
Pond 3539
Composite #1 Sampling Locations



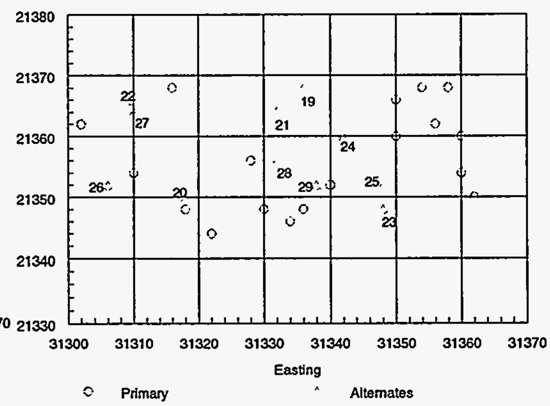
Pond 3539
Composite #2 Sampling Locations



Pond 3539
Composite #3 Sampling Locations



Pond 3539
Composite #4 Sampling Locations



Attachment B

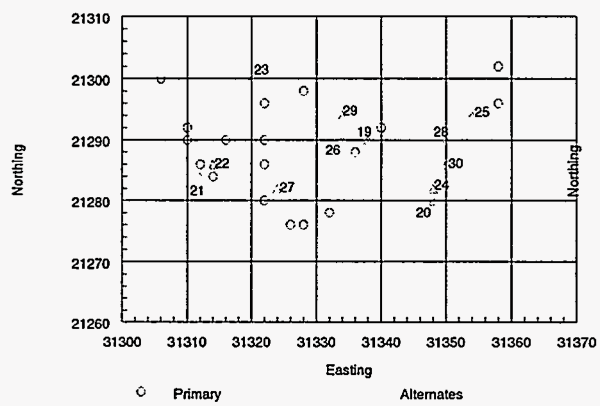
Pond 3540

	Composite #1		Composite #2		Composite #3		Composite #4	
Point #	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing
1	31336	21288	31332	21290	31350	21280	31328	21300
2	31326	21276	31314	21294	31342	21298	31360	21294
3	31328	21276	31358	21286	31338	21278	31336	21280
4	31322	21286	31312	21296	31330	21288	31314	21296
5	31312	21286	31328	21284	31322	21278	31342	21300
6	31328	21298	31326	21288	31350	21294	31334	21292
7	31310	21290	31342	21286	31316	21296	31332	21292
8	31340	21292	31358	21280	31324	21294	31328	21294
9	31322	21280	31358	21300	31318	21282	31338	21292
10	31322	21290	31336	21292	31322	21276	31322	21292
11	31332	21278	31344	21280	31318	21278	31322	21302
12	31306	21300	31320	21284	31352	21286	31332	21294
13	31322	21296	31348	21296	31328	21288	31332	21288
14	31358	21302	31338	21290	31338	21282	31346	21288
15	31314	21284	31306	21294	31322	21298	31354	21292
16	31310	21292	31360	21278	31358	21292	31320	21282
17	31316	21290	31352	21290	31314	21280	31354	21298
18	31358	21296	31324	21298	31360	21300	31322	21282
19	31338	21290	31328	21280	31342	21278	31346	21302
20	31348	21280	31346	21298	31316	21278	31348	21296
21	31312	21284	31314	21278	31350	21282	31336	21302
22	31314	21286	31344	21276	31320	21298	31344	21280
23	31320	21300	31338	21296	31330	21284	31356	21292
24	31348	21282	31330	21298	31306	21302	31308	21284
25	31354	21294	31324	21300	31328	21280	31320	21280
26	31334	21290	31348	21278	31310	21302	31328	21280
27	31324	21282	31316	21302	31344	21296	31326	21294
28	31350	21290	31332	21292	31360	21286	31348	21298
29	31334	21294			31356	21296	31340	21302
30	31350	21286			31306	21290		

Attachment B
(continued)

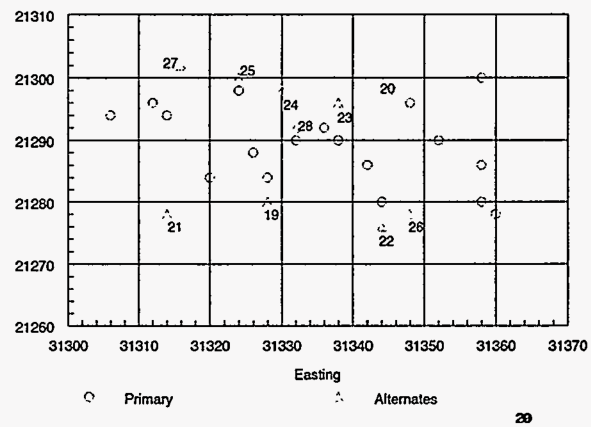
Pond 3540

Composite #1 Sampling Locations



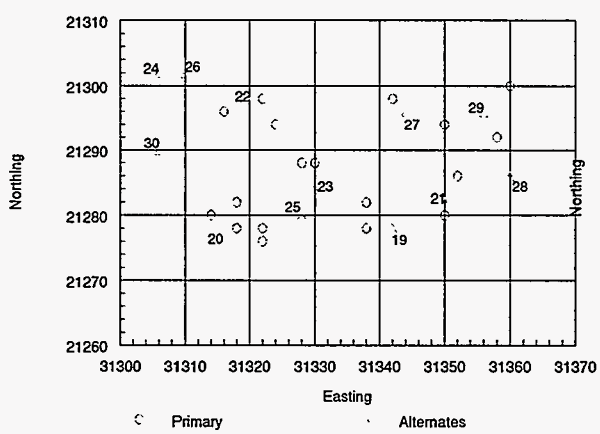
Pond 3540

Composite #2 Sampling Locations



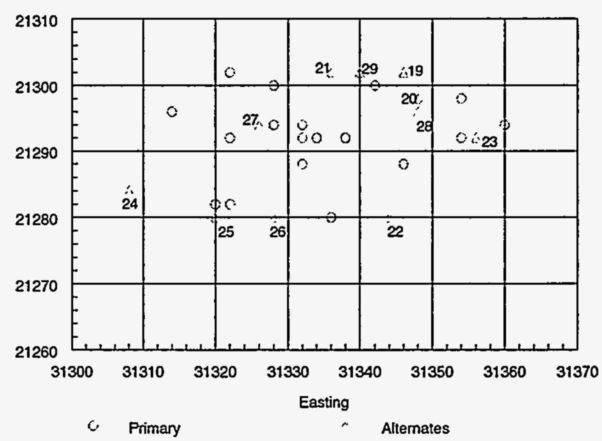
Pond 3540

Composite #3 Sampling Locations



Pond 3540

Composite #4 Sampling Locations



Attachment C.
Jacobs Engineering

Jacobs EM Team

CALCULATION PACKAGE COVER SHEET

Name of Assembler: G. John Hampshire

Date: October 15, 1997

Task/Task Designator: 35H83040, Surface Impoundments Operable Unit (SIOU)

Calculation Description: Calculation of the number of individual core samples to obtain in composite samples to be taken from Impoundments 3539 and 3540.

References:

C.W. Francis and Sealand, O.M. September 1987. *Concentrations of Radionuclides in ORNL Wastepond Sediments and Their Leaching Characteristics.* Oak Ridge National Laboratory, Oak Ridge, Tennessee. ORNL/RAP/LTR-87/70.

DOE. November 1995. *Remedial Investigation/Feasibility Study for Surface Impoundment Operable Unit, Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.* DOE/OR/02-1346&D2.

U.S. EPA. September 1986. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, Chapter 9: Sampling Plan. EPA/SW/846 (Rev. 0).

Assumptions:

See attached sheets.

Checked By	Date	Approved By	Date

Keywords:

SIOU ROD

JOR-ENG-1 Rev. 0 (11/94)

SIOU Sample Number Requirements for Impoundments 3539 and 3540

Past investigations have only yielded one sample result for PCBs from each of these two impoundments. Furthermore, the methodology used to obtain these samples was a field modification of the sampling plan employing a scooping device being dragged along the impoundment bottom until sufficient volumes were collected, as well as reporting dry-weight-basis concentrations. The representativeness of this sample methodology to the expected method of waste generation from these impoundments is suspect, and it is therefore desired to obtain additional sample results to re-characterize these sediments. The methodology to be employed will obtain random, multiple-plug composite samples for each impoundment, to include 0.1 feet of subsurface clay liner (consistent with the stated expectations of the signed SIOU ROD). The following calculations attempt to estimate the number of individual plugs desired for each composite sample.

1. Previous sample results.

Although the representativeness of the previous sample results is suspect, they still represent the only measurement of PCB concentrations to date. Therefore, the information from these samples will be used to gain a rudimentary estimate of potential waste concentrations.

Previous sample results

PCB Isomer	Impoundment 3539	Impoundment 3540
Aroclor-1254	150 mg/kg (dry-weight)	180 mg/kg (dry-weight)
Aroclor-1260	Not detected	120 mg/kg (dry-weight)

It is notable that the sample concentrations for Aroclor-1260 are significantly different between the two impoundments. It is generally assumed that the two impoundments, which have had very similar operating histories, should have very similar contaminant concentrations. Therefore, either the assumption that the impoundments are similar is incorrect, or the sample results for Aroclor-1260 are incorrect. In order to derive worst-case (i.e., maximum concentration) estimates, this calculation replaces the non-detect result with a value proportional to the ratio of Aroclor-1260 to Aroclor-1254 seen in Impoundment 3540.

$$Aroclor{-}1260\ (Impoundment\ 3539)\ =\ 120\ mg/kg\ (\frac{150\ mg/k}{180\ mg/k}$$

2. Conversion to wet-weight-basis concentrations.

Assuming the sediments are 20% solids and 80% water, and assuming the bulk density of the sediments is 1.2 g/cc (wet-weight-basis)(per Francis & Sealand 1987):

$$specific\ gravity\ of\ dry\ sediments\ =\ (1.2\ g/cc\ -\ (80\%\ x\ 1.0$$

Converting dry-weight concentrations to wet-weight (i.e., as found) concentrations, assuming the concentration of PCBs in the interstitial water = 0 mg/kg:

$$wet{-}weight\ mg/kg\ =\ \frac{(dry{-}weight\ mg/kg)(2.0\ g/cc)(20\%)\ +\ (}{1.2\ g/cc}$$

Previous sample results re-expressed as wet-weight concentrations

PCB Isomer	Impoundment 3539	Impoundment 3540
Aroclor-1254	50 mg/kg (wet-weight)	60 mg/kg (wet-weight)
Aroclor-1260	33 mg/kg (wet-weight)	40 mg/kg (wet-weight)

3. Estimation of the data variability.

Since only one sample exists for each impoundment, there is no direct basis for estimating the variability of the concentrations in these impoundments. Therefore, the variability must be based on assumptions, and the effect of these assumptions needs to be examined in an uncertainty analysis. One overriding assumption for these impoundments is that, due to their relatively small size, the deposition of contaminants within each impoundment is somewhat uniform, such that normal statistics are applicable. It is also assumed that total PCB concentrations equal the sum of the individual detected isomer concentrations. It is uncertain what effect the additional clay material will have on the final sample concentration. It is possible that the clay has accumulated and concentrated PCBs, and will have higher concentrations than the overlying sediments. It is also possible that the clay will be devoid of PCB contaminants. For this calculation, it is assumed that the clay concentration equals that of the overlying sediment.

$$Total\ PCBs = (Aroclor{-}1254\ (mg/kg) + Aroclor{-}1260\ (mg/l$$

a. Assuming the standard deviation equals 1/4th of the mean:

PCB Isomer	Impoundment 3539	Impoundment 3540
Aroclor-1254	50 +/- 12.5 mg/kg	60 +/- 15 mg/kg
Aroclor-1260	33 +/- 8.25 mg/kg	40 +/- 10 mg/kg
Total PCBs	83 +/- 15 mg/kg	100 +/- 18 mg/kg

b. Assuming the standard deviation equals half of the mean:

PCB Isomer	Impoundment 3539	Impoundment 3540
Aroclor-1254	50 +/- 25 mg/kg	60 +/- 30 mg/kg
Aroclor-1260	33 +/- 16.5 mg/kg	40 +/- 20 mg/kg
Total PCBs	83 +/- 30 mg/kg	100 +/- 36 mg/kg

c. Assuming the standard deviation equals the mean:

PCB Isomer	Impoundment 3539	Impoundment 3540
Aroclor-1254	50 +/- 50 mg/kg	60 +/- 60 mg/kg
Aroclor-1260	33 +/- 33 mg/kg	40 +/- 40 mg/kg
Total PCBs	83 +/- 60 mg/kg	100 +/- 72 mg/kg

4. Calculation of the numbers of cores to combine into a composite sample.

The numbers of individual core samples that make up a composite sample are theoretically linked to the confidence that the composite sample result equals the population mean. In other words, the more cores taken randomly across the impoundment, the closer the result should be to the actual mean. In order to express this relationship, the number of cores to theoretically obtain various relative fractional differences between the UCL_{95} and the mean is used.

$$UCL_{95} = \bar{x} + t_{(0.05,\ n-1,\ one\text{-}tailed)} \frac{\sigma}{\sqrt{n}}$$

$$\frac{((1 + relative\ fractional\ difference)\bar{x} - \bar{x})}{\sigma} = \frac{t_{(0.05, n-1, one\text{-}tailed)}}{\sqrt{n}}$$

$$\frac{(relative\ fractional\ difference)\bar{x}}{\sigma} = \frac{t_{0.05,n-1,one-tailed)}}{\sqrt{n}}$$

The following attached sheet details the evaluation of the required number of cores to give a 95% confidence that the UCL_{95} of each data set is within a given relative fractional difference of its mean. These results can also be interpreted as a concentration range over which multiple composite samples would fall if they were drawn from a population represented by these averages and standard deviations. Such an interpretation would take the form of an expectation for 90% of the composite results to fall within a range of plus or minus the relative fractional difference expected for a given number of cores.

5. Selection of the number of cores to obtain for each composite sample.

The number of cores obtained for each sample must balance practical considerations such as time to obtain samples and limitations on the amounts of material that can be effectively composited, with technical considerations, such as the expected representativeness of the composite sample to the actual population mean. The uncertainties associated with the estimates of the population variability also need to be considered.

A review of the results of these analyses indicates 18 cores per composite sample would be desirable. This number of samples would yield less than a 10% (approximately 7%) relative fractional difference between the composite result and its expected UCL_{95} if the population standard deviation was 1/4th of the population mean, a 15% relative fractional difference for a population where the standard deviation is half the population mean, and a 30% relative fractional difference for a population where the standard deviation is equal to the population mean. Fewer cores than this may result in unacceptable relative fractional differences if the population in fact has a large standard deviation, while significantly more cores than this may be difficult to justify from a cost-benefit and practicality perspective. The maximum suggested number of cores is 38 for similar reasons.

6. Numbers of composite samples and final data usage.

The following basic equation in EPA's SW-846 guidance was used to determine the maximum concentrations that would be considered as less than the regulatory limit of 50 ppm total PCBs for various hypothesized relative fractional differences and numbers of sample taken.

$$number\ of\ samples = \frac{t^2_{(0.20,n-1,two-tailed)}s^2}{(regulatory\ threshold\ -\ population\ m\iota}$$

Also attached is an analysis of the effect of various numbers of composite samples that could be obtained from each impoundment on the mean concentration of those composite samples that could be construed as meeting the release limit (assuming that no individual sample exceeded the release limit). As can be seen, a total of four composite samples yields an acceptable degree of conservatism (i.e., an average concentration that is reasonably close to 50 ppm) for the least number of samples. It also gives a degree of assurance that acceptable release limits could be derived should one of the composite samples be rejected for failing to meet quality assurance/quality control requirements. Beyond four samples, the next significant gain that would be achieved would not be realized until 10 samples were taken which, given the small size of these impoundments, is deemed to be impractical. In total, four composite samples with 18 individual cores per sample would yield 72 individual cores per impoundment, a significant coverage for these 60-foot by 90-foot structures.

Furthermore, since uncertainties are introduced by the potential for improper compositing, it is suggested that field duplicate samples be obtained for each of the composites. If the relative fractional difference between the composites exceeds 20%, it is suggested that the data from that particular composite sample be considered suspect (i.e., potentially unreliable). Otherwise, the average of the two results should be used as the best estimate of the actual concentration in each composite sample set.

Once validated results are obtained, it is suggested that the average results of each composite sample be compared to the regulatory threshold of 50 ppm total PCBs. If any one of these results exceeds 50 ppm total PCBs, the impoundment would be concluded to contain TSCA-regulated material. If all results meet this threshold criterion, a secondary criterion for the UCL_{90} of the results to be less than 50 ppm (consistent with guidance in EPA SW-846) would have to be met before the impoundments would be considered as not regulated under TSCA.

SIOU - Number of Cores

Assuming the standard deviation = 1/4 the mean:					
Impoundment 3539			*Impoundment 3540*		
average	83		average	100	
std dev	15		std dev	18	
relative difference	criterion	number of samples	relative difference	criterion	number of samples
30%	1.66	4	30%	1.6666667	4
25%	1.383333	4	25%	1.3888889	4
20%	1.106667	5	20%	1.1111111	5
15%	0.83	6	15%	0.8333333	6
10%	0.553333	11	10%	0.5555556	11
5%	0.276667	38	5%	0.2777778	37
Assuming the standard deviation = 1/2 the mean:					
Impoundment 3539			Impoundment 3540		
average	83		average	100	
std dev	30		std dev	36	
relative difference	criterion	number of samples	relative difference	criterion	number of samples
30%	0.83	6	30%	0.8333333	6
25%	0.691667	8	25%	0.6944444	8
20%	0.553333	11	20%	0.5555556	11
15%	0.415	18	15%	0.4166667	18
10%	0.276667	38	10%	0.2777778	37
5%	0.138333	144	5%	0.1388889	143
Assuming the standard deviation = the mean:					
Impoundment 3539			Impoundment 3540		
average	83		average	100	
std dev	60		std dev	72	
relative difference	criterion	number of samples	relative difference	criterion	number of samples
30%	0.415	18	30%	0.4166667	18
25%	0.345833	25	25%	0.3472222	25
20%	0.276667	38	20%	0.2777778	37
15%	0.2075	65	15%	0.2083333	65
10%	0.138333	144	10%	0.1388889	143
5%	0.069167	568	5%	0.0694444	563

$t_{0.05,\ n-1,\ one\text{-}tailed}/\text{sqrt}(n)$							
		51	0.234674	101	0.1652	151	0.134688
2	4.464494	52	0.23232	102	0.164372	~	
3	1.685855	53	0.230036	103	0.163558	560	0.069623
4	1.176682	54	0.227818	104	0.162755	561	0.069561
5	0.953391	55	0.225664	105	0.161964	562	0.069499
6	0.82264	56	0.223569	106	0.161184	563	0.069437
7	0.734453	57	0.221531	107	0.160416	564	0.069375
8	0.669834	58	0.219548	108	0.159658	565	0.069313
9	0.619849	59	0.217618	109	0.158912	566	0.069252
10	0.579681	60	0.215737	110	0.158175	567	0.069191
11	0.546478	61	0.213905	111	0.157448	568	0.069129
12	0.518427	62	0.212118	112	0.156732	569	0.069068
13	0.494317	63	0.210376	113	0.156025	570	0.069008
14	0.473301	64	0.208675	114	0.155328		
15	0.454768	65	0.207016	115	0.15464		
16	0.438263	66	0.205395	116	0.153961		
17	0.423439	67	0.203812	117	0.153291		
18	0.410029	68	0.202264	118	0.15263		
19	0.397821	69	0.200752	119	0.151977		
20	0.386646	70	0.199273	120	0.151332		
21	0.376364	71	0.197826	121	0.150695		
22	0.366864	72	0.196411	122	0.150067		
23	0.358049	73	0.195025	123	0.149446		
24	0.349842	74	0.193668	124	0.148833		
25	0.342176	75	0.192339	125	0.148228		
26	0.334994	76	0.191037	126	0.147629		
27	0.328246	77	0.189762	127	0.147038		
28	0.321891	78	0.188511	128	0.146454		
29	0.315892	79	0.187285	129	0.145877		
30	0.310217	80	0.186082	130	0.145307		
31	0.304837	81	0.184903	131	0.144743		
32	0.299728	82	0.183745	132	0.144186		
33	0.294868	83	0.182609	133	0.143635		
34	0.290237	84	0.181494	134	0.14309		
35	0.285818	85	0.180399	135	0.142552		
36	0.281595	86	0.179324	136	0.14202		
37	0.277554	87	0.178267	137	0.141493		
38	0.273683	88	0.177229	138	0.140973		
39	0.269969	89	0.176209	139	0.140458		
40	0.266402	90	0.175207	140	0.139948		
41	0.262974	91	0.174221	141	0.139444		
42	0.259674	92	0.173252	142	0.138946		
43	0.256495	93	0.172298	143	0.138453		
44	0.253431	94	0.171361	144	0.137965		
45	0.250474	95	0.170438	145	0.137482		
46	0.247618	96	0.16953	146	0.137004		
47	0.244858	97	0.168637	147	0.136532		
48	0.242188	98	0.167758	148	0.136064		
49	0.239603	99	0.166892	149	0.1356		
50	0.2371	100	0.166039	150	0.135142		

SIOU - Number of Composites

Numbers of composite samples			assuming s= 0.3(mean)/1.645		assuming s= 0.15(mean)/1.645		assuming s= 0.07(mean)/1.645	
n	n/t(.2,n-1)^2		mean concentration	s^2/delta^2, delta=50-x	mean concentration	s^2/delta^2, delta=50-x	mean concentration	s^2/delta^2, delta=50-x
2	0.211145		35	0.18110978	35	0.04527744	35	0.00986042
3	0.843749		36	0.21995673	36	0.05498918	36	0.01197542
4	**1.491308**		37	0.26946668	37	0.06736667	37	0.01467096
5	2.127008		38	0.33357464	38	0.08339366	38	0.01816129
6	2.754523		39	0.41815007	39	0.10453752	39	0.02276595
7	3.37692		40	0.53224098	40	0.13306024	40	0.02897756
8	3.995986		41	0.69035269	41	0.17258817	41	0.03758587
9	4.612797		42	0.91686825	42	0.22921706	42	0.04991838
10	5.228024		**43**	**1.2552469**	43	0.31381173	43	0.06834122
11	5.842085		44	1.78892107	44	0.44723027	44	0.09739681
12	6.455284		45	2.69446996	45	0.67361749	45	0.14669892
13	7.067801		46	4.39930434	**46**	**1.09982609**	46	0.23951768
14	7.679797		47	8.16472446	47	2.04118112	47	0.44452389
15	8.291374		48	19.1606752	48	4.79016881	**48**	**1.04319232**
16	8.902624		49	79.8694119	49	19.967353	49	4.34844576
17	9.513579							
18	10.1243							

SIOU - Number of Composites

Numbers of composite samples			assuming s= 0.3(mean)/1.645		assuming s= 0.15(mean)/1.645		assuming s= 0.07(mean)/1.645	
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APPENDIX B

HEALTH AND SAFETY ADDENDUM

Sediment Sampling, Impoundments SIOU 3539 and 3540

HEALTH and SAFETY ADDENDUM

Date: November 12, 1997
Project: Sediment Sampling, Impoundments SIOU 3539 and 3540
Initiator of Form: D.E. Rice / D.A. Rose **Phone :** 576-8565 / 574-5837

Task or Hazard: ORNL/ MAD personnel will collect and sample sediment materials from each of the impoundments. The samples will be analyzed for selected chemical and radiological constituents. ORNL / MAD personnel will perform these activities under the guidelines and requirements of the original Health & Safety Plan (No. 001-226/0010 0396, completed and signed March 1996). The new task of sampling these impoundments will be performed using the guidelines and requirements of this addendum.The new task will require the use of a boat and other work over water will still be required. These hazards are covered under the original plan. No additional hazards other than those covered under the original H&S plan are anticipated. Appropriate sampling tools will be devised and fabricated for the task. Samples will be contained, packaged, and analyzed following the guidelines of the project Sampling and Analysis Plan(SAP). Perimeter support services will be provided by P&E and Health Physics personnel. A new "Roles and Responsibilities" list will be prepared due to changes in support personnel. The new list can be found in the project SAP, and will be available to on-site workers at all times.

Project / Facility Managers Information

Name: R.A. Dean	Phone / Pager Contact: 574-7951 / 873-4911
Name: Hollis Wooten	Phone / Pager Contact: 241-4872 / 873-5038
Name: R.H. Coe III	Phone / Pager Contact: 241-5026 / 873-4937

Additional Hazards:

Physical Hazards

(x) Cold Stress ( ) Compressed Gas/Cylinders ( ) Confined Space ( ) Enclosed Space
(x) Ergonomics ( ) Explosive/Flammable (x) Heat Stress ( ) High Pressure
( ) Manual Lift ( ) Noise ( ) Oxygen Deficient ( ) Oxygen Enriched
(x) Tripping/ Falling (x) Work On/Over Water (See administrative controls)

Safety and Construction Hazards

( ) Demolition
( ) Drum Handling
(x) Electrical (See additional comments)
(x) Elevated Work (See additional comments)
( ) Energized Sources (Lockout/ Tagout)
( ) Excavation/ Penetration
(x) Hoisting/ Rigging (See additional comments)
( ) Overhead Hazards
( ) Trenching/ Shoring
( ) Underground Hazards
( ) Welding/ Burning/ Cutting

Additional Hazards: (cont.)

Chemical Hazards

( ) Asbestos **(x)** Carcinogen ( ) Corrosive ( ) Inorganics
( ) Lead ( ) Manmade Mineral Fibers **(x)** Mercury **(x)** Metals
( ) Mutagen ( ) OSHA Specific **(x)** PCBs ( ) Reproductive Toxicant
( ) Volatile Organic ( ) Other_______________

Ionizing Radiological Hazards

(x) External Exposure
( ) Internal Exposure
(x) Contamination Hazard (Type: **Beta-Gamma**)
Note Possible Routes: ( ) Ingestion, ( ) Inhalation, ( ) Absorption

Non-Ionizing Radiological Hazards

( ) High Voltage ( ) Laser ( ) Microwave
( ) RF ( ) UV

Biological / Vector Hazards

( ) Bacterial ( ) Medical Wastes ( ) Parasites **(x)** Plants (Allergens) **(x)** Wildlife (snakes, ticks, insects)

Controls:

Engineering Controls:

- Support personnel involved with engineering aspects of the tasks will be responsible for controls.
- A boat and walkboards with handrail support will be utilized during sample collections.
- Hoisting and rigging of the walkboards and the boat will be performed by the ORNL P&E rigging crews.
- Tools will be designed and utilized to reduce radiological exposures to sampling personnel.
- Ropes should be placed across walkbeam access to prevent unauthorized entries and provide fall protection.
- Aluminum walkboards will be utilized if available and practical.

Administrative Controls:

- RCT will be responsible for controls such as RWP requirements, etc.
- ORNL / MAD will be responsible for daily activity controls such as access, sample collection activities, etc.
- Facility representative will be responsible for obtaining the appropriate work permits as required.
- Quality control measures will be addressed in the Sampling and Analysis Plan and will be the responsibility of the MAD sampling team.
- D.E. Rice will replace P. Abston as SSHO (original plan); D.A. Rose will be designated as the alternate
- All personnel will review and sign off on original H&S plan. The signature list will be maintained in the project logbook.
- Pre-task and daily H&S briefings will be performed by the SSHO or the SSHO alternate.
- For the work performed on water, the handrails and walkboards will be utilized as fall protection. Spotters will be on-site at all times during work on the water. A safety line will be available from the walkboard and zone boundaries.

Permits Required

(x) Radiation Work Permit ( ) Lockout / Tagout ( ) PACSE ( ) Excavation/ Penetration
( ) Hoisting/ Rigging

Are Changes Required in Existing Permits ? ( ) Yes (x) No
Are Design / Specification Needed ? ( ) Yes (x) No
Other (Specify): A new RWP will be issued prior to the start of work.

Personal Protective Equipment: (Suggestions for minimum site access only, work to be performed under RWP PPE requirements)

Level of Protection

( ) Level "A" ( ) Level "B" (x) Level "C"
(x) Level "D" ( ) Modified

Respiratory Protection

( ) SCBA ( ) Full-face ( ) Half-face
( ) PAPR ( ) Supplied Air ( ) Other__________
Cartridge Type:______________________________

Protective Clothing

(x) Apron (Rubber if applicable) ( ) Impermeable Suit
( ) Saranex (x) Tyvek ( ) Encapsulating Suit
( ) Splash Suit ( ) Welded Saranex ( ) Lab Coat
(x) Company Clothing (Khakis) ( ) Other__________ ( ) Other__________

Head/Eye/Ear

( ) Ear Plugs ( ) Ear Muffs ( ) Splash Shield ( ) Monogoggles
(x) Safety Glasses ( ) Welding Goggles ( ) Face Shield ( ) Goggles

( ) Hard Hat ( ) Laser Eyewear

Gloves

(x) Cotton (Inner) ( ) PVC ( ) Leather
( ) Latex (Inner) ( ) Welding Gloves (x) Nitrile
( ) Neoprene ( ) Insulating ( ) Vinyl
( ) Rubber (Outer) ( ) Other__________

Footwear

( ) Chemical Overboots ( ) Shoe Covers (x) Other: Black rubber
(x) Steel-toed Leather ( ) Steel-toed Rubber ( ) Other__________

Health & Safety Monitoring Requirements: No routine monitoring is anticipated during the sampling activities due to open air conditions. Initially, OVM measurements will be performed on samples as a precaution.

Additional Comments / Changes

1. Chemical hazards listed were found in small quantities in the sediments of the impoundments, and should pose no risk to the workers.

2. Heat and cold stress concerns will be addressed and emphasized at all times. All workers may use their option of stop work authority when dealing with heat and cold stress issues. Shaded rest areas and iced drinking fluids will be available at when heat stress is likely. A warm shelter will be available when necessary during cold weather.

3. In case of injuries or an emergency, workers should contact appropriate organizations such as the LSS office, etc. The emergency contacts list is available in the original Health & Safety Plan and will be readily accessible at the work site. Evacuation procedures for general plant announcements will be followed.

4. When electrical equipment (pumps, lighting, etc.) is utilized at the site, GFCI outlets will be made available and used by workers.

Additional Comments / Changes: (cont.)

5. Hoisting and rigging plan is not required due to general lift activities. No critical lifts are anticipated. If a need arises, a lift plan will be developed and implemented.

6. If elevated work is required, the task will be performed under standard OSHA quidelines and regulations. This may involve the use of harness equipment and additional fall protection. The elevated work, if required, will be evaluated and discussed prior to beginning task, and any necessary controls will be implemented.

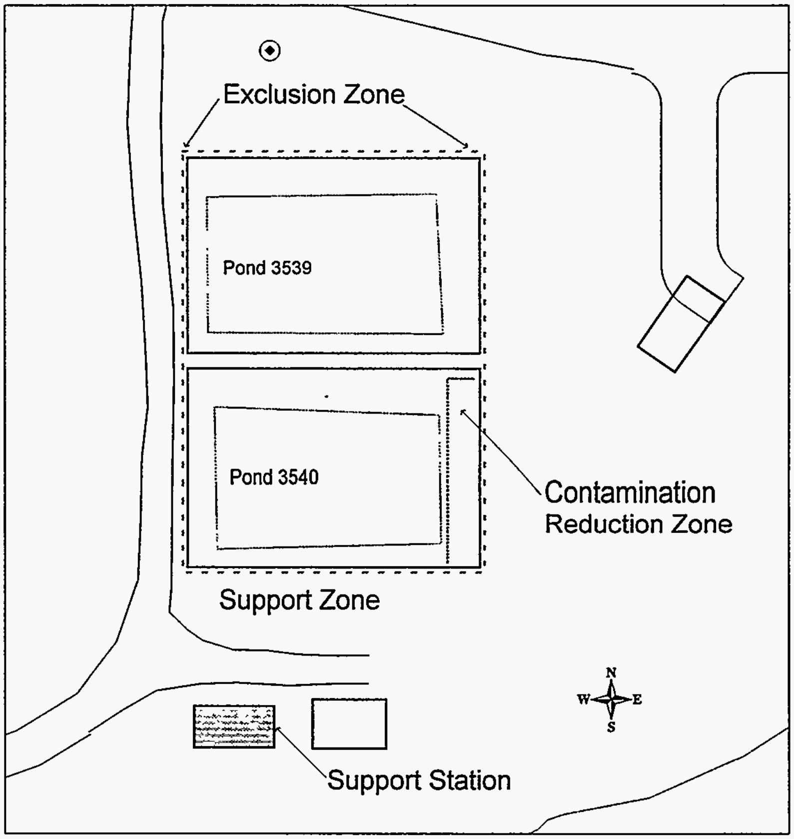
7. A site map is attached showing the approximate locations of zones for contamination control.

Approvals

(Original signed and located in project files)

Project Manager	Date	
Health & Safety Officer	Date	
Health Physics (If Applicable)	Date	
SHEST (If Applicable)	Date	
ORNL ER Program ES&H Manager	Date	
Other (Specify)	Date	
Other (Specify)	Date	

Site Layout
Ponds 3539 and 3540
Sampling Project



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